



National Aeronautics and
Space Administration

GSDO-PLN-1002

REVISION N

RELEASE DATE: 04/29/2025

EXPLORATION GROUND SYSTEMS PROGRAM SYSTEMS ENGINEERING MANAGEMENT PLAN

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Reference EDR # 16977: NASA KSC Export Control Office, 321-867-9209

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REVISION AND HISTORY PAGE

Status	Revision No.	Change No.	Description	Release Date
Baseline			Baseline (Approved at PRB, per GSDO-D0017, dated 05/19/12) Prepared By: Yves Lamothe Lead Systems Engineer GSDO Program Integration Technical Management Office	06/28/2012
Revision	A		Revision A (Approved at PRB, per GSDO-D0046, dated 12/18/12) Prepared By: Yves Lamothe Lead Systems Engineer GSDO Program Integration Technical Management Office	01/28/2013
Revision	B		Revision B (Approved at PRB, per GSDO-D0071, dated 06/04/13) Prepared By: Yves Lamothe Lead Systems Engineer GSDO Program Integration Technical Management Office	06/18/2013
Revision	C		Revision C (Approved at PRB, per GSDO-D0196, dated 03/20/14) Prepared By: Paul Mogan Program Integration GSDO Program	06/04/2014
Revision	D		Revision D (Approved at PRB, per GSDO-D0233, dated 12/16/14) Prepared By: Paul Mogan Program Integration GSDO Program	01/06/2015
Revision	E		Revision E (Approved at PRB, per GSDO-D0317, dated 08/18/15) Prepared By: Paul Mogan Program Integration GSDO Program	08/26/2015

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Status	Revision No.	Change No.	Description	Release Date
Revision	F		Revision F (Approved at PRB, per GSDO-D0462, dated 08/30/16) Prepared By: Paul Mogan Program Integration GSDO Program Change Summary: Incorporation of items from errata sheet including parts tracking and traceability for heritage equipment; Unexplained Anomalies, clarification on Test Readiness Reviews and updates due to changes in GSDO-PLN-1155. Addition of EM-2 information. New sections related to operation plans. Figure updates. Added supplemental guidance on mods to systems after SAR/DCR. Addressed or closed CDR RIDS.	09/28/2016
Revision	G		Revision G (Approved at PRB, per GSDO-D0734, dated 08/01/2017) Prepared By: Kevin Ingoldsby Program Integration GSDO Program Change Summary: Incorporation of items from errata sheet. Addition of EM-2 information. Clarification of Program Deviation/Waiver process. Closes directive action ESD-MD-12026-04, GSDO-D0451 1-6, and GSDO-D0713 2-2.	08/10/2017
Revision	H		Revision H (Approved at PRB, per GSDO-D0859, dated TBD) Prepared By: Kevin Ingoldsby Program Integration GSDO Program Change Summary: Close PRB Action [CDR-AI-054], closes <FWD-001>, update of section 5.4.1, Added new Appendix to provide GSDO M&S assessment criteria, assessment form and results of GSDO subsystem M&S assessment, Replace references to Flight Integration Engineer (FIE) with Operations Project Engineer (OPE).	11/16/2017

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Status	Revision No.	Change No.	Description	Release Date
Revision	J		Revision J (Approved at PRB, per GSDO-D0917, dated 09/29/2020) Prepared By: Kevin Ingoldsby Program Integration EGS Program Change Summary: Close <FWD-002>; implement program name change; incorporate Errata, revise content to reflect transition to operations and sustainment phase; update SEMP compliance matrix to comply with NPR 7123.1 Rev C; Implement IDM 040 (partial) & 052; incorporate directive actions D1185 1-1, D0992 1-2, D1179 2-2, C3-D0132 1-5, D0836 2-2, D1039, D0410 1-2, ESD-S2D-0013-X.	10/5/2020
Revision	K		Revision K (Approved at PRB, per GSDO-D1621, dated 05/18/2021) Prepared By: Kevin Ingoldsby Program Integration EGS Program Change Summary: Incorporate Errata, Implement GSDO-IDM-097; Update Technology Infusion section.	05/20/2021
Revision	L		Revision L (Approved at PRB, per GSDO-D1784, dated 10/19/2021) Prepared By: Kevin Ingoldsby Program Integration EGS Program Change Summary: Child/Reference Document updates/cleanup; Implement GSDO-IDM-123; Implement GSDO-D1520 1-4; Acronym Updates; Air Force to Space Force unit name updates.	11/9/2021
Revision	M		Revision M (Approved at PRB, per GSDO-D1915, dated 04/04/2023) Prepared By: Kevin Ingoldsby Program Integration EGS Program Change Summary: LIMITED SCOPE, addition to program Guidance for Subsystem SARs and DCRs in Section 4.5.1.	04/10/2023

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Status	Revision No.	Change No.	Description	Release Date
Revision	N	GSDO-C2286	Revision N (Approved at PRB, per GSDO-D2286, dated 04/15/2025) Prepared By: Kevin Ingoldsby Program Integration EGS Program Change Summary: Update for compliance with NPR 7123.1D; COMET contract updates; Incorporate Lessons Learned from Artemis I Post Flight Assessment Reviews; Operations & Sustainment phase updates; Removal of Artemis I-specific content; Realignment with new Moon to Mars enterprise structure	04/30/2025

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1.0 INTRODUCTION

This document is the Systems Engineering Management Plan (SEMP) for the National Aeronautics and Space Administration (NASA) Exploration Systems Development Mission Directorate (ESDMD) Exploration Ground Systems (EGS) Program. The EGS SEMP describes how EGS will perform the Systems Engineering function across the Program. This SEMP is compliant with NPR 7123.1D, NASA Systems Engineering Processes and Requirements.

1.1 PURPOSE

This SEMP establishes the technical management approach for the EGS Program. The EGS Program has transitioned from Initial Operational Capability (IOC) development into the steady-state operations and sustainment phase. This revision of the SEMP removes IOC-specific content no longer required for the operations and sustainment phase of the program life cycle.

This SEMP provides the communications bridge between the Program management team and the technical team. The SEMP defines a roadmap of the key processes, offices, working groups, tools and the foundational plans/documents. It also provides the framework for integrating the appropriate work products that define the Program technical processes and that supply management with the necessary information for making effective decisions.

1.2 SCOPE

This document is intended to apply to all technical management and integration activities related to EGS Program funded activities. This SEMP encompasses the complete integrated technical effort for the EGS Program, including all work performed by Kennedy Space Center (KSC), other NASA Centers, and any other organizations involved in development, delivery, and sustainment of EGS components and products required to meet all entrance and success criteria for each technical milestone review per NPR 7120.5E NASA Space Flight Program and Project Management Requirements and NPR 7123.1D.

This document is written so as to avoid duplication of information available in other EGS documents. Information in this document will supplement and elaborate (where necessary) on the information contained in the EGS Program Plan but will not re-state information available in that plan or any other EGS documents except high-level general information to provide context for subjects covered in this document.

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Note: The term “requirements” is used extensively throughout EGS program documentation. There are different categories of requirements with their own associated processes and governance, the most prevalent use of “requirement” in this Systems Engineering Management Plan is in reference to Program Design Requirements which define the program architectural, system and subsystem developmental needs. Other major categories of requirements defined in this plan include Program Interface Requirements with flight and payload elements, system Operations and Maintenance (O&M) requirements, program support requirements (Section 5.4.2), and safety requirements (embodied in applicable NASA/government standards). When reading the term “requirements” in any program document, pay careful attention to the scope, context and description of the section to avoid confusion.

1.3 CHANGE AUTHORITY/RESPONSIBILITY

An EGS Program Change Request (CR) shall be submitted to the EGS Program Review Board (PRB) for consideration and disposition for proposed changes to this document. All such requests will adhere to the change management process described in GSDO-PLN-1001, Exploration Ground Systems Program Information and Configuration Management Plan. The appropriate NASA Office of Primary Responsibility (OPR) identified for this document is the EGS Systems Engineering and Integration (SE&I) Division.

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

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

NASA-STD-7009	Standard for Models and Simulations
NPR 7120.5	NASA Space Flight Program and Project Management Requirements
NPR 7123.1	NASA Systems Engineering Processes and Requirements
NPR 7150.2 ¹	NASA Software Engineering Requirements
NPR 8705.2	Human-Rating Requirements for Space Systems
NPR 8820.2	Facility Project Requirements (FPR)

¹ EGS Program compliance is with NPR 7150.2 Revision B which was in effect through program CDR

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NPD 8730.2	NASA Parts Policy
M2M-30003	Moon to Mars (M2M) Systems Engineering Management Plan
M2M-30003-ANX01	Moon to Mars (M2M) Systems Engineering Management Plan (SEMP), Annex 01: Exploration Ground Systems (EGS) Program Integration Lead Cross-Program Product List
ESD 10009	ESD Human Rating Certification Package
M2M-30007	Artemis Integrated Concept of Operations
M2M-30012	Moon to Mars (M2M) Verification and Validation Plan
M2M-30016	Moon to Mars (M2M) Human Systems Integration Plan (HSIP)
KDP-KSC-P-2393	KSC Lessons Learned System
KDP-P-2713	Technical Review Process
KDP-P-2713A ²	Technical Review Process for Architect and Engineering (A&E) Design and Development
KDP-P-5035	System Acceptance Process
KDP-KSC-P-5005	Process for Approval of Uncertified Ground Support Equipment (GSE)
KTI-1036	KSC Safety Mission Assurance Exploration Ground Systems Division Certification of Flight Readiness Implementation Plan
KSC-DE-512-SM	Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements
KSC-IT-13550	Communications Development Project (CDP) Systems Engineering Management Plan (SEMP)
KSC-PLN-5406	Design and Development Electrical, Electronic, Electromechanical (EEE) Parts Plan
KSC-PLN-6445	Support Requirement System and Automated Support Requirements System Management Plan

² Specific revision of KDP-P-2713 created for and specified in ML2 contract

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GSDO-6005	Exploration Ground Systems (EGS) Program Product Tree Drawing
GSDO-6004	EGS Program Product Breakdown Structure for Block 1 Crewed Missions
GSDO-6007	Exploration Ground Systems Program Product Breakdown Structure for Block 1B
GSDO-ACO-1010	Exploration Ground Systems Program Architectures and Concept of Operations Document
GSDO-FM-1035	Program Assessment Request Form
GSDO-FM-1122	Exploration Ground Systems Program Request for Deviation/Waiver
GSDO-FM-1297	Exploration Ground Systems Program Heritage Hardware Assessment Data Sheet
GSDO-P-1060	Exploration Ground Systems Program Technical Baseline Management Procedure
GSDO-P-1061	Exploration Ground Systems Program Assessment Procedure
GSDO-P-1097	Exploration Ground Systems Program Interdependency Hardware, Software, and Data Exchange Procedure
GSDO-CHTR-1003	Exploration Ground Systems Program Control Board and Launch and Recovery Control Board Charter
GSDO-CHTR-1017	Exploration Ground Systems Program Review Board and Launch and Recovery Integration Control Board Charter
GSDO-CHTR-1019	Explorations Ground Systems Program Command, Control, and Communications Forum Charter
GSDO-CHTR-1175	Exploration Ground Systems Program Operations Processing Project Review Forum
GSDO-CHTR-1176	Exploration Ground Systems Program Ground Systems and Implementation Forum Charter
GSDO-CHTR-1296	Exploration Ground Systems Program Software Configuration Control Board Charter

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GSDO-CHTR-1303	Exploration Ground Systems Program Ground Configuration Control Board Charter
GSDO-ICD-1246	Exploration Ground Systems Program Command, Control, and Communications Kennedy Ground Control Subsystem Interface Control Document and Interface Requirement Document
GSDO-MVVP-1042-01	Exploration Ground Systems Program Master Verification and Validation Plan Volume 1: Program Verification and Validation Policies and Guidelines
GSDO-MVVP-1042-02	Exploration Ground Systems Program Master Verification and Validation Plan Volume 2: Program Verification and Validation Plan
GSDO-PLN-1001	Exploration Ground Systems Program Information and Configuration Management Plan
GSDO-PLN-1013	Exploration Ground Systems Risk Management Plan
GSDO-PLN-1024	Exploration Ground Systems Program Integrated Logistics Support Plan
GSDO-PLN-1027	Cross-Program Ground Hardware/Software Acceptance Data Package Plan
GSDO-PLN-1036	Exploration Ground Systems Program Safety and Mission Assurance Plan
GSDO-PLN-1043	Exploration Ground Systems Program Master Subsystems List
GSDO-PLN-1046	Exploration Ground Systems Program Software Management Plan
GSDO-PLN-1055	Cross-Program Ground Hardware Integration Plan
GSDO-PLN-1069	Cross-Program Heritage Ground Support Equipment Assessment and Certification Plan
GSDO-PLN-1070	Cross-Program Logistics Integration Plan
GSDO-PLN-1075	Cross-Program Ground Support Equipment Sustaining Engineering Plan

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GSDO-PLN-1076	Cross-Program Operations and Maintenance Requirements and Specifications Management Plan
GSDO-PLN-1079	Exploration Ground Systems Program Requirements Management Plan
GSDO-PLN-1087	Exploration Ground Systems Program Technical Performance Measures Management Plan
GSDO-PLN-1087-ANX-01	Exploration Ground Systems Program Technical Performance Measures Log
GSDO-PLN-1088	Kennedy Space Center and Exploration Ground Systems Program Certification of Flight Readiness Plan
GSDO-PLN-1094	Exploration Ground Systems Program Electromagnetic Environmental Effects Control Plan
GSDO-PLN-1130	Exploration Ground Systems Program Integrated Training Plan
GSDO-PLN-1142	Exploration Ground Systems Program Operations and Maintenance Controlled Requirements Management Plan
GSDO-PLN-1143	Cross-Program Flight Hardware and Software Acceptance Data Package Plan
GSDO-PLN-1153	Cross-Program Integrated Physical Configuration Audit Plan
GSDO-PLN-1174	Exploration Ground Systems Program Site Activation Management Plan
GSDO-PLN-1183	Exploration Ground Systems Program Ground Operations Management Plan
GSDO-PLN-1195	Cross-Program Processes and Agreements for Launch Site Ground Operations
GSDO-PLN-1229	Exploration Ground Systems Program Sustaining Engineering Plan
GSDO-PLN-1242	Exploration Ground Systems Program Payload Integration Plan
GSDO-PLN-1260	Cross-Program Flight Asset Turnover Plan

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GSDO-PLN-1261	Exploration Ground Systems Program Post-Flight Assessment Plan
GSDO-PLN-1276	Exploration Ground Systems Program Human Systems Integration Plan
GSDO-RPT-1096	Ground Systems Development and Operations Program Support Services Requirement Report
GSDO-TEMPL-031	Exploration Ground Systems Program Test Readiness Review Template
GSDO-WBS-1009	Exploration Ground Systems Program Work Breakdown Structure and Work Breakdown Structure Dictionary
GSDO-SPEC-1262	Exploration Ground Systems Program Engineering Model Delivery Standard
B-0001	Facility Management Board (FMB)
B-0026	Integrated Engineering Review Board (IERB)
B-0032	Design Certification Review Board (DCRB)
B-0050	KSC Information Technology (IT) Technical Review Board (TRB)
C3-3005	Exploration Ground Systems Program Command, Control, and Communications Project Team Implementation and Integration Plan

2.2 REFERENCE DOCUMENTS

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

HEOMD-003	Crewed Deep Space Systems Human Rating Certification Requirements and Standards for NASA Missions
NASA-STD-8719.29	NASA Technical Requirements for Human Rating
NASA-STD-5005	Standard for the Design and Fabrication of Ground Support Equipment
B-0025	Spaceport Integration and Services Engineering Review Board,

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ENG-P-0019	BOSS Engineering Review Board (ERB)
KDP-KSC-P-1864	KSC Center Planning and Development (CPD) Partnership Development Process
KTI-2713C	Engineering Directorate (NE) Certification Review Team Technical Instructions
GSDO-PLN-1002-ANX-01 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-01: Mission Concept Review Plan
GSDO-PLN-1002-ANX-02 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-02: System Requirements Review/System Definition Review Plan
GSDO-PLN-1002-ANX-03 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-03: Integrated Product Team Preliminary Review Plan
GSDO-PLN-1002-ANX-04 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-04: Preliminary Design Review Plan
GSDO-PLN-1002-ANX-05 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-05: Critical Design Review Plan
GSDO-PLN-1002-ANX-06 (Retired)	Ground Systems Development and Operations Program Systems Engineering Management Plan Annex-06: System Integration Review Plan
GSDO-PLN-1002-ANX-07 (Retired)	Exploration Ground Systems Program Systems Engineering Management Plan Annex-07: System Acceptance Review / Operational Readiness Review Plan
GSDO-RPT-1086-01	EGS Program Vehicle Integration and Launch Heritage Hardware Assessments
GSDO-RPT-1086-02	EGS Program Offline Processing and Infrastructure Heritage Hardware Assessments.
SLS-SPEC-030-05	SLSP Support Equipment Spec Vol V Heritage GSE Certification Process Plan

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2.3 PARENT DOCUMENT

The following document is the higher level specification, standard, guideline, handbook, special publication or requirement document that contains the requirement driving the creation of this document.

GSDO-PLN-1000 Exploration Ground Systems Program Plan

3.0 TECHNICAL SUMMARY

3.1 PROGRAM DESCRIPTION

The EGS Program provides the ground systems, infrastructure, and services to perform pre-launch processing and launch of the Space Launch System (SLS), Orion spacecraft and associated mission payloads. EGS also performs recovery and post flight processing of the Orion. A detailed description of the EGS Program is located in GSDO-PLN-1000, Exploration Ground Systems Program Plan. As a member of the Moon to Mars (M2M) Program Office, EGS is responsible for Systems Engineering & Integration functions under the Launch and Recovery Phase, as defined in M2M-30001, M2M Implementation Plan. The M2M Integration will be further defined in Section 3.6.3.

3.2 PROGRAM STRUCTURE

The EGS Program is a single-project Program as defined in NPR 7120.5. When referring to the single Project under EGS, this document uses the term "Project" (capitalized). When referring to work assigned to the Element Integration Teams (EITs) or an independent Architecture and Engineering (A&E) firm, the term used is "projects" (lowercase). For example, the EGS Project Management (PM) Division manages projects, not the Program's single Project. These projects are defined and implemented to support the Project and EGS compliance with NPR 7120.5 , NASA Space Flight Program and Project Management Requirements. Implementing organizations deliver end products based on the definition and requirements of these projects. The EGS Program Organization, Teaming Structure, and external entities interface with the Program is illustrated in Figure 1.

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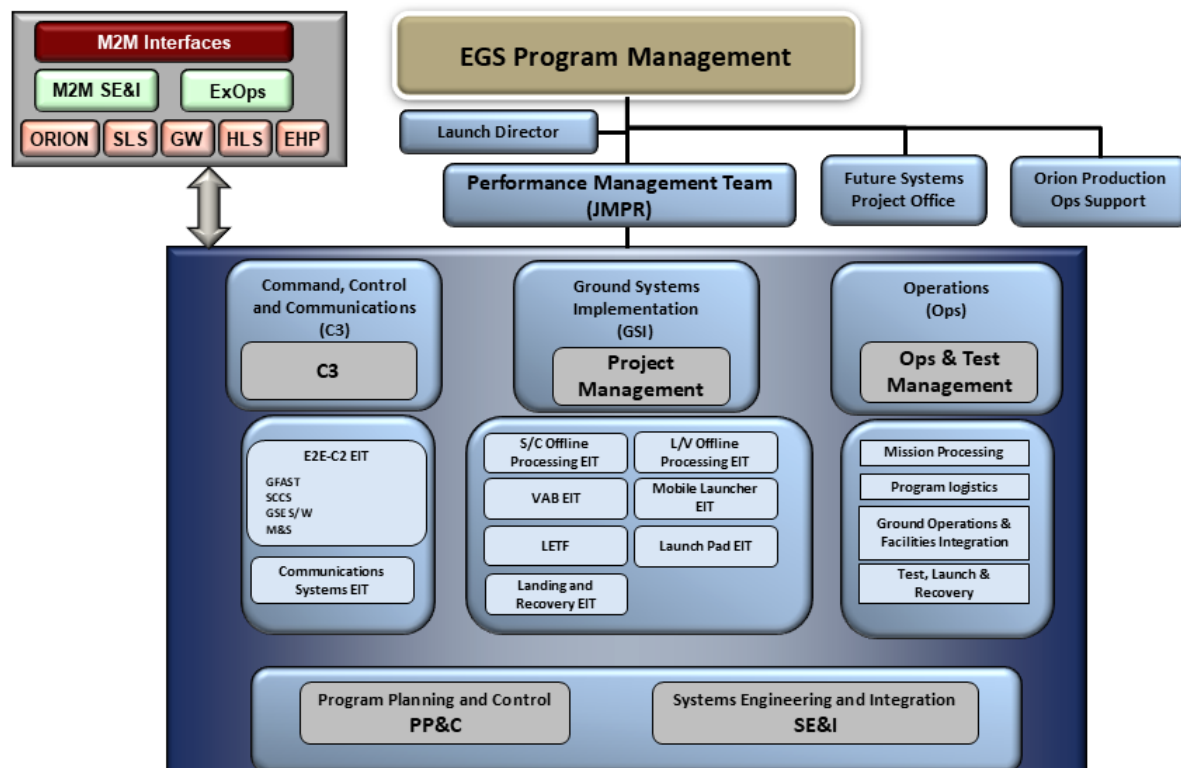


FIGURE 1 EXPLORATION GROUND SYSTEMS PROGRAM ORGANIZATION AND TEAM STRUCTURE INCLUDING CROSS-PROGRAM INTERFACES

3.3 EGS FUNCTIONAL ORGANIZATION STRUCTURE

The EGS organization has seven functional areas, or Divisions/offices. The group of Divisions and Offices within EGS are referred to as functional areas within this document, a specific Division (e.g., PM) will be referred to as a Division. Three of the functional areas lead implementation teams and have decisional forums. Two functional areas are cross-cutting and provide support and integration functions within the implementation teams, across the teams and with external organizations (the KSC institution, SLS, Orion, Gateway (GW), Human Landing System (HLS), Extravehicular Activity and Human Surface Mobility Program (EHP) and M2M). All seven functional areas provide support as needed to all of the EGS teams. The sixth functional area provides KSC-based support to Orion Production Operations in the Operations and Checkout Facility. The seventh functional area, Future Systems Project Office, is focused on supporting future Artemis campaign efforts and providing the strategic framework for how the unique skills developed in the EGS Program can be leveraged to make the enterprise more successful.

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The cross-cutting functional areas (shown across the bottom of Figure 1) are Program Planning and Control (PP&C) and SE&I. These cross-cutting functional areas have personnel matrixed into the implementation teams and provide cross-cutting products and integration functions to the teams. The PP&C functional area includes Risk Management (RM), scheduling, budget and cost management and Information and Configuration Management (ICM). The SE&I functional area is responsible for ground systems and vehicle integration, setting technical policy, requirements management, technical plans and processes, cross-element and cross-team integration as well as cross-program integration and program review planning and execution. These functions will be described in greater detail in the following sections.

3.4 EGS TEAMS

3.4.1 EGS Performance Management Team

The EGS Performance Management Team (PMT) leads the tactical execution of Ground Systems Implementation (GSI) and operations planning and execution activities. The PMT leadership is composed of senior EGS leaders from NASA and contractor organizations, including EGS division/office chiefs and representatives from Safety and Mission Assurance (S&MA), institutional design organizations and the Program Chief Engineer (PCE). The PMT utilizes the weekly COMET-led Joint Mission Processing Review (JMPR) forum to monitor and manage overall Program performance and implementation.

3.4.2 Implementation Teams

There are three implementation teams under EGS Program Management (indicated in the center of Figure 1). These teams are the Command, Control, and Communications (C3) team, the GSI team and the Operations (Ops) team. Each of these teams has a discrete area of focus and is responsible for Mission deliverables within their area. The implementation teams are tasked with executing design, development, implementation, integration, Verification and Validation (V&V) and operations for the EGS Program. Each of the three teams has decision-making authority to implement their responsibilities within their allocated cost, technical, and schedule authority. Refer to the following charters: GSDO-CHTR-1175, EGS Program Operations Processing Project Review Forum; GSDO-CHTR-1176, EGS Program Ground Systems Implementation Leadership Team Forum; GSDO-CHTR-1019, EGS Command, Control, and Communications Forum Charter.

The GSI team, led by the Division Chief for the PM Division, is responsible for the design, development, build, hardware/software integration, V&V, test, and transition to operations for Program facility systems and Ground Support Equipment (GSE). The C3 team, led by the C3 Office Chief, is responsible for the development, operation, and sustainment of Communications services and End-to-End Command and Control (E2E-CC) systems. The C3 team delivers their capabilities to the GSI team to enable the overall Ground Systems capability. The Ops team, led by the Chief of the Operations and Test Management (O&TM) Division, is responsible for overall planning and

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execution of the flight hardware and ground systems processing and sustainment activities.

The GSI team and the C3 team each consist of one or more EITs as shown in Figure 1. The C3 team is composed of E2E-CC EIT and Communications Systems EIT. The GSI team is composed of the Spacecraft Offline Processing (SOP) EIT, the Vehicle Assembly Building (VAB) EIT, the Launch Equipment Test Facility (LETF), the Landing and Recovery (L&R) EIT, the Launch Vehicle Offline Processing (LVOP) EIT, the Crawler-Transporter (CT) EIT, the Mobile Launcher (ML) EIT and the Launch Pad EIT (LPE).

The Ops team has four major areas. These are the Mission Operations Branch, the Program Logistics Office, the Ground Operations and Facility Integration Branch, and the Test, Launch & Recovery Branch. These teams within the O&TM Division lead the development of an integrated operations concept, establish the operational requirements for the ground systems, provide program logistics analysis and integration, coordinate program training requirements and manage the validation testing of the ground systems. O&TM provides integrated cost, technical, and schedule leadership for operations planning, operations integration, and operations implementation, integrating ground operations resources and capabilities across supporting organizations to ensure efficiency in resource utilization and to enable a consistent operations interface to internal and external stakeholders. The Ops team is also responsible for managing EGS Sustaining Engineering projects as described in GSDO-PLN-1229, Exploration Ground Systems Program Sustaining Engineering Plan.

Each of the three EGS implementation teams also include personnel from KSC institutional organizations. Table 1 identifies the supporting KSC Institutional Organizations, respective mail codes, and a general description of the services provided to EGS. Membership on teams, and roles and responsibilities are further identified and/or described throughout this document.

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TABLE 1 KSC INSTITUTIONAL ORGANIZATIONS SUPPORTING EGS PROGRAM

KSC Institutional Organization		
Name	Mail Code	Description
Information Technology and Communications Services Organization	IT	The IT Organization provides responsive, innovative, secure, and cost effective end-user services, infrastructure, applications, and simulation IT services to enable customer and partner success. In addition, IT develops and maintains an experienced engineering workforce that performs design, development, applied research, Technology Development (TD), fabrication, construction, test, V&V, operations, maintenance, and sustaining of the Centers communications systems.
Engineering Organization	NE	The NE Organization develops and maintains an experienced engineering and science workforce that performs design, development, applied research, TD, fabrication, construction, test, V&V, operations, maintenance, and sustaining. The organization oversees and provides technical insight into GSE, ground systems, facilities, analog space environment test systems and flight systems to meet current and future space flight customer needs. The Engineering Director is the KSC Chief Engineer and is the primary KSC interface with the Headquarters (HQ) Office of Chief Engineer. The Director is the Engineering Technical Authority (ETA), responsible for providing recommendations to the Center Director for flight readiness for the Launch Services Program, the Commercial Crew Program, EGS Program, and the International Space Station Program.
Procurement Office	OP	OP provides acquisition planning support and policy direction of procurement activities to ensure effective and efficient management of the acquisition process. OP ensures that the right procurement tools are used to provide customers what they need at a fair and reasonable price and ensuring adherence to high standards of integrity.
S&MA Organization	SA	The SA Organization provides oversight, documentation and surveillance of both system safety and quality engineering, assurance, and consultation processes contained in GSDO-PLN-1036, EGS Program Safety and Mission Assurance Plan. This includes safety assessment/support of trade studies, hazard and fault tree analyses, quality assurance functions and products, and support to Program human rating activities, as required. This directorate provides KSC Center and EGS Program S&MA Technical Authority.

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KSC Institutional Organization		
Name	Mail Code	Description
Spaceport Integration and Services Organization	SI	Spaceport Integration and Services is responsible for the overall management and direction of Center activities with functions associated with Facilities, Facility Services, Propellants and Fluids, Environmental Programs, Protective Services, and Center Services

3.5 COMMERCIAL PARTNERS INTEGRATION AND SUPPORTABILITY

The EGS Program has responsibility to support a multi-use Launch Complex at KSC to support both NASA Artemis Program and external partners, such as commercial customers and other Governmental Agencies. The EGS Program supports trade studies initiated by the KSC Partnership Development Office (PDO) to facilitate, evaluate, and enable the integrated use of the KSC ground systems infrastructure. PDO is responsible for working with potential commercial customers and establishing agreements.

Architecture recommendations are coordinated through the Center Chief Architect and approved at the Partnership Board in accordance with KDP-KSC-P-1864, Partnership Development Process.

3.6 PROGRAM TECHNICAL INTEGRATION

Technical integration for the EGS Program is achieved through the organizational and teaming structure, common processes, common tools (e.g., requirements management tool), coordination with all interfacing organizations and the EGS Technical Baseline. The following sections provide additional details on the elements that enable technical integration across the Program.

3.6.1 Technical Baseline Management

The EGS Program Technical Baseline (which is different from its functional and allocated baselines) defines and communicates approved technical information used to support the development of ground systems, operational activities and capabilities required to meet the customer's needs. The Technical Baseline is a data-managed static snapshot in time of sources of information that defines facilities, GSE, flight hardware configurations, operations concepts, requirements, and design information. The Technical Baseline is utilized for all Program-related work, including hazard and risk assessments, Point of Departure for trade studies, budget development, operations development, and GSE/facility Design, Development, Test, and Evaluation (DDT&E) activities. The Technical Baseline also serves as an important tool for ensuring all organizations supporting EGS are in sync. GSDO-P-1060, EGS Program Technical Baseline Management Procedure governs the management of the Program Technical Baseline.

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The Technical Baseline is documented in TechDoc and is accessible through the EGS Program Change Management Workflow (CMW) site. This portal contains a data-managed spreadsheet documenting the current contents of the Technical Baseline including the current baseline number, links to all products in the Technical Baseline, as well as a history spreadsheet for previous versions of the Technical Baseline.

3.6.2 Performance Management Team

The EGS PMT is described in GSDO-PLN-1000, EGS Program Plan. The PMT leads the tactical execution of GSI, C3, and operations planning and execution activities. Its primary responsibility is to ensure the success of missions assigned to EGS by tracking and managing integrated program performance. The PMT is responsible for seeing that deliverables across all program teams are coordinated and completed to achieve successful mission element processing, launch, and recovery. The PMT convenes weekly at the JMPR forum to review Program mission performance.

3.6.2.1 EGS Implementation Teams

EGS has three teams tasked with DDT&E, transition and operation of the Ground Systems capability. These teams are the GSI team, the C3 team and the Ops team. These teams are staffed from across the EGS organization, institutional organizations and representatives from the Technical Authorities as applicable. Further details on membership, roles and responsibilities are provided in the sections below.

3.6.2.2 GSI Roles and Responsibilities

The GSI Team consists of the eight EITs identified in 3.4.2; a Cross-cut team; and the V&V Working Group (VWWG). The GSI team is led by the PM Division (LX-D). The GSI Team also includes a GSI Leadership Team, consisting of representatives from each of the LX functional areas, the C3 Team, NE, SI, IT, Kennedy LX Support Services Contract (KLXS) and Consolidated Operations, Management, Engineering and Test (COMET) contractor. The GSI Leadership Team meets weekly at the GSI Forum (GSDO-CHTR-1176, EGS Program Ground Systems and Implementation Forum Charter) to provide timely, integrated decision-making for cost, schedule, technical, and risks within the GSI baseline. The GSI Leadership provides an integrated decision or guidance for issues spanning all of the GSI Elements, Operations-related issues for pre-Operational Readiness Date (ORD) activities and the C3 Team milestones that directly affect the GSI development efforts. The GSI uses the Cross-cut team and a VWWG to support their integration efforts.

The Cross-cut team manages budget, schedule, and technical integration across the EITs within the GSI Team and is responsible for external integration with entities outside of the GSI Team. The Cross-cut team has Cross-Element Ground Integration Engineers (GIEs) responsible for working with the Element Technical Managers (ETMs) to ensure integration across the Elements and working with Operations Project Engineers (OPEs) to address ground-to-flight issues. The Cross-cut team also has Operations Managers to provide operations integration across the Elements and with the Ops team. The

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Cross-cut team has Chief Engineers assigned to the GSI Elements; Logistics; S&MA; schedule, risk and budget (PP&C personnel) support; and ICM support.

The VVWG is a working group consisting of personnel from the EGS functional areas, the KSC institution, and major contractors. The VVWG provides a forum to facilitate EGS verification, validation, and integrated V&V planning and implementation. This includes establishing common processes and tools and providing strategies and recommendations for optimizing V&V activities across all EITs, subsystems, and the organizations responsible for the implementation of V&V.

The VVWG provides a peer review forum for V&V-related topics prior to approval at GSI or formal boards. In addition, the VVWG works actions and issues assigned to the team that are deemed program priorities.

3.6.2.2.1 GSI Element Integration Teams

Each EIT is composed of representatives from all EGS functional organizations/disciplines and supporting KSC institutional organizations. EITs are structured to integrate and manage the various projects that are active within that Element to ensure that required mission capability upgrades are achieved in accordance with the EGS mission manifest throughout the Operations and Sustainment phase of the EGS Program life-cycle.

Each EIT has a core roster that ensures technical integration across the multiple subsystems of the Element. Within the EIT, project teams are formed to implement modifications/upgrades/new requirements as needed to meet ground processing needs of specific missions. Projects will often work across multiple subsystems within the Element. GSI maintains a master list of all EIT, Project, and System/Subsystem team roster assignments in the [GSI Cross-Ref Personnel SharePoint Library](#).

The various EIT team member roles and responsibilities are described in Table 2.

TABLE 2 GSI ELEMENT INTEGRATION TEAM ROLES & RESPONSIBILITIES

Element Lead Roles	
Role	Responsibilities
Element Project Manager (EPM)	Manage the projects within the Element providing an integrated Element-level capability to the GSI team.
	Technical content of all budgets, schedules, risks and performance metrics related to Element activities.
	Lead Element-level Planning, Programming, Budgeting, and Execution (PPBE) activities.

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Element Lead Roles	
Role	Responsibilities
	Integration of the Element team (including contractors) and communication within the Element.
	Develop Requests for Proposals (RFPs)/Statements of Work (SOWs) for Element-level contracts (such as A&E and construction) and other PM-related products. Work with Element GIE to ensure that that RFPs and SOWs capture project requirements and required evidence from the contractor required to close these requirements.
	Lead execution of DDT&E activities including Element verification activities, ensure the overall execution of V&V, and facilitate transition to operations.
	Support Element-level design requirement and Detailed Verification Objective (DVO) development.
	Provide Element information and status to the GSI team.
Element Operations Manager (EOM)	Leads the development and baselining of Program and Element-level Stakeholder Expectations (StEs)
	Support the EPM and represent Element to the Ops team.
	Develop/maintain Element ConOps and provide inputs to trade studies.
	Infuse operability into Element requirements, support analysis of operational flight availability requirements and lead development of timeline analyses for Element Operations.
	Coordinate resources from the Operations team for development of Element functional performance requirements, development of O&M Instructions, O&M procedures, etc.
	Manage ongoing maintenance of Elements for operational systems supporting development. Coordinate with and between the different maintenance contractors.

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Element Lead Roles	
Role	Responsibilities
	Coordinate Operations team support for V&V activities; Coordinate with C3, Integrated Testing, Verification, and Validation (ITV&V) and development to engage the Operations team during V&V looking to incorporate “training” opportunities for the operators.
	Identify Support Requirements related to Operations of the Element.
	Lead Element StE definition, Detailed Validation Objective (DVaO) requirement development, and associated validation planning in conjunction with GIE.
	Coordinate Cross-Program Technical Integration through OPEs including Original Equipment Manufacturer (OEM) flight and ground hardware, software, Operations and Maintenance Requirements and Specifications (OMRS) and related drawing deliveries via Bilateral Data Exchange Agreements, Lists, and Schedules (BDEALS)/ Bilateral Software and Hardware Exchange Agreements, Lists, and Schedules (BSHEALS).
	Manage Element Ops schedule for operational systems supporting development.
	Provide facility/GSE/Subsystem status for operational systems supporting development.
	Provide Procedure Development status for COMET-provided procedures.
	Support Ground System OMRS/Operation and Maintenance Controlled Requirement (OMCR) implementation (e.g., operational planning, support procedure development, scheduling) as defined in GSDO-PLN-1142, EGS Program Operations and Maintenance Requirements Management Plan.
	Provide Training Plan status in preparation for operational systems.
GIE	Lead Program Element-level requirements baselining/management and closed-loop accounting

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Element Lead Roles	
Role	Responsibilities
	Lead technical integration and technical issue assessment/resolution at the element level
	Lead V&V planning and implementation (partnering with GSI)
	Manage the flow of Element/subsystem change traffic, CRs, Deviations and Waivers (Program, Cross-Program and Institutional).
	Lead requirement assessments to determine element impacts and communicate requirement changes to the EPM and System Project Managers (SPM) as higher level requirement products are affected and/or revised
	For contracted projects, ensure that A&E SOW for design efforts are consistent with and encompass Programmatic and Interface Control Document (ICD) requirements: i. RFPs and SOWs include program requirements and applicable standards ii. Contract deliverables include any products necessary to close the requirements iii. Data deliverables include any products needed to support analysis and requirements closure iv. Appropriate data delivery methods and acceptable data formats are specified
	Support the development and baselining of Program and Element-level StEs
	Verify with System Engineer the design milestones have adequate product maturity. Perform audits to ensure design milestones are at the proper maturity, according to KDP-P-2713, Technical Review Process.
	Ensure that Design Verification Matrices (DVM) or other items required for requirements traceability are entered into the Cradle ® tool through coordinating with institutional design organizations.

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Element Lead Roles	
Role	Responsibilities
	Support completion of V&V testing and System Acceptance Reviews (SAR) by ensuring requirements closure evidence is linked in the Cradle ® tool.
	Serve as book manager for the Inter-Element ICDs
	Lead EIT-level requirement development efforts. Lead requirement integration by working with EPM, EOM, and Subsystem Leads. Ensure requirements are entered into the requirements management tool.
	Provide support to OMRS and OMCR development and tracking as defined in GSDO-PLN-1142.
	Provide oversight for "flight-to-ground" interface verifications.
	Partner with SPMs, Ops team and Institutional organizations to support planning for any Cross-Program Integrated ITV&V operations during flight processing at KSC
Element Subsystems Lead Responsibilities	
System Project Manager (SPM)	Produce Project Plans identifying organizational roles & responsibilities
	Present Product Tailoring Matrix (PTM) to GSI Forum to ensure cost, schedule, and owner commitments for each product (to be done prior to baselining at System Requirements Review [SRR])
	Determine if each project design review meets success criteria
	Manage project A&E delivery orders (technical, cost, schedule)
	Lead design reviews of A&E products – determine if success criteria are met
	Shepherd design team through design certification process (working closely w/ GIE & SEs)
	Oversee V&V planning, test design, and execution

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Element Lead Roles	
Role	Responsibilities
Systems Engineer (SE) COMET	Develop PTM and support SPM presentation to GSI Forum to ensure cost, schedule, and owner commitments for each product (to be done prior to baselining at SRR)
	Manage subsystem PTMs/DVMs from development to closure
	Perform subsystem technical integration and multi-subsystem integration
	Present entrance/exit criteria at design reviews
	In conjunction with GIE, develop comprehensive V&V Plan integrating with all stakeholders (i.e., event planning and Test Readiness Document [TRD])
Lead Design Engineer (LDE) NE	Assess technical adequacy of design products and analyses
	Ensure technical adequacy during fab/construction/installation of project subsystems
	Manage and execute design activities and product reviews and assure element design schedules are met
Lead Engineer (LE) COMET	Assess technical adequacy of design products and analyses
	Ensure technical adequacy during fab/construction/installation of project subsystems
	Manage and execute design activities and product reviews and assure element design schedules are met
Operations Engineer	Provide technical integration in the development of OMRS and OEM drawings.
	During operations, responsible for performing technical integration including requirement integration, requirement management, nonconformance integration, anomaly resolution, etc.
S&MA Integration	Support and provide S&MA input to EIT design reviews required for ground processing, facilities, and GSE

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Element Lead Roles	
Role	Responsibilities
	Perform hazard analyses (HAs) to systematically identify hazards, their associated causes, the control necessary to mitigate the risk to an acceptable level (if the hazards cannot be eliminated through the hardware/software design and processing operations development process), and the verification methods to demonstrate the effectiveness of these controls
	Ensure that S&MA requirements have been adequately defined and included in ground systems designs and planned processing operations
	Ensure that EIT-level S&MA risks are identified, technically assessed, processes and resources exist to adequately manage these risks, and ensure that safety impacts and consequence/likelihood scores associated with various program risks are consistently applied
Cross-Cut EIT Support Roles	
Program Support Team – (Business Integration):	Support EIT with budget, schedule and risk products as required.
	Provide EIT with metrics related to budget, schedule and risk
	Coordinate EIT PPBE submits
EGS Logistics:	Participate in development of logistics-related requirements
	Perform spares planning to support program goals and milestones
	Interface with Design Engineering teams to influence hardware design for supportability.
	Generate Logistics Support Analyses (LSAs) or Subsystem Supportability Assessment for all newly designed and modified GSE systems and develop, maintain, and update Logistics Assessments for heritage systems, as required.
	Assure ongoing maintenance and support activities are executed in support of program operations

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Element Lead Roles	
Role	Responsibilities
	Perform impact assessment for trade studies and CRs (e.g., propellants, commodities, materials, spares, and logistics process and workforce impacts).
	Resolve Element-level logistics issues (e.g., transportation, storage and warehousing needs, supply chain, spares/inventory issues)
	Provide development effort status for EGS training plans
KSC Institutional Organizations (IT, NE, SI) as applicable:	Support EIT team leads and EPM.
	Prepare information, including integration of design products, and metrics as directed by the EPM or ETM.
	Provide status on design reviews, technical and other issues within the institutional design organization.
	Provide reach-back into the institutional design organization to identify and coordinate input from Subject Matter Experts (SMEs).
	Support requirements and verification test planning.
	Responsible for the design and development of technologies and subsystems to support EGS activities.
	Responsible for the maintenance of subsystems during subsystem development.
Institutional Support contractor representative as applicable:	Support planning of V&V testing.
	Support preparation for turnovers, including assessing and evaluating products (e.g., documentation, drawings, plans, etc.) required for turnover.
	Coordinate and support integration with the COMET organization for readiness to support testing, operator training and other areas as required.

3.6.2.3 C3 Team Membership, Roles and Responsibilities

The C3 Project team is established as a distinct project within EGS, managing the E2E-CC and Communications (Comm) EITs with a single Senior Project Manager (the

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Comm EIT has an EPM). C3 is an integrated team with dedicated members from the LX Functional and KSC Institutional organizations committed to and under functional accountability to the C3 Project (see Figure 1). The structure of the C3 Project and its implementation teams is described in C3-3005, EGS Program Command, Control, and Communications Project Implementation and Integration Plan.

3.6.2.3.1 C3 EIT Membership, Roles and Responsibilities

Within the E2E-CC and Comm EITs, the Program Control and Systems Engineering, Integration, and Operations (SEI&O) functions are an integral part of the C3 Project, each with a Manager who functionally reports to the C3 PM. In addition, the Ground and Flight Application Software Integrated Product Team (IPT), GSE IPT, Launch Control System (LCS) IPT, and M&S IPT each have a PM who functionally reports to the C3 PM.

The C3 Team utilizes the C3 Forum, chaired by the C3 Manager, consists of representatives from each of the LX Divisions, NE, IT, SI, KLXS and COMET contractors. The C3 Forum meets weekly to provide a timely, integrated decision-making forum for cost, schedule, technical, and risks within the C3 baseline.

3.6.2.4 Ops Team Membership, Roles and Responsibilities

The Ops team is led by the O&TM Division (LX-O). The Ops Team is organized into four implementation teams: Mission Processing, Program Logistics, Ground Operations and Facilities Integration, and Test Launch and Recovery. These teams are described below:

1. The Mission Processing branch functions include Range Operations and Integration, Operations Analysis, Advanced Planning and Strategic Integration. The branch also provides Flight Element-focused operations management and L&R ops planning and management.
2. The Program Logistics Branch provides acquisition logistics planning, logistics analyses, spares budget, operational logistics services and other related responsibilities as further described in Section 7.5.
3. The Ground Operations and Facilities Integration branch provides the EOM function for all EGS facilities (both offline and integrated).
4. Test, Launch & Recovery team provides the NASA Test Director function to lead the planning and execution of Integrated Ground and Flight Element testing and operations. This includes the planning and execution of launch countdown simulations, Wet Dress Rehearsals, Launch Countdown, and the planning and execution of Underway Recovery Tests, nominal and contingency recovery operations.

In addition, the C3 Project SEI&O team supports the operation of communication systems and the Launch Control Center Control Rooms. With the exception of the

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aforementioned C3 roles and responsibilities, the Ops Team utilizes the Operations Processing Project Review (OPPR) Forum (GSDO-CHTR-1175, EGS Program OPPR Charter), consisting of representatives from each of the LX Divisions, the C3 Team, NE, SI, IT and COMET contractors. The OPPR meets weekly to provide a timely, integrated decision-making forum for cost, schedule, technical, and risks within the Ops baseline. The OPPR also provides integrated decisions or guidance for issues crossing all of the Elements, Operations-related issues for post-ORD activities and the C3 Team milestones that directly affect the Ops team processing efforts. The Ops team will use the Cross-cutting teams to support their integration efforts.

There are two NASA Operations Managers (NOM) within the Operations team. There is one NOM for Spacecraft Offline Operations (SOO) and one NOM for Integrated Operations. The NOMs each have a team of EOMs that support them. The NOMs manage budget, schedule, and technical integration across their elements. The Cross-cutting team has Cross-Element GIE's responsible for working with the processing leads to ensure ground system integration across the elements and to work with OPEs to address ground-to-flight issues. The Cross-cutting team will also utilize the NOMs to provide operations integration across the GSI Elements and within the Ops elements. The Cross-cutting team includes representatives from the Chief Engineer, Logistics, S&MA, PP&C, and Configuration Management (CM) support.

The Ground Operations Team roles and responsibilities are summarized in Table 3. EGS Program operations processes and responsibilities are fully described and detailed in GSDO-PLN-1183, EGS Program Ground Operations Management Plan. The Launch team roles are defined in GSDO-PLN-1129, Cross-Program Integrated Launch Operations Implementation Plan (ILOIP). The L&R team roles are defined in GSDO-PLN-1155, Cross-Program Orion Nominal End-of-Mission Recovery Plan.

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TABLE 3 GROUND OPERATIONS TEAM ROLES AND RESPONSIBILITIES

Role	Responsibilities
NOMs	Manage the elements within their Ops Team. Formulate and execute budget, technical, schedule, and risk for their Ops Processing Team. Provide integrated Cross-Element capability to the Ops team with EOM support.
EOMs	Manage sustaining projects within the element Formulate and execute budget, technical, schedule and risk for post ORD Processing Team work Provide integrated Element-level capability to the Ops team.
OPEs	Provide technical integration in the development of OMRS and OEM drawings. During operations, responsible for performing technical integration including requirement integration, requirement management, nonconformance integration, anomaly resolution, etc.
Chief Engineers (NE)	Provide Technical Authority review in support of sustaining engineering project evaluations. Provide/coordinate engineering insight for ground systems/software nonconformance evaluation and resolution.
Program Support Team – (Business Integration)	Provide support to each element for budget, schedule and risk activities as required. Support and coordinate PPBE and Phasing Plan efforts for the Ops Team.
EGS Logistics	Assure that ongoing maintenance and support activities are executed in support of program operations.
S&MA Representative	Provide S&MA input to operations reviews required for flight hardware, flight software involved in ground processing, facilities, and GSE. Ensure that hazard controls are implemented in O&M procedures. Participate in day to day operations.

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Role	Responsibilities
COMET representatives	Develop processing schedules, procedures, training plans, and other documentation as needed for flight vehicle processing, integration, testing, and launch. Support preparation for flight system hardware and software turnovers to EGS, including assessing and evaluating products (Acceptance Data Packages [ADPs], documentation, drawings, plans, etc.) required for turnover. Perform O&M of Element GSE/systems. Prepare and implement flight hardware/software processing procedures.
KSC Institutional Organizations as applicable (SI, IT)	Review and respond to operations support requirement requests. Perform O&M of facility/Comm/infrastructure systems.

3.6.3 Cross-Program Technical Integration

Cross-Program Technical Integration is described in M2M-30003, M2M Systems Engineering Management Plan. Cross-Program refers to M2M, EGS, SLS, Orion, HLS, EHP, and Gateway. Refer to GSDO-PLN-1000, EGS Program Plan for a description of EGS Integrated PP&C Integration Team interactions and functions.

EGS supports Cross-Program Technical Integration through the Phase-Based System Integration strategy, with delegated authority from the M2M SE&I office. M2M SE&I provides overall technical leadership and strategy and maintains the business rhythm for technical integration. Each of the six Artemis program offices are responsible for a Phase of the mission, including execution of systems engineering and integration activities within that phase, while M2M SE&I will be responsible for cross-phase systems engineering & integration activities.

3.6.3.1 Moon to Mars Phase Integration Approach

M2M has implemented a mission and phase-based integration approach to address how the technical integration work is performed while outlining clear roles and responsibilities of the M2M Program Office and its Programs. The mission and phase-based integration approach includes the assignment of phase integration to the following lead Programs:

- Launch and Recovery Integration – led by EGS
- Earth Ascent Integration – led by SLS,
- Earth-Lunar Co-manifested Payload Transit Integration - led by Orion
- Orion/HLS Direct Integration – led by HLS

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- Near Rectilinear Halo Orbit Integration – led by Gateway
- Lunar Surface Integration – led by EHP

Mission and phase-based integration activities are delegated from the M2M Deputy Associate Administrator (DAA) to the Program Phase Leads, with each Phase assigned to a single Program under M2M. The Program Phase Leads are delegated the tasks for completing the design certification and mission certification work within their Phase, with overall accountability remaining with the M2M DAA. The Program Phase Leads are solely responsible for the delegated integrated system work within their Phase. A system within a phase may cross integration Phase boundaries, but responsibility for the system is reflected in the allocation of requirements and assignment of cross-program products, as shown in M2M-30003, M2M Systems Engineering Management Plan annexes.

3.6.3.1.1 Launch and Recovery Phase Management

EGS is responsible for the Launch and Recovery Phase and fulfills its Cross-Program integration responsibilities through a Phase-Augmented Control Board and Phase Integration Control Board in addition to Panels, Working Groups, and Forums as defined in the M2M-30003, M2M Systems Engineering Management Plan. The comprehensive list of Phase teams is included in <TBD 3-1>.

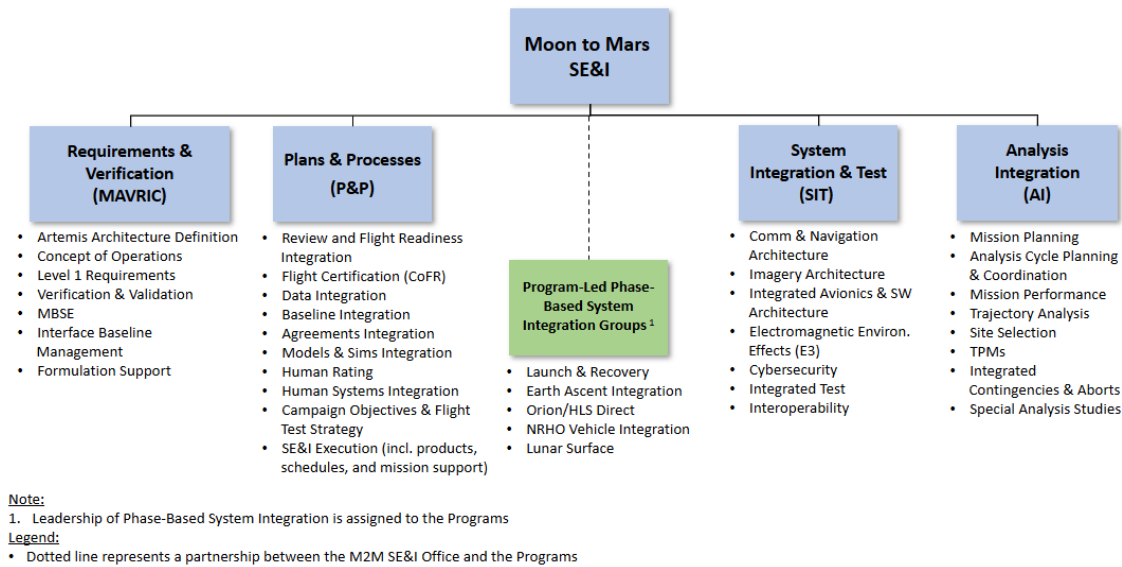


FIGURE 2 M2M SYSTEMS ENGINEERING AND INTEGRATION STRUCTURE

3.6.3.1.2 Requirements

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Requirements for Artemis II are established in ESD 10002-1, Common Exploration Systems Development (CESD) Requirements, and define the high-level baseline for the development of the requirements for the Space Launch System (SLS) Program, the Orion Program, and the Exploration Ground Systems (EGS) Program. These requirements are commonly referred to as “R-“ requirements. “R-“ requirements may be allocated to a Program, a Phase, or M2M. Verification and Closure of these requirements for EGS and the Launch and Recovery Phase is further defined in **<TBD 3-1>** Following the Artemis II Mission, M2M Requirements and Phase allocation will be defined in M2M-30002 M2M Artemis Requirements Document.

3.6.3.1.3 Interfaces

Interfaces are established via ICD and Interface Requirement Document (IRD). These are Cross-Program products that will be managed by the responsible Phase. ICDs and IRDs under the Launch and Recovery Phase are listed in M2M-30003-ANX01, M2M SEMP Annex 01:EGS Program Integration Lead Cross-Program Product List.

The Interface Management Process is described in Section 5.3.3.

3.6.3.2 M2M SE&I

The M2M SE&I Office is organized into four main technical areas: Requirements and Verification, Plans and Processes (P&P), System Integration and Test, and Analysis Integration. The primary focus of the technical areas is on processes, disciplines, and systems engineering that span M2M and that are not self-contained within a Program or phase. The technical areas rely on chartered teams to integrate across the M2M Program Office and its Programs. Further detail can be found in M2M-30003, M2M SEMP.

3.6.3.2.1 MAVRIC

The Requirements and Verification technical area is defined as Modeling Architecture, Verification, Requirements, Interfaces, and ConOps (MAVRIC). MAVRIC is responsible for establishing and maintaining the M2M top-level technical baseline, including the Artemis architecture, ConOps, and requirements. In addition, MAVRIC defines the top-level V&V policy, processes, and plans for M2M. MAVRIC is also responsible for establishing the interface baseline management approach for M2M.

EGS SE&I will collaborate with MAVRIC in V&V activities, including providing access to program products detailing requirements traceability and closure evidence.

3.6.3.2.2 Plans and Processes

The P&P technical area is responsible for establishing technical plans and processes and for the overall technical planning for the M2M SE&I Office. This includes support to the M2M SE&I Office in the following areas: schedule integration, risk management, and Artemis mission support planning and execution.

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P&P provides support to M2M in the performance of the following activities: human rating certification, Human Systems Integration (HSI), data integration, Post-Flight Assessment (PFA), Modeling and Simulation (M&S) integration, agreements integration, Artemis Campaign Objectives development, flight test strategy, and the baseline integration process. P&P is the book manager of M2M-30003, M2M Systems Engineering Management Plan. P&P is also responsible for developing the strategy and approach for M2M reviews in coordination with the M2M Program Office and its Programs. This includes planning, coordinating, and executing M2M top-level reviews, including the Artemis Flight Certification reviews and M2M Program Office support to Program reviews. P&P also provides baseline change coordination in support of the M2M CM system.

HSI and Human Rating Certification are further detailed in Sections 7.2 and 7.3.

3.6.3.2.2.1 Interdependencies

Cross-Program Interdependencies are negotiated and captured in BSHEALS and BDEALS. EGS interdependencies are captured in the Cross-Program Interdependency Database.

There are internal and external interdependencies for EGS.

External Interdependencies:

Cross-Program interdependencies are Program-to-Program or Program-to-Integrated Task Team (ITT) needs (Data/Hardware/Software), which drive a Program's technical design and/or V&V to the extent where a missed delivery would impact a Program's or ITT's schedule or risk posture. The EGS SE&I division coordinates Cross-Program Interdependencies and facilitates communication with the other programs and EITs and is known as the Interdependencies Points of Contact (POCs). Interdependencies range from routine exchange of design data or models/simulations to delivery of critical flight hardware and software. The overall Cross-Program Interdependencies Process is found in the M2M-30003, M2M SEMP, and the EGS Tailored Exchange Process is found in GSDO-P-1097, EGS Program Interdependency Hardware, Software and Data Exchange Procedure.

Internal Interdependencies:

Internal interdependencies are EGS EIT-to-EIT needs that affect one or more elements' technical design or affect the ability to verify or validate requirements. Interdependencies range from routine delivery or exchange of design data to delivery of critical hardware and software. Implementation teams and EITs will negotiate internal interdependencies based on schedule and technical constraints.

3.6.3.2.2.2 Flight Certification

The Artemis Certification of Flight Readiness (CoFR) process is a series of progressive activities that build up from Program activities, includes M2M-level integration milestones, and culminates with an Agency Flight Readiness Review (FRR) used to

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evaluate NASA launch and flight readiness. Agency FRRs are the culmination of the Artemis CoFR process defined in M2M-30020, Artemis Integrated Certification of Flight Readiness (CoFR) Plan. The Artemis CoFR process assesses the certified design capabilities of the systems against the planned mission, in addition to operational readiness.

The Artemis CoFR process is designed, planned, and executed by the M2M Review and Flight Readiness Integration team within the M2M SE&I Office. The team consists of members from the Programs, M2M offices, M2M Technical Authorities (TA), Flight Operations Directorate (FOD), Payload and Mission Operations Division (PMOD), and supporting organizations. The roles and responsibilities performed by the team include managing of M2M-30020, Artemis Integrated Certification of Flight Readiness Plan; developing mission-specific tailoring of the Artemis CoFR process for a specific mission and capturing tailoring in the applicable M2M mission-specific review plan; and planning and executing M2M and ESDMD CoFR milestone reviews. The team coordinates schedules of organizational, Program-level, M2M-level, and Agency-level CoFR milestone reviews. The team also coordinates technical content necessary to meet the Artemis Success Criteria defined in M2M-30020 to demonstrate overall launch and flight readiness with acceptable risk to the crew and mission.

EGS-specific CoFR activities are outlined in Section 4.4.1.2 EGS Pre-Flight Readiness Review and are fully described in GSDO-PLN-1088, KSC and EGS Program Certification of Flight Readiness Plan.

3.6.3.3 Operations Processing

GIEs and OPEs serve as the EGS technical representative to SLS and Orion Programs, providing Program-to-Program (P2P) technical integration during development, integrated testing and operations. GIEs are responsible for ground systems integration, while OPEs are responsible for flight systems integration. Their responsibilities are captured in Table 4 and include:

Table 4 – Operations Team Integration Responsibilities

<u>Responsibility</u>	<u>GIE</u>	<u>OPE</u>
Managing P2P interdependencies	X	X
Flight vehicle requirements allocation		X
P2P ICD management	X	
Leading technical integration and problem resolution as part of the launch team during integrated testing and launch countdown	X	X
Leading the integration of technical issues during flight processing		X

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For flight vehicle processing OMRS requirements development and management - providing technical integration within EGS and between flight vehicle and ground system and ensuring flight vehicle OMRS requirements are properly captured in flight processing procedures		X
For flight vehicle and ground Launch Commit Criteria (LCC) - providing the technical integration for flight vehicle and ground LCC requirements development and ensuring flight-vehicle LCC requirements are properly captured in flight processing procedures	X	X
Ensuring that OMRS or LCC that have Launch Control System application software impacts have been adequately implemented and that software products satisfy the intent of the OMRS or LCC, especially with respect to Ground Launch Sequencer implementation of LCC	X	X

3.6.3.4 Mission Integration Responsibilities

The M2M Exploration Operations Office is responsible for M2M mission integration, M2M utilization integration, and M2M logistics integration functions to ensure the implementation of the NASA Artemis Campaign strategic plan within each Artemis Mission. The M2M SE&I Office partners with the M2M Exploration Operations Office to ensure a comprehensive approach to technical integration from development through post-mission assessment of the Artemis Mission Campaign. M2M Integration Offices work with the Programs, Mission Managers, FOD, and TAs to identify, prioritize, and coordinate resolution of technical issues that impact the critical path or vehicle manifest, as well as identifying threats, liens, and opportunities in support of mission and campaign integration. The mission definition work performed is often iterative and each subsequent development builds upon the work done in a previous cycle, achieving a more mature level of fidelity and detail through the process. Mission integration is a joint effort among the M2M Program Office and its Programs, FOD, PMOD, users (utilization-related entities), and multiple internal and external support organizations described in M2M-30018, M2M Mission Integration Implementation Plan (MIIP).

M2M-30018 defines the M2M mission integration processes for managing mission requirements, decisions, risks, and operations for missions within an Artemis Mission Campaign.

3.6.4 Implementing Organizations Technical Integration

The Engineering Organization (NE) leads and coordinates subsystem integration activities ensuring that EGS designs are technically integrated and provide a fully functional ground system. Each design implementation organization utilizes support contractors, directorate processes, Control Boards (CB), PMs, and methods to deliver design products. These products are evaluated and integrated as defined in GSDO-PLN-1174, EGS Program Site Activation Management Plan. The Engineering Organization will lead and coordinate this overarching process with the participation and

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concurrence of EGS Program management, implementation teams, and the KSC institutional organizations.

Specific work packages and implementing organization assignments are collected through the EGS implementation teams. These work packages are analyzed to identify specific integration activities and responsibilities for performing these activities. These activities may include evaluation of existing products or the creation and evaluation of integrated products created from lower-level products. Specific integration activities will further identify actions required for each interface/dependency, personnel performing the activities, and specific products required for each integration activity and their availability. Any new work content will be approved through an EGS Decision Authority (DA) forum or CB.

The Engineering Organization tracks subsystem level products used as inputs to the integration process. Standard data and file formats ensure compatibility of various product types used to create integrated products. The Integrated Engineering Review Board (IERB) is utilized to review integration activity results not included in other design reviews. The Engineering Organization tracks integration need dates based on when integration activity results are needed for major Program milestone reviews.

3.6.5 Program Payload Integration

The EGS Program performs the KSC payload integration function for payloads flown on the SLS launch vehicle and the Orion spacecraft. This function includes evaluation of payload requirements, KSC-wide integration activities including pre-flight preparation, installation into the vehicle, and test/checkout within the vehicle for launch of Primary Payloads, CPLs, and Secondary Payloads. The EGS Program coordinates with a cross-functional team (including M2M, SLS, Orion, Gateway, etc.) to ensure payload ground processing requirements are defined and implementable. Refer to GSDO-PLN-1242, EGS Program Payload Integration Plan for additional information.

3.7 INTEGRATION SUPPORT TOOLS

The EGS Program utilizes a number of software applications to implement technical processes used across the Program and to support efficient integration of the overall effort. These tools are listed and discussed in detail in GSDO-PLN-1001, Exploration Ground Systems Program Information and Configuration Management Plan.

3.8 PROGRAM PLANNING CONTENT

The Program and Project life-cycle phases, reviews, entrance and success criteria, product maturity, and control gates are in accordance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements and NPR 7123.1, NASA Systems Engineering Processes and Requirements, and will be conducted for a single project Program as defined in NPR 7120.5. The following paragraphs elaborate on the top-level planning. The Review Plan section in the EGS Program Plan lists the

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Program-level reviews to be performed. The EGS Program Plan Schedule Baseline section shows the timing of these reviews.

Program-level technical reviews are based on a foundation of products from the implementation teams. These products are defined to provide EGS with insight into the maturity of the essential planning, requirements, function allocations, analyses, designs, and operations for content assigned to each implementation team. The specific Program deliverables and entrance/success criteria are defined in the Program review plans that are released into the EGS library.

The implementation teams align their phasing, product development/maturation, and internal reviews to support the EGS Program-level life-cycle phases, reviews, and product requirements. EGS leverages significant investments in heritage systems and the development efforts started during the execution of the Constellation Program.

The technical reviews constitute principal mechanisms for risk identification and management, ensuring EGS integration (within EGS as well as Cross-Program integration), and providing the basis for management decisions relative to Program control gates. A technical roadmap describing activities throughout the Program Life Cycle is detailed in Section 4 of this document.

3.9 BOUNDARY OF TECHNICAL EFFORT

The scope of the technical effort for EGS includes all development, ITV&V, and S&MA activities for the EGS Program end products. EGS Program development efforts include the definition of Program architecture; flow down of requirements to EGS EITs and subsystems; and design, construction, fabrication, integration, and verification of new and modified facilities, equipment, and software. The technical effort includes transition of new or modified assets to operations. The technical content also includes operations after delivery and transition of end products from development to operations as well as the associated sustaining engineering during the operational phase of the Program. Although personnel from various KSC organizations and support contractors may accomplish design, fabrication, testing, operations, and sustaining engineering tasks, this work will be accomplished under the EGS Program. The EGS system and organizational structure are defined in the EGS Program Plan. The Program Work Breakdown Structure (WBS) is defined in GSDO-WBS-1009, EGS Program Work Breakdown Structure and Work Breakdown Structure Dictionary.

EGS has physical, electronic, logical and/or functional interfaces with systems outside the Program boundary including Orion, SLS, Eastern Range (ER) (weather data and other information systems), commercial entities and other NASA assets. These interfaces are defined in the associated IRDs/ICDs with those external elements. EGS Program internal Element to Element interfaces are documented in GSDO-ICD-1250, EGS Program Element to Element Interface Control Document

The Ground System architecture and the high level EGS Concept of Operations are defined in GSDO-ACO-1010, EGS Program Architecture and Concept of Operations

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Document. The identification and definition of all EGS Subsystems is documented in GSDO-PLN-1043, EGS Master Subsystems List. The breakdown of EGS EITs into facilities and subsystems is shown the EGS Program Product Breakdown Structure drawings which also illustrate the evolution of EGS facility/subsystem capabilities required to support the Artemis manifest:

- GSDO-6004, EGS Program Product Breakdown Structure for Block 1 Crew
- GSDO-6007, EGS Program Product Breakdown Structure for Block 1B

4.0 TECHNICAL EFFORT SUMMARY

4.1 RESPONSIBILITY AND AUTHORITY

These sections summarize the overall responsibilities for the EGS technical effort, including the assignment of technical authority, responsibility for the generation of technical products, enabling products, and responsibility for the management and conduct of the technical processes.

4.1.1 Program Manager

Overall EGS Program authority resides with the EGS Program Manager. The Program Manager chairs the EGS Program Control Board (PCB), which serves as the Program-level authority for baseline approval (cost, technical, schedule), risk acceptance/approval, and changes to the baseline for EGS. The Program Manager also has the authority to elevate decisions or consolidated Program position to the higher-level boards (e.g., Moon to Mars Control Board (M2MCB) and Center Management Boards and Councils). The Program Manager's role in program integration includes communication of Programmatic issues and decisions as well as integrating all work performed within the Program.

Additionally, the EGS Program Manager chairs the Launch and Recovery Control Board (LRCB), delegated authority by the M2MCB to baseline, disposition, and implement proposed changes to requirements and Cross-Program data products associated with the Launch and Recovery Phase of the Artemis mission. The LRCB is delegated control authority and responsibility from the M2MCB for specific items within the M2M cross-program technical baseline as defined in M2M-30003-ANX01, Moon to Mars (M2M) Systems Engineering Management Plan (SEMP), Annex 01: Launch and Recovery Program Integration Lead Cross-Program Product List.

See GSDO-CHTR-1003, EGS Program Control Board and Launch and Recovery Control Board Charters, for additional details.

4.1.2 Senior Technical Integration Manager

The EGS Program Manager is supported by the EGS PRB in the execution of changes to the Program technical baseline. The PRB is chaired by the EGS Senior Technical Integration Manager (STIM) and is responsible for Program policies, processes, tools, and documentation, along with coordinating with external interfaces for process and

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policy definition and development of Cross-Program products. The STIM is also responsible for the overall technical effort, technical integration across Implementation Teams, and issue resolution between Implementation Teams.

The EGS STIM also chairs the Launch and Recovery Integration Control Board (LRICB), delegated authority by the LRCB to baseline, disposition, and implement proposed changes to requirements and cross-program data products associated with the Launch and Recovery Phase of the Artemis mission.

See GSDO-CHTR-1017, EGS Program Review Board and Launch and Recovery Integration Control Board Charter, for additional details.

4.1.3 EGS Program Chief Engineer - Engineering Technical Authority

In accordance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements, NASA has adopted a governance model, which is comprised of two authorities (Programmatic authority and Institutional Authority), in order to establish checks and balances that will ensure decisions are not made in isolation. In the event that an agreement on a proposed Programmatic or technical action cannot be reached between the Technical Authority and the Programmatic authority, the issue will be escalated to the next higher level of management for resolution. The EGS Program Manager is the ultimate authority at the Program level.

Per NPR 7120.5, the ETA establishes and is responsible for the engineering design processes, specifications, rules, etc., necessary to fulfill Programmatic requirements. Specific ETA responsibilities have been delegated down through the NASA Chief Engineer to the KSC Center Director and from the Center Director to the Engineering Director. The Engineering Director delegates Technical Authority to the Chief Engineers, Division and Branch Chiefs, and on a case-by-case basis, to SMEs.

The PCE performs oversight and serves as the Technical Authority for the EGS Program through either direct involvement or delegation, for activities related to DDT&E, and operations. The PCE is responsible for the technical integrity of the complete system being developed by EGS; therefore, the PCE evaluates key technical deliverables of EGS Projects by participation as a voting member of the EGS PRB and PCB. The Chief Engineer is also a voting member on all formal EGS Program reviews. The PCE will also monitor EGS Technical Performance Measures (TPMs) and related risks and will concur on technical mitigation strategies on Program risks through participation in risk reviews.

The PCE provides technical guidance to the EGS Program Manager and technical leadership for Center engineering within the Program. The PCE ensures that the Program has identified and imposed appropriate technical requirements.

The PCE may request that the Program initiate special investigations if further evaluation or testing is deemed prudent for risk quantification, if technical boundaries may have been exceeded, or if alternate technical options may be required to solve a

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complex issue. The EGS Program Manager has the authority to make a decision (and proceed at risk) while issues are being resolved at higher levels of Programmatic authority and Institutional Authority.

4.1.4 EGS Program Chief Safety Officer - S&MA Technical Authority

The KSC S&MA Directorate supports the EGS Program with resources for meeting safety, reliability, quality, and mission assurance requirements. The S&MA Directorate integrally sustains and strengthens the success of the KSC mission, serving as an independent, value-added partner and Agency leader in S&MA expertise. The organization plans, establishes, implements, and directs all S&MA functions for KSC responsible activities, ensuring compliance with Federal, Agency, Program, KSC, and contract S&MA requirements and controls.

The Program S&MA authority directs and controls S&MA elements of the Program. This includes appropriate S&MA budget/resource management (cost authority), and development of Program/project S&MA requirements. The Program S&MA authority supplies management/oversight of S&MA product development (schedule authority), as well as prime contract SOW/design review development and performance evaluation. The Program S&MA Authority provides management of Program/project Quality Management System and gives status reports, metrics, and risk reports for S&MA WBS.

The Chief Safety Officer (CSO) has the responsibility to ensure proper flow down and application of S&MA Technical Authority requirements; and provides interpretation of such requirements, as needed. The CSO also serves as a member of Program/project decision forums and internal review boards to ensure compliance with S&MA Technical Authority requirements and concur on the acceptability of residual safety risk. The CSO further provides concurrence on the technical suitability of S&MA products provided for approval. The CSO also has responsibility to ensure that requests for waivers or deviations from Technical Authority requirements are submitted to, and acted upon by, the appropriate level of Technical Authority, as well as ensure proper disposition of any Formal Dissent.

4.1.5 NASA Chief Health and Medical Officer – Health and Medical Technical Authority

The NASA Chief Health and Medical Officer (CHMO) is the Agency Health and Medical Technical Authority (HMTA). The HMTA provides independent oversight and assurance that Agency health, medical, and human performance policy, requirements, and standards are addressed in Program/PM when applicable and appropriate and provides interpretation of such requirements, as needed. The CHMO delegates HMTA to each Center's Chief Medical Officer (CMO), if one exists. For human space flight issues, the Center CMO coordinates all HMTA issues through the Johnson Space Center CMO. For human non-space flight issues, the Center CMO coordinates all HMTA issues through the CHMO. The Center CMO serves as a member of Program/Project decisional forums and internal review boards to ensure compliance with HMTA requirements. The Center CMO also has responsibility to ensure that requests for

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waivers or deviations from Technical Authority requirements are submitted to, and acted upon by, the appropriate level of Technical Authority, as well as to ensure proper disposition of any Formal Dissent.

4.1.6 Technical Change Assessments

The EGS Program performs two primary types of technical assessments, categorized as either a Study or CR. Studies identify and document potential Program baseline impacts and do not result in changes to the Program baseline. Assessments associated with an internal EGS CR, if approved, result in changes to the EGS Program baseline.

All EGS studies are conducted in accordance with GSDO-P-1061, EGS Program Assessment Procedure. Studies requested by an external organization require coordination through the associated EGS Lead OPE, typically with use of GSDO-FM-1035, Program Assessment Request Form.

There are multiple mechanisms to change the EGS Technical Baseline as a CR or CR equivalent. Programmatic CRs are described in GSDO-PLN-1001, EGS ICM Plan. There are also a number of CR-equivalent documents that drive change into the EGS Technical Baseline. These processes are defined in in GSDO-PLN-1195, Cross-Program Processes and Agreements for Launch Site Ground Operations. Many of these are flight engineering changes (such as drawing revisions, unplanned work, travelled work, or special requests), operational requirements revisions, and Launch Commit Criteria changes. EGS assessments of these changes are managed in the associated cross-program database tools: Launch Site Assembly and Integration Baseline (LSAIB), Operations and maintenance requirements Management System (OMS), and Launch commit criteria Management System (LMS).

4.1.7 Control and Review Boards

A set of technical boards has been established to facilitate and implement technical control for EGS. The EGS boards and panel structure is defined in GSDO-PLN-1000, EGS Program Plan. The implementation approach, including the Formal Dissent and deviations/waivers processes, are outlined in the respective EGS board charters.

The KSC Engineering Organization (NE), Spaceport Integration and Services Organization (SI), and the Information Technology Organization (IT) have authority for ground systems under their purview.

The KSC Engineering Organization chairs the IERB which provides an open forum for discussion, analysis, and disposition of engineering issues associated with design and development projects, in order to provide the programs with a range of integrated engineering technical recommendations with varying degrees of cost, schedule, and risk impacts. The IERB provides the engineering community a forum that bridges across both NASA and contractor internal and external organizational lines of responsibility, and it ensures that dissenting opinions are discussed, documented, and elevated if required. The IERB ensures integration of technical issues of physically-related or

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functionally-related related ground systems, GSE, and facilities design and development projects performed by the engineering institution (i.e., Engineering Organization, SI Services Organization, IT and Communications [Comm] Services Organization, S&MA Organization) for the EGS Program. The IERB Chair has accountability and authority to resolve ground systems, GSE, and facility projects' issues, including proposed changes to architecture, interfaces, or major milestones that can affect other EGS systems across the engineering institution organizations, with decisions that increase cost, schedule, or risk being elevated to the Program for acceptance. B-0026, IERB Charter, provides more detail on this topic.

SI chairs the Facility Management Board (FMB), which is the DA for assignment of Center administrative space and other facilities, sites, and real property assets within its purview. B-0001, FMB Charter, provides more detail on this topic.

SI also chairs the Center Operations Engineering Review Board (ERB), which provides an open forum for discussion, analysis, and disposition of engineering issues associated with NASA-owned facility systems and equipment at KSC that are designed, constructed, operated, maintained, sustained, or otherwise controlled by Center Operations. B-0025, SI ERB Charter, provides more detail on this topic. SI also co-chairs the BOSS ERB, which provides an open forum for discussion, analysis, and disposition of engineering issues associated with facility systems and equipment. Issues that affect programs and/or need center wide integrated forum are then channeled to the Center Operations ERB, and then the NE IERB. The BOSS ERB charter, ENG-P-0019, BOSS ERB, provides more detail on this topic.

The IT Organization hosts an IT PM Board for IT-related projects. The IT Board Charter, B-0050, KSC IT TRB, provides more detail on this topic.

Other institutional organizations may also have boards established to implement the work content for the Program.

4.2 TECHNICAL PRODUCTS

GSDO-6005, EGS Program Product Tree Drawing depicts the hierarchical, parent-child-sibling relationship of the EGS documentation products in an interactive tool providing links to document metadata in the program CMW site, as well as links to the latest revisions in the KSC TechDoc archive. GSDO-6005 content includes program plans, specifications, requirements, charters, forms, reports, analysis, templates, reference guides, desk instructions and memorandums. EGS documents are housed in the EGS Library. The EGS Technical Baseline is discussed in Section 3.6.1.

4.3 CONTRACTOR INTEGRATION

The EGS Program fulfills the "prime integrator role" to design, develop, manage, and integrate the elements/subsystems within the Program/Project rather than using a prime contractor. The EGS Program has established teams (e.g., the GSI team and the C3 team) to integrate the development project activities and ensure that all development

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activity is orchestrated to achieve operational readiness required to support mission processing dates associated with the EGS launch manifest. The Program ensures that all contractor development schedules provide the ability to design, develop, deliver, integrate, and checkout the integrated systems to meet the agreed upon EGS ORDs. Details on the approach to contractor insight and oversight are provided in GSDO-PLN-1000, EGS Program Plan.

4.4 LIFE-CYCLE TECHNICAL MILESTONE REVIEWS

Refer to GSDO-PLN-1000, EGS Program Plan for the complete set of life-cycle milestones, including the Program's Key Decision Points.

For each EGS Program-level technical review (e.g., SRR, Preliminary Design Review [PDR], Critical Design Review [CDR]), a review plan is developed to describe the approach, schedule, review strategy, boards, entrance and success criteria and other activities associated with the review. Program-level technical milestones are defined in NPR 7123.1, NASA Systems Engineering Processes and Requirements, and EGS executes those reviews in compliance with the NASA Procedural Requirements (NPR). Lower-level subsystem reviews (e.g., 30%, 45%, 60%, 90% design reviews) will be executed by the implementing organizations in accordance with their respective established processes.

EGS historical and active Life Cycle Review products can be accessed at the EGS Program Milestone Review SharePoint site:

<https://gsdo.ksc.nasa.gov/MR/Lists/MRLinks/AllItems.aspx>.

4.4.1 Operations and Sustainment Phase Review Strategy

EGS has established and demonstrated Program Initial Operational Capability (IOC). The summary of key Program-level milestone reviews conducted to accomplish this transition from program start to Phase E are documented in Appendix B.

Throughout the operations and sustainment phase, EGS will conduct periodic Program Status Reviews (PSR) to review program performance, trends, risks and implementation. EGS Program Implementation Reviews (PIR) may be conducted if directed by Agency leadership (see NPR 7120.5, NASA Space Flight Program and Project Management Requirements, for PIR triggers).

EGS will continue to perform development projects that provide safety and performance upgrades for flight crew certification and ground systems modifications to support vehicle upgrades and future missions as required by the mission manifest. EGS developmental upgrade projects will include life cycle reviews structured appropriately to the size and scope of the work to be performed.

Reflights of an SLS block configuration (i.e., Block 1) will utilize a streamlined review process employing EGS Operational Readiness Checkpoint (ORC) reviews at the program level. Upgrade projects to provide new capabilities for launch system block upgrades that exceed Agency thresholds of cost/complexity will re-enter the NPR

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7120.5/NPR 7123.1 lifecycle at Phase B/C with the appropriate governing management council. These Block upgrades may be of sufficient scope to trigger a Program-level Delta SAR/ORR for acceptance of the upgraded capabilities.

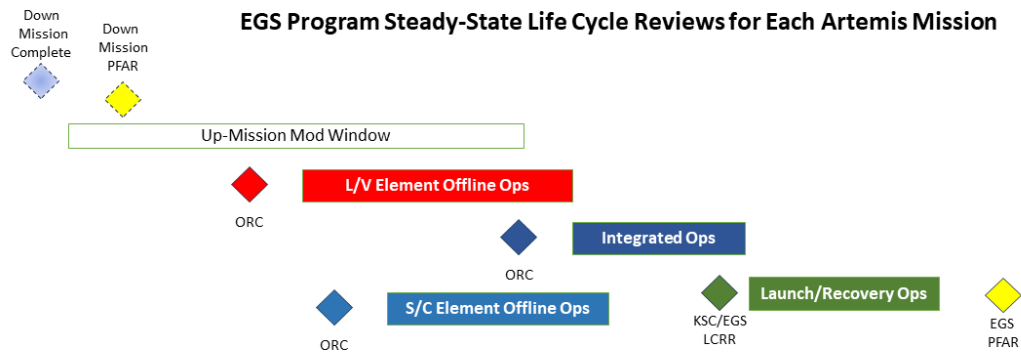


Figure 3 EGS Mission Focused Life Cycle Reviews

Each Artemis mission processing campaign will be initiated by one or more Launch Site Requirements Reviews (LSRR) where mission element specific requirements for processing will be baselined at the LRICB. LSRR will nominally be held at least 60 days prior to start of operations for the affected EGS processing segment (e.g., Booster Offline Processing, Spacecraft Offline Processing, and Vehicle Stacking/Integration Processing). The operations team will present the detailed plans, schedules, and procedures to implement the LSRR baseline for the processing segment at the associated Key Milestone Review (KMR), which will be held roughly 30 days before turnover of the associated flight elements for offline processing or one week prior to start of operations for integrated operations segments. Detailed description of KMRs is found in GSDO-PLN-1183, EGS Program Ground Operations Management Plan.

4.4.1.1 Operational Readiness

The program will conduct ORCs as needed to ensure that all upgraded/new subsystem capability projects have been successfully certified for use. EGS ORC is a functional equivalent to EGS Program SAR/ORR, and will occur prior to flight element processing operations. The ORC will focus on new/modified EGS capabilities and verify updated capabilities have been incorporated into the EGS baseline. ORCs are presented at EGS PCB. Center leadership is invited *ex officio* but not required. The ORC is structured like an SAR/ORR but does not require an Independent Review Team.

Each ORC will include an overview, GSE and Facility Certification Overview (subsystem by subsystem); it will also include a safety assessment, an HSI assessment and technical authority assessments. EGS ORC Success Criteria is customized from NPR

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7120.5, NASA Space Flight Program and Project Management Requirements and NPR 7123.1, NASA Systems Engineering Processes and Requirements.

The ORC pre-planning starts approximately 90 days prior to the associated operations segment for an Artemis mission. ORC reviews are conducted approximately 30 days prior to the operational start date and are evidence for EGS CoFR. Content from ORCs may be mapped into M2M-level ORR for an Artemis Mission as appropriate.

4.4.1.2 EGS Pre-Flight Readiness Review

EGS conducts an integrated Pre-FRR with the KSC institutions at the KSC/EGS Launch Center Readiness Review (LCRR). This review is the culmination of the CoFR process which is fully described in GSDO-PLN-1088, KSC/EGS Program Certification of Flight Readiness Plan.

4.4.1.3 Post-Flight Assessment

EGS conducts PFAs to review the observed performance of ground systems and processes in support of flight element receipt, servicing, integration, checkout, launch, and recovery. Problems encountered and lessons learned are reviewed with emphasis on ground system performance. EGS PFAs provide identification and analysis of modifications to ground systems and processes prior to conducting subsequent mission-flow operations. Output reports contribute to the closure of functional operational capability validation at the Enterprise level. The detailed PFA process is described in GSDO-PLN-1261, EGS Program Post Flight Assessment Plan.

The EGS PFA process for each mission begins with the start of flight element processing, accumulating lessons learned at each KMR for inclusion into assessment of the preceding operational segment. This accumulation continues through launch and recovery of the Orion Crew Module and crew.

The formal program-level Post-Flight Assessment Review (PFAR) for the mission begins with Post-Launch assessment quick-look reviews of subsystem launch performance 3-7 days after launch at the EGS PRB. These assessments evaluate the data collected and any nonconformances taken to inform the Program decision to proceed with disconnect of systems (i.e., Break of Configuration) at the pad and rollback of the ML.

The PFA process continues for several months culminating in the formal EGS PFAR nominally held four months post-splashdown.

4.4.1.4 Post Artemis I Acquisition Strategy

The SLS Block 1B configuration drives major infrastructure modifications to the KSC ground systems infrastructure. The modifications primarily impact the ML and VAB elements. The Pad and other elements will use discrete, independent stand-alone projects. To improve integration across all impacted ground systems during the design and development phase, several functions are consolidated at the Program level and a

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prime A&E is in place for each element. The A&E is responsible for all aspects of the design work including the delivery of pertinent products as part of the design package. These products are clearly defined in the SOW provided to the A&E. The A&E contractor will comply with KDP-P-2713A, Technical Review Process for A&E Design and Development.

The Engineering Directorate performs the LDE role, performs engineering reviews and analyses, provides technical authority and certifies the systems. PM, project engineering, scheduling, and program integration are performed within the EGS Program Office. The operations organization is engaged throughout design, development, and activation to ensure that requirements are met satisfactorily and that the system will operate efficiently as intended.

The Chief Engineer manages the technical baseline for all EGS subsystem projects. The IERB approves the PTM and DVM/System Requirements Document. In addition, the IERB approves system performance requirements, and review process (typically documented in the SOW). Changes to the technical baseline identified above require IERB approval (requirements and evidence of closure).

4.4.2 Closeout Phase Review Strategy

At the conclusion of active operations for segments of the EGS infrastructure, EGS will conduct a Decommissioning Review (DR) to confirm the decision to terminate or decommission EGS systems and assess the readiness for the safe decommissioning and disposal of affected system assets. DRs will be followed by Disposal Readiness Reviews (DRR) to confirm the readiness for the final disposal of the system assets.

4.4.3 Verification and Validation Test Readiness Reviews

The guidance in this section applies to Test Readiness Reviews (TRRs) conducted for V&V testing performed under the EGS Program. For details on the specific testing to which the guidance in this section applies, specific approval roles and TRR approval Board membership and the policy for which tests require a TRR refer to GSDO-MVVP-1042-02, EGS MVVP Volume 2, Program Verification and Validation Plan. In the case where a test is to be conducted using a contractor, it is EGS policy that TRRs be coordinated with the contractor so that both EGS and the contractor can effectively meet their requirements for TRRs. This statement does not mean that the EGS Program will follow contractor TRR processes. For the purposes of the discussion in the following sections, the term "Test Director" is used generically to refer to the person having responsibility for conducting a particular test or series of tests.

1. A TRR for an event will not be held for a verification or validation that is only inspection or analysis. The term "test" will be used to refer to events that include test or demonstration as verification/validation methods for the purposes of the TRR and Pre-Test Briefing (PTB) sections of this document.

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2. TRRs will most often be conducted to cover a logical grouping of tests or series of tests performed in a particular location or with a particular set of hardware but may also be held for a single major test.
3. The TRR will be held at least one week prior to the test or series of tests, to allow time to close out issues identified during the TRR.
4. EGS TRRs utilize GSDO-TEMPL-031, EGS Program Test Readiness Review Template. The TRR template provides guidance on TRR content and ensures that TRRs address the criteria in NPR 7123.1, NASA Systems Engineering Processes and Requirements, Table G.10.
5. For tests spanning multiple Elements, a test configuration drawing may be required, at the discretion of the DA; the DA is described in GSDO-MVVP-1042-02.
6. In addition to a TRR that will have the required level of detail for the particular test, a PTB will also be required before testing starts.
7. The TRR must include an assessment of the LCS role in planned tests as follows:

LCS Level Testing Approvals:

Level 0 – All local testing with zero connectivity to LCS

Level 1 – Test is Non-hazardous OR LCS behavior cannot directly increase the hazard, limit the control of the hazard or limit the ability to safe from a hazardous event.

Level 2 – Test is Hazardous and LCS behavior can cause a direct increase in the hazard, limit the control of a hazard or limit the ability to safe from a hazardous event.

Analysis for determination of Level 1 or 2 involves collaboration between Engineering and Safety to determine all hazards of the test and hazards present within the supporting system. Specific attention should be paid to the following while performing this analysis:

- LCS-based reactive control logic not functioning when it should be triggered
- LCS-based prerequisite logic not blocking commands when it should
- LCS data visibility reduction resulting in inability to adequately determine the state of a potentially hazardous system

The analysis should take credit for hazard controls outside of LCS. Operational mitigations such as clears, physical mitigations such as relief valves, and software controls such as those part of Kennedy Ground Control Subsystem

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(KGCS) can all be part of the analysis placing a test into Level 1 rather than Level 2.

8. System tests that require temporary/special reconfiguration of certified support systems (such as KGCS) shall have that configuration change reviewed and approved by the Operations Engineering Review Board (OERB) prior to the TRR event. If the reconfiguration has significant impact to cost/schedule, an OPPR/C3 Forum may also be required for approval.

4.4.3.1 Test Readiness Review Entrance and Success Criteria

The specifics for the TRR Entrance and Success Criteria for the entire EGS Program are listed in NPR 7123.1, NASA Systems Engineering Processes and Requirements Procedural Requirements, Table G.10 – TRR Entrance and Success Criteria. TRRs will be presented, as described below, for approval to proceed with the test. GSDO-MVVP-1042-02, EGS Program MVVP Volume 2: Program V&V Plan defines the responsibilities for TRRs including the presenting group, the DA, and the appropriate forum and audience.

4.4.3.2 Test Readiness Review Content

The purpose of a TRR is to demonstrate the readiness for proceeding into a test (or series of tests), to review the results of safety analysis/risk assessments related to the test (in accordance with GSDO-PLN-1036, EGS Program S&MA Plan), and to approve a plan of action for closing open items and constraints (as applicable). Items to be considered for possible constraints include any open work identified during previous reviews. If open items or constraints exist, TRRs will provide rationale for why the open items or constraints will not impact the test or what limitations open items and constraints may place upon full completion of the test. TRRs are not required for subsequent runs of the same test unless the Test Director (or designee) determines that substantial changes require another TRR.

The TRR presentation and the list of open items, waivers, exceptions and constraints identified during a TRR are Configuration-Managed items and as such will be available for reference in an official data repository. Ensuring that these items are Configuration-Managed is the responsibility of the Test Director (or designee) and the CM is to be performed per GSDO-PLN-1001, EGS Program ICM Plan.

The TRR presentation package must include a statement of readiness and the board voting members must concur with the statement of readiness in order to successfully complete the TRR. The Board concurrence must be captured and released into an official repository. If there is no concurrence, the testing cannot proceed.

TRRs will have the following minimum Board participants (representatives of these functions will be selected based on the level of the TRR):

- a. The TRR DA will chair the TRR

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- b. S&MA representative
- c. SE&I (responsible for requirements closure)
- d. Test Conductor(s)
- e. Independent Technical Authority(s) representative including Chief Engineer representative
- f. Design (Lead design expertise)
- g. Operations (planned user of the capability being tested)
- h. Program/Project Management
- i. Non-voting attendees will include support functions (facilities, SMEs and others as required) and other Management representatives (Division Managers, etc.).

The following guidance also applies:

Subsystem Offline testing is conducted by a design organization of a subsystem or group of equipment at a particular facility (location). This testing is conducted in accordance with the applicable processes and procedures of the design organization.

Element-level testing is performed within a single Element of subsystem(s) or equipment within one facility (or location), important enough to require EIT-level approval. Element-level testing may be end-to-end for the subsystem(s) and may include testing with associated monitoring and control systems. Subsystems are defined in GSDO-PLN-1043, EGS Program Master Subsystems List.

Multi-Element testing spans multiple Elements within an implementation team and includes tests that cover the functional capabilities provided by the Elements. Multi-Element testing also includes major operational capabilities within the EGS Program that do not require higher levels of approval.

Cross-implementation team testing includes multiple EGS Elements (e.g., ML and LPE or ML and VAB) where capabilities supplied by more than one EGS EIT are tested and the testing does not require approval at the highest level.

Cross-Program testing is testing that requires approval by all involved Programs, due to the complexity or importance of the test.

Note: The authoritative source for determining the level of testing is GSDO-MVVP-1042, EGS Program Master Verification and Validation Plan (MVVP).

4.4.4 Pre-Test Briefing

A PTB will be conducted before the commencement of testing. In the case where a test is to be conducted using a contractor, it is EGS policy that PTBs be coordinated with the

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contractor so that EGS and the contractor can both effectively meet their requirements for PTBs. The above statement does not mean that EGS will follow the contractor's PTB process. The PTB will be led by the Test Director (or designee) and will be conducted within two days of the test. The PTB will ensure, at a minimum, the test configuration is ready and available, and all the resources, facilities, procedures, and support items are available to support the scheduled activities. In addition, the PTB will address applicable open items, constraints, waivers, and exceptions identified during the TRR, as well as any open items or constraints identified since the TRR. If an open item or constraint is not cleared, the Test Director (or designee) must determine if parts of the test or the whole test can proceed without clearing the open item or constraint. The constraint must be cleared before executing the affected work. The PTB will include any participants identified as mandatory during the TRR.

The topics to be covered in a PTB at a minimum include:

- a. Personnel – Identify test team participants and readiness to support
- b. Test Objectives – Address if the work is being done under normal work procedures and/or addressing anomalies)
- c. Hazardous details, if applicable. This includes identification of the hazard, limited access locations, Personal Protective Equipment, and any special operator certifications required.
- d. Test Procedures status
- e. Special services or crews (e.g., high crew, heavy equipment)
- f. Emergency instructions (safing or evacuation procedures, etc.)
- g. S&MA topics as appropriate
- h. Questions and comments

4.4.5 Post-Test Briefing

At the conclusion of the test or series of tests, a post-test briefing will be held to address the following:

1. All test requirements have been met
2. All identified anomalies have been documented and processed with no further troubleshooting required
3. All deviations have been identified and approved as required.
4. Obtain team consent to deconfigure from test
5. Possible improvements to the design of any future operations have been identified (including improvements to Safety, efficiency, and Human Factors [HF]).

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4.4.6 Lessons Learned

The EGS Program will ensure that lessons learned are appropriately captured, documented, reviewed, and incorporated into future activities (e.g., lessons learned from a test event will be incorporated into planning for future test events). Prior to Artemis I, the program established a [Knowledge Management Tool](#) for candidate lesson collection. That initial collection site has been superseded by the COMET contract-owned Lessons Learned for COMET tool which the program will continue to use for collection and dissemination of lessons learned knowledge. *(The pre-Artemis I Knowledge Management Tool content remains in place for reference.)*

The EGS Program assesses lessons learned after major Program milestones, at the conclusion of testing activities, after major mission processing activities, and launch and recovery operations. Management briefings are conducted for lessons learned from major activities such as Multi-Element Verification and Validation, launch and L&R operations, and the lessons learned briefings are archived in TechDoc to support future activities across the M2M programs. Following Program-level lessons learned briefings, EGS assesses the lessons learned for possible entry into the NASA Lessons Learned Information System. The EGS Program implements the lessons learned requirements by collecting, vetting, and documenting Program lessons learned through KSC's institutional process KDP-KSC-P-2393, KSC Lessons Learned System.

EGS lessons learned are also captured and assessed as part of the PFA process for each mission as defined in GSDO-PLN-1261, EGS Program PFA Plan.

4.5 GROUND HARDWARE CERTIFICATION AND ACCEPTANCE

All hardware/software and infrastructure involved in ground operations with the SLS and Orion flight hardware require a formal Certification or Acceptance prior to use in operations with flight elements. This section describes the different ways in which that certification or acceptance occurs.

The GSDO-PLN-1055, Cross-Program Ground Hardware Integration Plan, establishes guidelines across the implementing programs (SLS, Orion, and EGS) for ground hardware development and certification activities of GSE being developed by SLS and Orion for use by EGS at KSC. The LRICB serves as the P2P forum for facilitation of issue resolution related to GSE development and certification activities for GSE being developed by SLS and Orion for use by EGS at KSC. Refer to GSDO-PLN-1055 for further information related to GSE provided to EGS by SLS or Orion.

The term "unmodified" in this document refers to subsystems and equipment on which only routine maintenance has been performed. Routine maintenance tasks include corrosion control, painting, and other tasks normally performed by maintenance organizations. The term "modified" refers to a change in form, fit, or function.

Equipment requiring Certification or Acceptance is grouped into four primary categories:

1. Developmental Subsystems

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- a. New/Modified Fluid, Mechanical, Structural, Facility, etc. subsystems currently under development by NE/IT/LX
- b. May include existing equipment in the design (the equipment is not standalone but part of the overall subsystem, e.g., reuse of an existing gaseous nitrogen (GN2) panel as part of a GN2 subsystem that is being modified)
- c. Will be certified or accepted via a Design Certification Review (DCR) or SAR as identified in GSDO-PLN-1043, EGS Program MSL

2. Unmodified Facility Systems

- a. Existing institutional facility systems that will not undergo development (modified Facility Subsystems are in the "Developmental Subsystems" category)
- b. Will be accepted for operational use via a Heritage Facility Subsystem assessment (Refer to section 4.5.2) and approval by the PRB

3. Standalone Heritage Equipment (this includes standalone unmodified equipment that is included in the grouped subsystems as defined in GSDO-PLN-1043 such as Handling and Access, elevators, etc.)

- a. Existing equipment that will be used without modification for operations
- b. Can be used "as-is" for identical operation as originally certified or repurposed to support a different operation without modification (note that repurposed equipment requires additional analysis as described in Section 4.5.3)
- c. Will be accepted for operational use via a Heritage assessment (Refer to Section 4.5.3 for GSE and 4.5.2 for facility systems) and approval by the PRB

4. Equipment transferred to EGS from another Program

- a. Includes the repurposing and reuse of hardware from other programs such as Launch Services Program
- b. Certified by Program providing the equipment via the process guidelines described in GSDO-PLN-1055 (refer to section 4.5.4)

In accordance with the EGS requirements development process, program requirements are decomposed and allocated to the architecture (reference GSDO-ACO-1010, EGS Program Architectures and Concept of Operations Document) and decomposed and allocated as appropriate to the subsystems which are defined by GSDO-PLN-1043. The implementing organizations satisfy those requirements through new designs, modifications to existing subsystems, and/or heritage equipment.

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For requirements satisfied by heritage equipment (standalone or part of new design), the OPR as identified in GSDO-PLN-1043 may choose to utilize a heritage assessment (Heritage Assessment or Heritage Facility Subsystem Assessment) per GSDO-PLN-1069, Cross-Program Heritage Ground Support Equipment Assessment and Certification Plan. The Heritage assessment is available as an option to the development organization allowing separate assessments of heritage equipment in lieu of testing. As an alternative, the OPR may choose to perform an end-to-end analysis of the subsystem in its entirety (including new, modified, and heritage components) to ensure requirements are met. This process applies to GSE subsystems and facility subsystems.

4.5.1 Developmental Subsystem Reviews

GSDO-PLN-1043, EGS Program MSL identifies and describes each of the subsystems, the OPR, and the type of review required to approve the system(s) for operational use. GSDO-PLN-1043 is the authoritative source specifying the acceptance/certification reviews required for subsystems. There are two types of certification/acceptance reviews for developmental subsystems specified in GSDO-PLN-1043:

- a. DCR
- b. SAR

For subsystems that are not part of the EGS DDT&E and/or that will not be turned over to EGS for operations, a SAR or a DCR is not required (this statement applies to L&R Subsystems). If capabilities are to be provided as a service type arrangement with another organization, they will undergo the typical Program Requirements Document (PRD) process as defined in GSDO-PLN-1174, EGS Program Site Activation Management Plan.

General Guidance for SARs and DCRs

Both DCRs and SARs are a collaborative effort between the design organization and the EIT(s) of which the subsystem is a part. The DCR and SAR will use KDP-P-2713, Technical Review Process, as a guide with the entrance and success criteria for the DCR and SAR as defined in sections 4.5.1.1 and 4.5.1.2 below.

SAR or DCR reviews may be conducted for individual subsystems or for groups of subsystems. For example – a project may modify a number of subsystems. The subsystem SARs or DCRs associated with that project may be conducted as a single combined review or in multiple reviews at the discretion of the project.

Subsystems or equipment requiring a SAR may be folded into a DCR, since a DCR represents a “higher bar”. Subsystems or equipment that have been accepted (SAR) as part of a combined DCR do not have their status changed for subsequent upgrade/modifications - the level of acceptance required for those subsystems remains as defined in GSDO-PLN-1043.

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SARs and DCRs must be tailored in collaboration with the ETA. This tailoring should be aimed at efficiently achieving the aims of the SAR or DCR considering size, complexity, risk and criticality of the systems being reviewed.

In cases where an EIT retains design responsibility for all or part of a subsystem (LX is indicated in GSDO-PLN-1043 as the OPR), the EIT will utilize a tailored version of KDP-P-2713. Tailoring of products to be produced will be documented using the PTM (KDP-P-2713) for all subsystems for which LX, IT and SI are the OPR and the PTM, DVM and any changes to the subsystem technical baseline will be approved by the IERB. Required SARs or DCRs will be conducted as described in the section 4.5.1.

Applicable standards and specifications (such as KSC-DE-512-SM, Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements) do not require decomposition into lower-level verification/validation requirements in the DVM. Adherence to KDP-P-2713 will ensure that standards compliance is met without need for additional documentation of detailed line-by-line DVM evidence statements for each applicable standard/specification.

The EIT(s) are responsible for presenting the closure status of DVOs and DVaOs and rationale for any DVOs and DVaOs that remain open with a closure plan. The EIT(s) are responsible for tracking all open work identified at DCRs/SARs.

The OPR is responsible for providing the DCR/SAR subsystem technical presentation.

The DCRs and SARs are conducted by the institutional design organizations (led by the OPR as documented in GSDO-PLN-1043). The Board for SARs is the IERB. The Board for DCRs is defined in B-0032, Design Certification Review Board (DCRB). For DCRs involving physical or functional interfaces to a flight program, the flight program should be considered for representation on the DCRB.

The SAR and DCR will also have the appropriate EGS personnel (EPM, EOM, and EGS ICM) in attendance. Where applicable, and as described in GSDO-MVVP-1042-02, EGS Program MVVP Volume 2: Program V&V Plan, external stakeholders will be included in these reviews.

Official records from the DCR/SAR include items such as all presentations, meeting minutes, action item log, and subsystem V&V reports from the requirements management tool. All official DCR/SAR records must be retained in a configuration-managed repository as specified by CM.

Alternate Certification Plan Review (ACPR)

Subsystems that support multiple phases of operations (such as Spacecraft Offline processing and Integrated SLS/Orion Test Checkout and Launch processing) may have a need to break full system certification into two or more phased configurations driven by schedule or technical issues. To allow EGS program agility to meet Artemis manifest needs, the certification events may be partitioned to allow certification of subsets of the

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total system capability to allow offline flight element processing to proceed while final development/verification of full system capabilities continues.

To accomplish this configuration-based certification, the project must present a detailed ACPR to the IERB and the PRB for approval and program acceptance of any risks this may present. The ACPR must define in detail the successive configurations being requested for approval. The ACPR must address all baselined and proposed system Requirements/DVOs/StEs/DVaOs and show the applicability of each to the specific configurations being requested. This may require the addition of configuration-specific DVOs/DVaOs to the system requirements in Cradle®. The ACPR must provide justification for the subset of verifications for each configuration as providing adequate certification evidence to safely operate the defined system configuration. For each defined configuration, required system products as defined by the PTM must be completed and released prior to the configuration certification event (DCR/SAR) to sufficiently document the certified configuration.

The final configuration certification event will address the full system capability and show that all requirements are met, and that all system products are complete and released.

Upon approval of the ACPR by the PRB, the configuration-based certification phase events will be added and tracked in the Program Integrated Master Schedule (IMS). Each configuration-based certification event will be conducted in accordance with the DCR/SAR guidance instruction in the following sections.

4.5.1.1 Subsystem Design Certification Reviews

For Subsystems requiring a DCR per GSDO-PLN-1043, EGS Program MSL:

The DCR is the formal board review that confirms and endorses that all of the requirements and correlating verifications relating to a subsystem have been satisfied and that the subsystem logistics supportability issues have been addressed. The DCR confirms that the design is in compliance with applicable standards (e.g., KSC-DE-512-SM, Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements) and also serves the purpose of an EGS Program acceptance review. The initial DCR for a subsystem addresses the entire subsystem end-to-end to ensure that newly designed and heritage portions of the subsystem function together to meet the subsystem's requirements. Subsequent modifications to the subsystem that impact prior certification require a delta-DCR to address the changes to the system and ensure that the modified subsystem meets the current system requirements.

GSE must successfully complete a DCR prior to first use with flight hardware (flight hardware shall not be used to perform GSE V&V testing). All requirements (programmatic requirements, DVOs, DVaOs and subsystem-level engineering derived requirements [subsystem engineering requirements]) must be closed prior to obtaining the DCR certification.

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If it is expected that a requirement and/or StE will not be able to be closed, a variance must be processed in order to certify the subsystem and use it with flight hardware. If an open requirement and/or StE is allocated across multiple Elements and/or subsystems or has functionality across multiple Elements and/or subsystems, and the DVO and/or DVaO item were shown as satisfied at the associated subsystem DCR, then the system is approved for **limited use** based on the certified configuration.

Subsystems required to have a DCR must have completed a DCR, a V&V Status Review (VSR), or a Requirements Closure Review prior to being used in hazardous integrated V&V test operations with other subsystems (this does not include hazardous V&V testing of the subsystem itself). Refer to the sections below for additional discussion of VSRs.

After executing GSE subsystem V&V testing and prior to supporting a GSE Subsystem hazardous testing TRR, the Design Team (including program S&MA and GIE) will review their respective TRD, V&V as-run procedures, and other relevant evidence as applicable to:

1. Update an in-work (not released) version of the DVM in KSC Design Data Management System (KDDMS) indicating in the Design Team Status Column which requirements have been satisfied and
2. Complete charts for the TRR indicating the status of these items:
 - a. V&V Test Status (TRD Doc #, As-Run Procedures #)
 - b. Requirements Status (closed/open, are any open a constraint to ability to support hazardous testing – leverage any Reliability and Safety Analysis Report [RSAR]/ Hazard Analysis Risk Assessment [HARA]/Ground Ops Risk Assessment [GORA] to substantiate)
 - c. Open Items Review and confirmation that no open items are a constraint to ability to support hazardous testing
 - d. Standalone Electromagnetic Interference (EMI) Status (may be addressed as part of open requirements)
 - e. Pressure Vessel Systems (PVS) data as applicable

Note: There may be open items and actions carried past DCR, however, it is expected that prior to entering a DCR, all allocated programmatic/subsystem requirements (including programmatic and engineering derived requirements), StEs, DVOs, DVaOs are closed for the subsystem under review. In rare cases a DCR may be necessary prior to closing all programmatic/subsystem requirements, StEs, DVOs, DVaOs and subsystem engineering derived requirements. In these cases, EGS PRB approval is required prior to conducting the DCR, where the PRB Chair will accept the technical risk associated with Program/Subsystem requirement closure deferrals post-DCR. The PRB presentation, using the Open Requirements Proposal Review (ORPR) template, must

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present rationale for proceeding to DCR with the open requirements, must include closure plans (including funding and schedules) for the open requirements, and must identify the associated risks (technical/schedule). Open programmatic/subsystem requirements, StEs, DVOs, DVaOs and subsystem engineering requirements at the subsystem DCR will be captured as action items via external constraints that will be tracked to closure in support of the operational first use event. If a DCR is conducted where items are open, then these open items must be closed prior to the relevant Program-level Integrated ORC or delta-SAR/ORR. If these open items are not closed prior to the applicable ORC or delta-SAR/ORR, this results in a Systems Engineering Management Plan Process Deviation that must be approved by the PRB to continue into the applicable operational phase and potentially into operations with flight hardware. These open items will be clearly documented with a plan forward for closure and any associated risks identified for approval at PRB.

DCR technical reviews that are conducted by SI on behalf of EGS will use KDP-P-2713, Technical Review Process, as a guide. If a DCR is conducted for a subsystem specific to an EIT, the entrance and success criteria as well as requirements (DVOs/DVaOs) will only address the applicable EIT.

Note: The design of some subsystems may include heritage components that were certified in previous projects/programs but will be included in the end-to-end subsystem design (e.g., a regulator panel in a gaseous helium [GHe] system). As the DCR will certify the end-to-end design of the system, it is the responsibility of the team conducting the DCR to ensure that all heritage end items or components are addressed.

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4.5.1.1.1 Subsystem Design Certification Review Entrance Criteria and Products

1. DCR Certification package has been made available to the participants prior to the review. Contents of the Certification Package are provided below.
2. All design-to requirements (including EGS Program Requirements allocated to the subsystem/GSE, subsystem specifications or other derived requirements) for the subsystem/GSE have been satisfied, or PRB approval of closure plan exists for those remaining open.
3. All DVOs have been closed or PRB approval has been obtained and a timely closure plan exists for those remaining open. DVOs/DVaOs status and subsystem V&V reports from the requirements management tool will be provided.
4. All applicable Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) activities have been identified and mitigated or a rationale for their acceptance exists.
5. All hazards have been dispositioned and successfully mitigated or operations controls have been identified.
6. All Problem Reports (i.e., anomalies and nonconformances) have been successfully dispositioned.
7. All operational and maintenance requirements (Operations and Maintenance Requirements and Specifications Document [OMRSD] or O&M data) for the item have been defined and approved and all operating constraints for the item have been identified.
8. The required ADP/material history associated with the product baseline has been released to CM control.
9. Open items have been identified and a timely closure plan exists with identified constraints for each item.
10. Logistics analyses have been conducted for the subsystem, any open issues are understood and a plan to address them is in place.
11. Electronic or direct access to obtain specific evidence that may be required during DCR has been provided to review participants.
12. All reused/existing hardware in subsystem has been addressed.

4.5.1.1.2 Subsystem Design Certification Review Success Criteria

1. Required tests and analyses are complete and indicate that the system meets all design and functional requirements.
2. Risks (reference GSDO-PLN-1013, Exploration Ground Systems Program Risk Management Plan) are known and manageable.

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3. Technical data package/ADP are complete and reflect the delivered system.
4. Applicable lessons learned for organizational improvement and system operations have been submitted to the appropriate lessons learned information system.
5. Waivers or deviations are approved by the conclusion of DCR, or PRB approval of requirement closure plan exists for those requirements remaining open.
6. Board members have approved the Statement of Certification.
7. Functional Configuration Audit (FCA) and Physical Configuration Audit (PCA) reports from the CM organization have been completed. PRB approved closure plans for open requirements include provision for final FCA/PCA amendment of the associated subsystem ADP(s).

4.5.1.1.3 Certification Package

A certification package contains documented evidence that all verification requirements for a Subsystem/GSE have been satisfied, the design is in compliance with applicable standards (e.g., KSC-DE-512-SM, Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements), and that the Subsystem/GSE is ready for operational use. The following are the minimum required contents of a certification package:

- a. Table of Contents
- b. Project Team Membership
- c. Pictures of Subsystem/GSE
- d. Overview of Subsystem/GSE
- e. Project History
- f. Requirements Traceability and Status
- g. Technical Concerns
- h. O&M Documentation Summary (e.g., ADP, OMRSD, System Documentation List, Software Version Description Document)
- i. ICDs, if required
- j. Safety, Reliability, Maintainability and Quality Assurance Summary (e.g., System Assurance Analysis, FMEA, HA, CIL, Risk Analysis for legacy, heritage or reused software)
- k. CM Summary (e.g., summary of reports from FCA and PCA)
- l. Verification Testing Summary

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- m. Validation Testing Summary
- n. Program Deviations Waivers
- o. Open Work Issues
- p. Statement of Certification (Required Signatures: All DCR Team Members)
- q. Heritage Assessment (if applicable)

4.5.1.2 Subsystem System Acceptance Review

For subsystems requiring a SAR per GSDO-PLN-1043, EGS Program MSL:

The Subsystem SAR verifies the completeness of the specific subsystem in relation to the expected maturity level and assesses compliance to StEs. The SAR examines the subsystem design and functional requirements with respect to its end products, documentation, test data and analyses. The SAR confirms that the design is in compliance with applicable standards and that all of the requirements have been verified and that the subsystem's logistics supportability issues have been addressed. Subsystems implemented through NE and IT will perform SARs in accordance with KDP-P-2713, Technical Review Process, and guidelines as applicable. SAR technical reviews that are conducted between SI and EGS will use KDP-P-2713 as a guide. If a SAR is specific to an EIT, the entrance and success criteria as well as requirements (DVOs/DVaOs) will only address the applicable EIT.

Note: The design of some subsystems may include heritage components that were certified or used in previous projects/programs but will be included in the end-to-end subsystem design (e.g., a regulator panel in a GHe system). As the SAR will verify the end-to-end design of the system, it is the responsibility of the team conducting the SAR to ensure that all heritage end items, or components are addressed. An approved heritage assessment may be used to fulfill the SAR requirement for standalone (independent) heritage equipment within the subsystem.

All requirements (programmatic requirements, DVOs, DVaOs and subsystem-level engineering derived requirements [subsystem engineering requirements]) must be closed prior to obtaining the SAR certification. If it is expected that a requirement and/or StE will not be able to be closed, a variance must be processed in order to certify the subsystem and use it with flight hardware. If an open requirement and/or StE is allocated across multiple Elements and/or subsystems or has functionality across multiple Elements and/or subsystems, and the DVO and/or DVaO item were shown as satisfied at the associated subsystem SAR, then the system is approved for **limited use** based on the certified configuration.

Prior to supporting a GSE Subsystem hazardous testing TRR, the Design Team (including program S&MA and GIE) will review their respective Heritage Assessments, TRD, V&V as-run procedures, and other relevant evidence as applicable to:

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1. Update an in-work (not released) version of the Subsystems Requirements Document/DVM indicating which requirements have been satisfied and
2. Complete charts for the TRR indicating the status of these items:
 - a. V&V Test Status (TRD Doc #, As-Run Procedures #)
 - b. Requirements Status (closed/open, are any open a constraint to ability to support hazardous testing – leverage any RSAR/HARA/GORA to substantiate)
 - c. Open Items Review and confirmation that no open items are a constraint to ability to support hazardous testing
 - d. Standalone EMI Status (may be addressed as part of open requirements)
 - e. PVS data as applicable

Note: There may be open items and actions carried past SAR, however, it is expected that prior to entering a SAR, all allocated programmatic/subsystem requirements (including programmatic and engineering derived requirements), StEs, DVOs, DVaOs are closed for the subsystem under review. In rare cases a SAR may be necessary prior to closing all programmatic/subsystem requirements, StEs, DVOs, DVaOs and subsystem engineering derived requirements. In these cases, EGS PRB approval is required prior to conducting the SAR, where the PRB Chair will accept the technical risk associated with Program/Subsystem requirement closure deferrals post-SAR. The PRB presentation, using the ORPR template, must present rationale for proceeding to SAR with the open requirements, must include closure plans (including funding and schedules) for the open requirements, and must identify the associated risks (technical/schedule). Open programmatic/subsystem requirements, StEs, DVOs, DVaOs and subsystem engineering requirements at the subsystem SAR will be captured as action items that will be tracked to closure and added to an operations constraints list (e.g., for use with flight hardware or in certain operations). If a SAR is conducted where items are open, then these open items must be closed prior to the relevant Program-level Integrated ORR.

4.5.1.2.1 Subsystem SAR Entrance Criteria and Products

1. SAR technical Review products (e.g., Drawings, V&V procedures, Transition Plan, O&M Requirements) have been made available to the participants prior to the review.
2. All design-to requirements (including EGS Program Requirements allocated to the subsystem, subsystem specifications or other derived requirements) for the subsystem have been satisfied, or PRB approval of closure plan exists for those approved to remain open.

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3. All DVOs have been closed or a timely closure plan exists for those remaining open. DVOs/DVaOs status and subsystem V&V reports from the requirements management tool will be provided.
4. Center infrastructure (power distribution, bridges, etc.) necessary to support the Subsystem functionality has been assessed for adequate performance and connectivity.
5. Electronic or direct access to obtain specific evidence that may be required during SAR has been provided to review participants.
6. Logistics analyses have been conducted for the subsystem, any open issues are understood and a plan to address them is in place.
7. Assessments (e.g., Heritage Assessments) complete for reused equipment in subsystem, if applicable.

4.5.1.2.2 Subsystem SAR Success Criteria

1. Required tests and analyses are complete and indicate that the system will perform properly in all specified operational environments.
2. Risks (reference GSDO-PLN-1013, Exploration Ground Systems Program Risk Management Plan) are known and manageable.
3. System meets the Requirements or PRB approval of requirement closure plan exists for those requirements remaining open.
4. ADP/Technical Review Products complete and reflect the delivered system.
5. Applicable lessons learned for organizational improvement and system operations have been submitted to the appropriate lessons-learned information system.
6. Operations organization endorses the availability and adequacy of subsystem.

4.5.1.3 Verification and Validation Status Reviews

In order to complete DCRs for complex subsystems, the KSC Engineering Organization may utilize an incremental approach called VSRs. The scope of the VSR is limited to a specific set of subsystem functionality (requirements and capabilities) and does not address all its capabilities. The VSR is used to close out V&V activities that have been completed at the time of the review and serves as the basis for EGS accepting the subsystem for a limited scope for non-flight element ground operations with constraints identified during the VSR. The VSR provides a thorough review of a specific subset of the subsystem and is used to incrementally close out requirements and build-up evidence required for the final subsystem DCR (**VSR does not replace a DCR**). VSRs are currently described in the KTI-2713C, Engineering Directorate (NE) Certification Review Team Technical Instructions, and will be included in the Engineering Organization review and transition plan.

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4.5.2 Unmodified Facility Subsystems

Unmodified Facility Subsystems (UFS) are existing institutional facility subsystems that will not undergo development, and which are to be used to accomplish EGS operations. All UFS that meet EGS Program requirements will undergo a Heritage Facility Subsystem Assessment per GSDO-FM-1297, EGS Program Heritage Hardware Assessment Data Sheet. Any existing facility subsystems with no direct requirements from EGS will require no review or assessment.

The Heritage Facility Subsystem Assessment is used to identify potential impacts of activating and using these subsystems in order to meet EGS requirements. Heritage Facility Subsystem Assessment ensures that applicable EGS requirements are satisfied by the subsystem; provide analysis of any risks of using the subsystem to meet EGS requirements (historical subsystem performance issues, outstanding maintenance and repairs, subsystem supportability, or other issues); and ensures readiness of the subsystem to support operational needs.

Complete Heritage Assessments (including parts 1 and 2) will be required prior to first use of a specific piece of equipment. The Part 2 Heritage Assessments will be reviewed and concurred by the applicable EIT and approved at the PRB. The assessments are documented in GSDO-RPT-1086-01, EGS Program Vehicle Integration and Launch Heritage Hardware Assessments and GSDO-RPT-1086-02, EGS Program Offline Processing and Infrastructure Heritage Hardware Assessments.

4.5.3 Standalone Heritage Equipment

This section describes the identification and approval process for equipment previously used in past Projects/Programs and transferred to EGS for operational use in its existing configuration. This equipment may be an entire subsystem, as defined in GSDO-PLN-1043, EGS Program MSL, or only an independent part, standalone part of a subsystem (e.g., a piece of Handling and Access consisting of a sling or hoist). Since no changes will be made to the configuration of this equipment, the equipment in this category does not undergo the design and development process led by Design Engineering (tasks may have been performed by the O&M organization such as painting, corrosion control, calibration and other routine maintenance tasks, these are not considered new design). Therefore, it will not be certified for operational use via a subsystem DCR or SAR. The organization performing O&M retains control of this hardware from the original transfer to EGS through operational use and is responsible for providing the necessary assessment to verify the hardware can meet the requirements levied on it (e.g., in the EGS requirements tool).

There are two subcategories of Standalone Heritage Equipment that will be addressed:

1. Heritage GSE

This equipment will require an assessment for reuse or repurposing per the guidelines established by GSDO-PLN-1069, Cross-Program Heritage Ground

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Support Equipment Assessment and Certification Plan. Heritage GSE Assessments are led by the appropriate EIT and approved by the PRB. Heritage GSE assessments will consider deviations or waivers that applied to heritage GSE under the Program (e.g., Space Shuttle Program) from which the hardware was obtained; any deviations or waivers may affect the GSE's ability to meet EGS requirements. If Heritage GSE requires a deviation or waiver for use by EGS, a waiver must be requested using the applicable EGS process. This assessment is defined below and the assessment data form is GSDO-FM-1297 – EGS Program Heritage Hardware Assessment Data Sheet.

Heritage GSE can be operated in two ways:

- a. Use "as-is": Non-modified heritage hardware equipment certified from previous programs that will function and operate as originally designed.

Use "as-is" Heritage Hardware Equipment will be assessed via heritage assessment to ensure that no configuration changes have been made to the equipment, intended process, or application since the Hardware was last controlled by the previous Program and that there are no unincorporated configuration changes.

- b. Repurpose: Non-modified Heritage Hardware Equipment from previous Programs that will be used in a different application from past use.

Repurposed Heritage Hardware Equipment will be analyzed by Operations to ensure that the Hardware Equipment's new application/function does not exceed the designed-to specifications (lifting loads, pressures, safety device applications, power ratings, etc.). The GSI Chief Engineer will authorize use of repurposed heritage equipment. If the repurposed use of the equipment exceeds the previous designed-to specifications, the equipment will be analyzed by design engineering to determine whether or not the equipment may be used as-is. If repurposed use is not within scope of original design, then a delta-DCR will be required to certify the hardware equipment for its new use or application.

2. Heritage Non-GSE

Existing equipment not incorporated into new/modified designs and not designated as GSE but is required in order for the subsystem to function, will be selected and turned over to the responsible Operations organization for maintenance and reuse to support the EGS Program as needed. This equipment will be transferred per established KSC processes for equipment transfer.

A condition assessment will be performed for all non-GSE that is not part of an end-to-end subsystem design but is required in order for the subsystem to function. The condition assessment is to be performed by the Operations organization. The EOM is responsible for planning and overseeing the progress

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of these condition assessments. In cases where the EIT identifies non-GSE as essential or critical to Operations, a Heritage Assessment may be performed instead of a condition assessment.

A full condition assessment for each non-GSE item must be completed before the item's first use in V&V testing or operations. A non-GSE condition assessment evaluates overall condition and ranks each item between new/like new (no corrective maintenance required) to very poor (major correction required) condition.

4.5.3.1 Heritage Equipment Planning Assessment and Maturity

Prior to the IPT Preliminary Review (IPR), all Standalone Heritage GSE and UFS being considered for use by EGS had a preliminary Heritage Assessment performed. The assessments were data managed products and have been incorporated into GSDO-RPT-1086-01, EGS Program Vehicle Integration and Launch Heritage Hardware Assessments, and GSDO-RPT-1086-02, EGS Program Offline Processing and Infrastructure Heritage Hardware Assessments.

4.5.3.2 Heritage Equipment Identification

Heritage Equipment is chosen from existing inventories that have been properly vetted for reuse by both EGS and the responsible Flight Program if required. If multiple units of selected Heritage equipment exist, then the equipment that is in the best condition will be selected for operational use and the extra units will be tagged out to separate them from the operational units. Tagged out items may be retained for spare parts by the owner/sustainer or excessed.

4.5.3.3 Heritage GSE Assessment and Acceptance Process

Assessment and acceptance of heritage GSE is governed by the GSDO-PLN-1069, Cross-Program Heritage GSE Assessment and Certification Plan, as well as the information found within this document. The heritage assessment process utilizes an approach that ensures the identified GSE meets EGS requirements and is functional for use with minimal risks and cost impacts. After the Heritage GSE has been identified, GSE Heritage Assessment will be completed per GSDO-FM-1297, EGS Program Heritage Hardware Assessment Data Sheet.

This process will be used for Heritage use-as-is GSE. Also, this process will be used for repurposed GSE with an additional analysis to confirm the new GSE application does not exceed the original GSE designed-to specifications. This assessment process may be performed at a number of levels of detail to offer a cost/risk trade-off. As stated above, this part focuses on five areas of emphasis as described below.

1. GSE Requirement Assessment:

Compare Heritage requirements with new Program requirements. Verify the new requirements are equivalent to the Heritage requirements. Compare the Heritage

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Flight Vehicle with the new Flight Vehicle ground processing configuration (e.g., Shuttle Solid Rocket Booster configuration used for new SLS Booster configuration). Does the new Flight Vehicle ground processing configuration accommodate the as-is Heritage GSE. If conflicts exist, then further analysis must be completed to determine if Heritage GSE will meet new Program requirements.

2. Hardware operability and configuration verification:

Review of Heritage Hardware documentation and physical walk downs will be a part of identifying any open items or unincorporated configuration changes. Where open items are identified, an engineering assessment shall be performed to determine:

- a. if the open item affects configuration
- b. if the open item needs to be implemented
- c. if the open item disqualifies the Hardware for reuse
- d. if the open item is inconsequential

3. Logistics Supportability Assessment:

Logistics shall perform supportability assessments. As part of these assessments, Logistics will coordinate with engineering to identify subsystems or parts of subsystems that will be transitioned. Logistics shall review identified Heritage subsystems drawings and parts lists and determine the availability and supportability of Line Replaceable Units and Shop Replaceable Units that make up these subsystems. From this, any obsolescence, limited life or vendor support concerns will be identified and addressed. This Supportability Assessment will aid in the engineering assessment for reuse.

4. S&MA Assessment:

Safety shall review existing S&MA analysis documentation. For use as-is Hardware existing S&MA analysis documentation will remain intact and unchanged. Existing S&MA analysis is considered sufficient for use by the acquiring Program until a configuration change or repurpose has been identified. For Heritage system/equipment without existing S&MA analysis documentation, S&MA shall determine the appropriate level of analysis to be performed.

An updated HA for repurposed Heritage Hardware shall be performed. The updated HA may use the existing safety assessment as a starting point and assess the design and operational hazards introduced by the changes made to the hardware, software, operations, maintenance, or environments for the future use of the repurposed Heritage Hardware (i.e., non-explosion proof Hardware now used in a hazardous environment, lifting equipment used in a new configuration, etc.). The updated HA shall identify any shortfalls between

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compliance with the original Hardware safety design standard and the new Program Hardware safety standard as applicable.

5. Preservation O&M and Functional Validation:

Once Heritage Hardware is identified the O&M requirements or Maintenance Plans will be based on historical and present job plans for preserving Hardware during non-operational status to eliminate Hardware degradation. This preservation maintenance will be adhered to until operational status changes to active at which time normal periodic maintenance will be performed. Functional validation shall be performed to ensure operational readiness prior to use. Functional validation will include but not limited to calibration, load test, sampling, etc.

Figure 3 below depicts the overall high-level process for the heritage hardware assessment. Note all assessments and recommendations are reviewed by the applicable EIT and approved at Chief Engineers Review (CER). All EGS-provided Heritage Assessments will require baselining in the appropriate volume of GSDO-RPT-1086 at PRB.

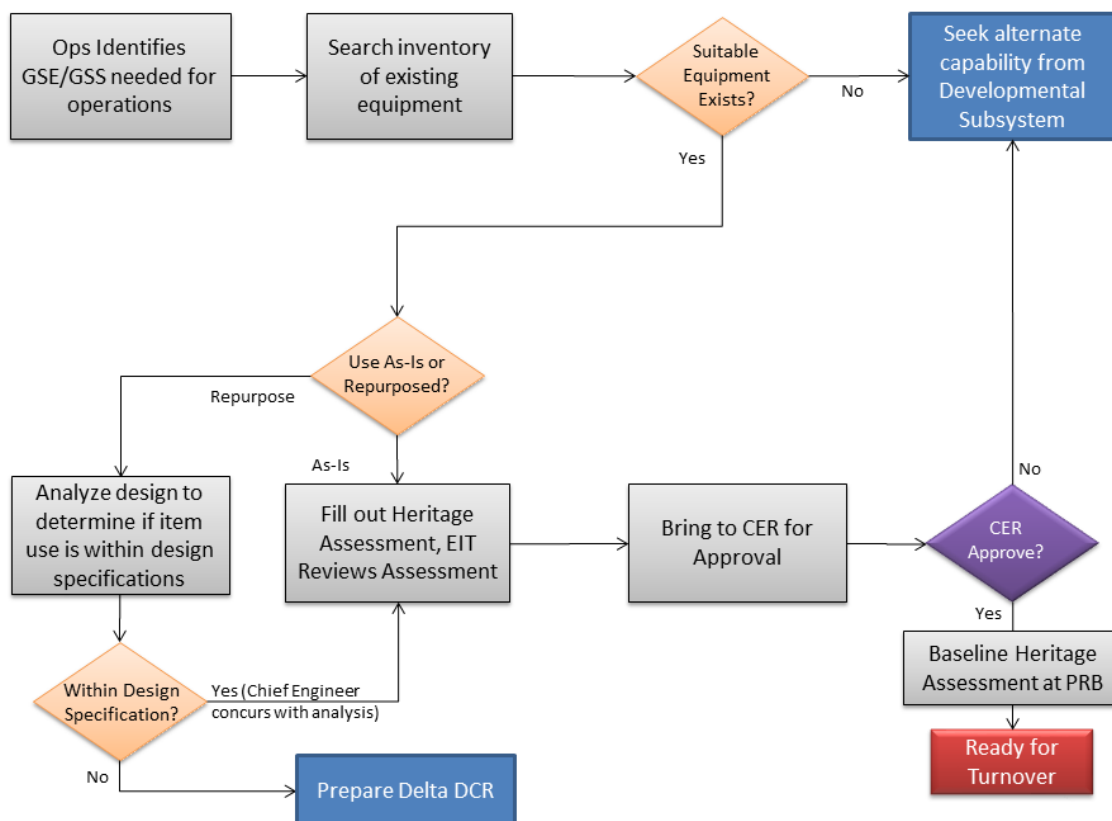


FIGURE 3 HERITAGE HARDWARE ASSESSMENT DECISION FLOW DIAGRAM

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4.5.3.4 Heritage GSE Assessment Approval

“As-is” GSE

After completion of the Heritage Assessment the five areas of emphasis are recorded on GSDO-FM-1297, EGS Program Heritage Hardware Assessment Data Sheet, and reviewed and concurred by applicable EIT, the use “As-Is” Heritage Assessment will be approved at CER. All EGS provided Heritage Assessments require baselining in the appropriate volume of GSDO-RPT-1086 at PRB. See figure 4.

Repurposed GSE

After analysis of hardware’s new function and the successful completion of the five areas of emphasis are recorded on GSDO-FM-1297 and reviewed and concurred by applicable EIT, the use “Repurposed” Heritage Assessment will be approved at CER. If use of repurposed heritage GSE is outside the scope of the original certification, a DCR will be required for that item. All EGS provided Heritage Assessments require baselining in the appropriate volume of GSDO-RPT-1086 at PRB. See figure 4.

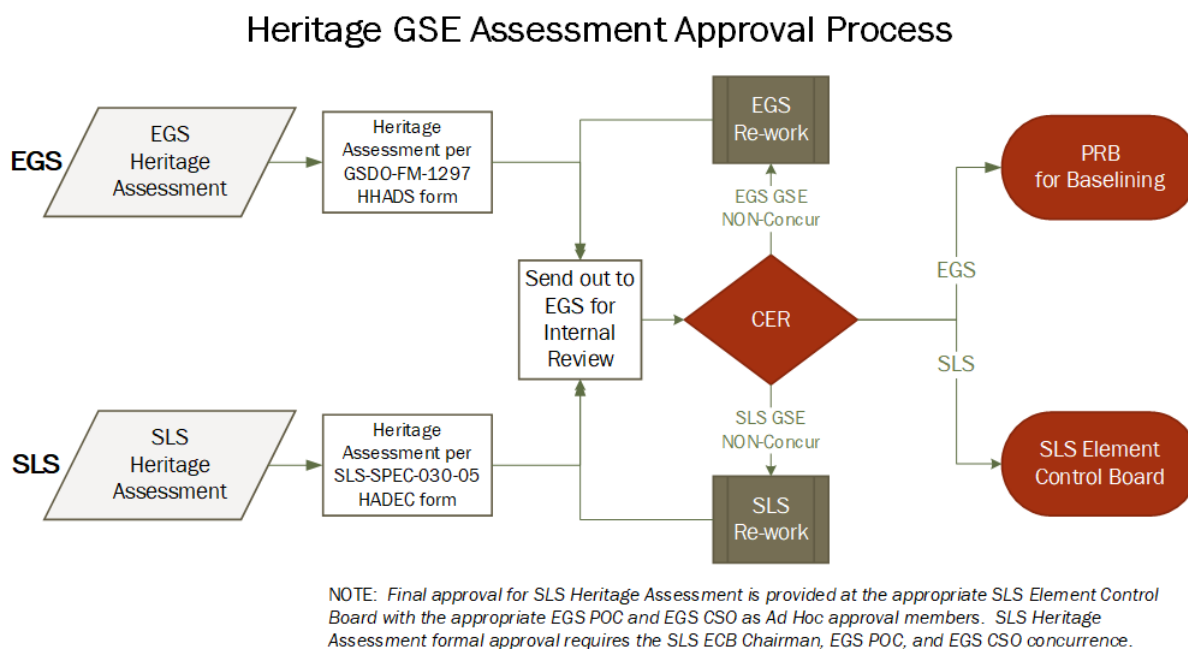


FIGURE 4 HERITAGE GSE ASSESSMENT APPROVAL PROCESS

SLS-Provided Heritage GSE

After SLS completes Heritage Assessment as defined in SLS-SPEC-030-05, SLSP Support Equipment Spec Vol V Heritage GSE Certification Process Plan, EGS will review and provide concurrence. EGS concurrence of SLS Heritage Assessments will be approved at CER. Final approval for SLS Heritage Assessment is provided at the appropriate SLS Element Control Board with the appropriate EGS POC and EGS CSO as Ad Hoc approval members. SLS Heritage Assessment formal approval requires the

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SLS Element Control Board Chairman, EGS POC, and EGS CSO concurrence. See Figure 4.

4.5.4 GSE Provided to EGS

Certified GSE delivered to KSC for operational use will require an audit of the documentation, including certification documentation, assessment of open items, and an inspection of the ADP (for residential support equipment) or End-User Reference Data (EURD) for rotational support equipment. GSDO-PLN-1027, Cross-Program Ground Hardware/Software Acceptance Data Package Plan, defines the ADP for residential support equipment. EURD is defined in GSDO-PLN-1055, Cross-Program Ground Hardware Integration Plan for rotational support equipment. Programmatic agreements for ADP and EURD to be delivered in advance to the hardware for Operations Procedure development will be annotated in appropriate BDEALS.

Figure 5 details the process for handling of offsite GSE provided to EGS for use.

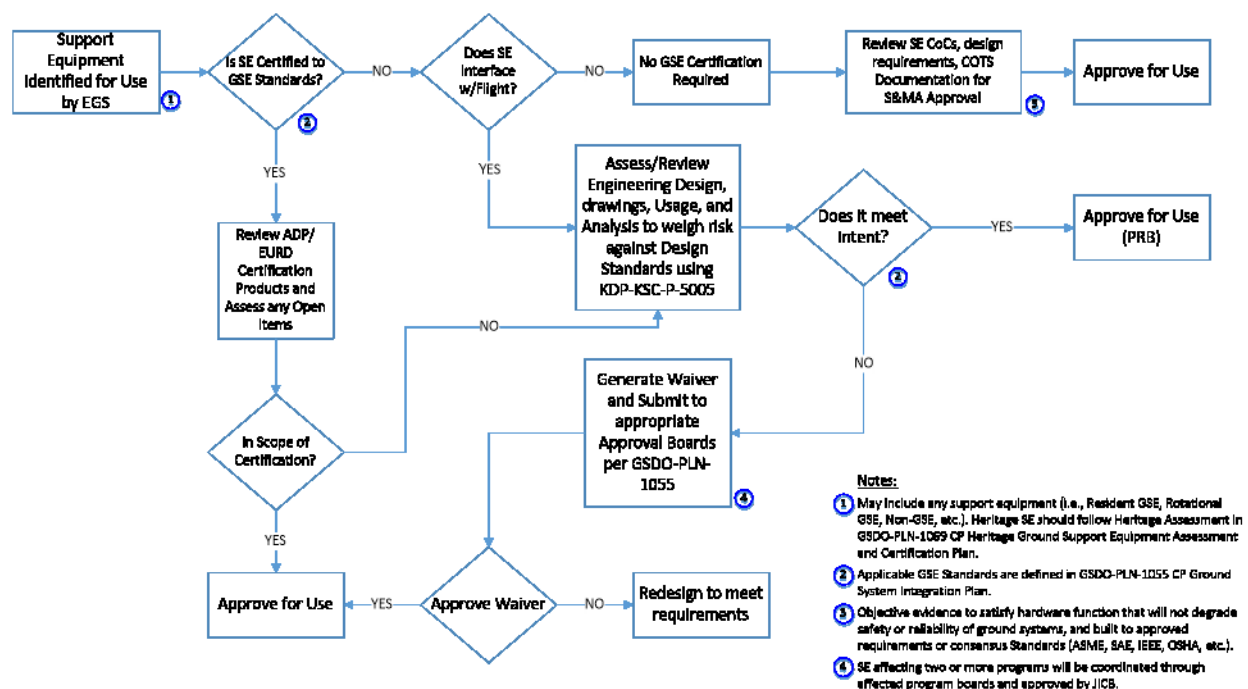


FIGURE 5 CERTIFICATION PROCESS DECISION DIAGRAM OF OFFSITE SUPPORT EQUIPMENT (SE) DELIVERED TO KSC

4.5.4.1 Use of Non-GSE or Manufacturing Equipment as GSE

Equipment not certified as GSE (manufacturing equipment, special test equipment, etc.) which has a proposed use that will have a physical or direct functional interface with flight hardware during vehicle processing, launch, recovery, transportation, storage, and de-servicing operations must be approved for use by the program. Hardware that can be shown to meet the intent of applicable engineering and safety requirements shall be

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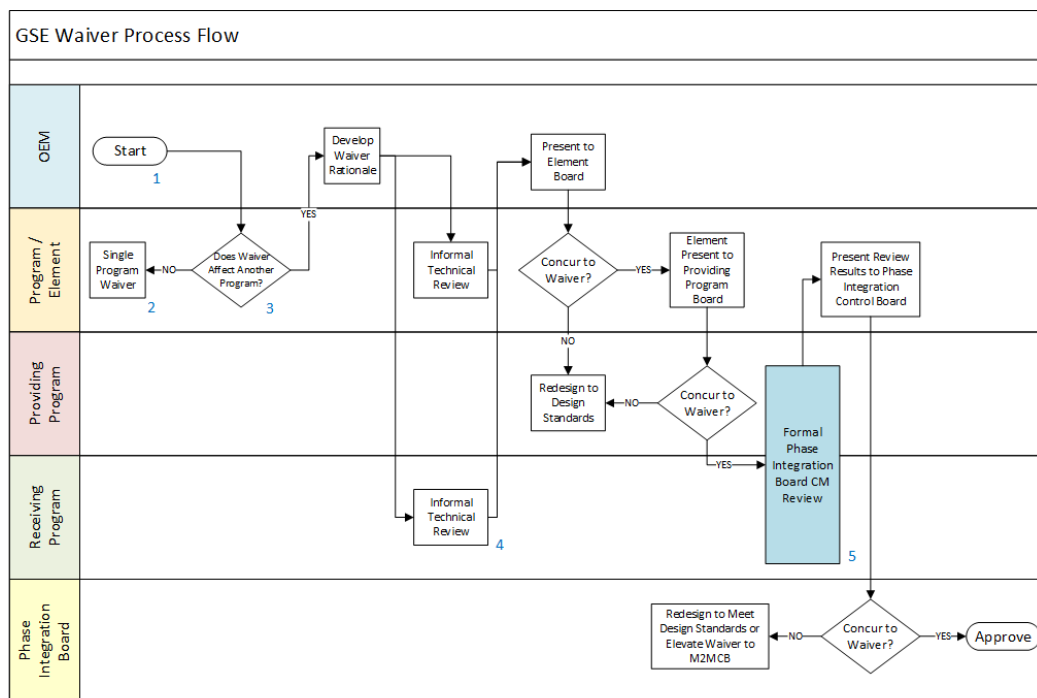
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accepted through KDP-KSC-P-5005, Process for Approval of Uncertified Ground Support Equipment. If the hardware does not meet the intent of applicable engineering and safety requirements, the following will apply:

1. A waiver to the applicable program design standard for GSE will be processed to identify requirements not being met, quantify risk, and document the justification for use (limited use, extenuating circumstances, etc.).
2. The equipment will be configuration-managed to a level necessary to quantify risk (material compatibility, factors of safety, fault tolerance, etc.).
3. Operational or procedural controls (including any specialized training) will be put in place as needed to mitigate risks during use of the equipment.

The program utilizing KDP-KSC-P-5005 verifies that the intent of engineering and safety requirements are met by the use of uncertified GSE within specified limitations. This process demonstrates that the design of uncertified GSE provided by organizations outside of KSC meets the intent of NASA-STD-5005, Standard for the Design and Fabrication of Ground Support Equipment, (or an approved alternative) prior to use at KSC. Approval requires submittal to the KSC IERB for technical review and recommend use of uncertified GSE to the EGS Program. The providing Program/Element will provide the technical rationale for use of uncertified GSE by EGS to the IERB, with facilitation provided by EGS cross-program ground hardware integration personnel.



Notes:	1. GSE not meeting Design/Tailored Standards
	2. Program option to notify EGS (awareness)
	3. Reference GSDO-PLN-1055 Waiver process to evaluate impacts/risks to Receiving Program
	4. Informal Review coordination / Ops Working Group engagement
	5. Includes additional Program Reviews (e.g. IERB, Technical Reviews, etc.)

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FIGURE 6 CROSS-PROGRAM GSE WAIVER PROCESS FLOW

GSE waivers that affect two or more programs require Phase Integration Control Board approval (Figure 6). The GSE waiver request will be documented by the providing program. The providing program will be accountable to coordinate any Waiver/Deviation with the receiving program and will provide the request and rationale for approval to the program boards. GSE waivers that affect only one program can be approved by that program's existing board structure and they can also determine if notification is warranted to other programs as applicable.

4.5.4.2 Shop Aids

Shop Aids are equipment utilized to support Flight Vehicle processing, maintenance, and/or handling of GSE or facility equipment. Shop Aids may not be used for lifting flight hardware, GSE, or personnel. Shop Aids may not be utilized if their use increases risk related to the operation they perform as defined in GSDO-PLN-1055, Cross-Program Ground Hardware Integration Plan, Section 9.0 (Assessment and Acceptance of Shop Aids).

4.5.5 Modifications to Subsystems After Certification or Acceptance

Subsystems and equipment may require modification after SAR, DCR or the completion of a Heritage Assessment. SAR, DCR and approved Heritage Assessments are used by EGS to accept hardware/software and certify them if required (not including hardware developed by SLS and Orion for use by EGS). These modifications may (but do not always) require an update to the SAR or DCR. The specific EGS processes and guidance for the upgrade of certified systems is fully documented in GSDO-PLN-1229 EGS Program Sustaining Engineering Plan. Guidance provided in this section supplements guidance provided throughout Section 4.5 of this document.

Modification of Heritage equipment that affects the critical form, fit, or function of the system, or provides a new capability meeting requirements beyond those of the heritage system requires a SAR or DCR (per GSDO-PLN-1043, EGS Program MSL) to re-certify the system. SAR or DCR shall address the scope of the modification and any effect it has (if any) to the critical form, fit, or function of the end-to-end system.

Heritage subsystems may be modified during routine maintenance or replacement of existing parts with parts approved in the engineering package without invalidating acceptance or certification of the subsystem. An example of this type of change is replacement of limited life items, corrosion control or swapping a valve for a different valve the engineering package indicates as an acceptable substitute. In the case of a Configuration-Managed system the engineering documentation must be updated to indicate the use of different parts in the as-built system.

GSE may be modified by replacing parts that do not interact with the GSE's functional or physical interactions with other systems (including flight hardware) without invalidating the DCR. An example of this would be replacing a door or panel fastener

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not involved in the function of the equipment or replacing castors on a GSE cart. The engineering documentation must be updated to reflect the change in the as-built configuration.

GSE may be modified by replacing a passive component or measurement device (gauge or flowmeter) with a part having similar characteristics and reliability at least as high as the component it is replacing without the need for an updated DCR. Approval must be obtained from a NASA SME or Chief Engineer's representative and this must be documented in the engineering package. The as-built configuration documentation must be updated to reflect the change. An example of this kind of change is replacing a flowmeter or gauge with one from the same manufacturer based on similar technology but with a slightly different measurement range.

4.5.6 Limited Use Test Equipment

Limited Use Test Equipment (LUTE) is not a hardware classification but a process used by the operations community to temporarily upgrade equipment. LUTE is engineering configured SE specifically designed and developed for a limited, non-recurring direct physical or functional interface with flight hardware. LUTE provides the process to approve the limited use of a GSE configuration that was not originally configured/certified for the requested configuration. All LUTE will be approved by the OERB for use for a specific function or functions. This includes Engineering test setup configurations using already certified active subsystems.

5.0 PROGRAM TECHNICAL PROCESSES

This section summarizes the implementation of NASA's Systems Engineering Common Technical Processes as tailored for EGS. Additionally, the EGS Document Links Library contains links to all EGS business and technical processes and procedures (Note that some processes may be standalone, and others are parts of plans). These processes and procedures allow for standardization and repeatability of execution. The processes and procedures are stored in TechDoc with unrestricted access. Process flowcharts and procedure documents are stored in .pdf file format. All processes and procedures are reviewed and updated periodically or as needed.

Table 4 summarizes all processes described herein and their OPR. The OPRs will be responsible for development, implementation and execution, tailoring, training, auditing, and improvement of their respective processes. In instances where EGS has process, procedures or plans detailing this information, the section of this document will provide a high level description and point to the associated process, procedure or plan.

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TABLE 4 EXPLORATION GROUND SYSTEMS TECHNICAL PROCESSES

Section	Common Technical Process	OPR
5.1	System Design Processes	
5.1.1	Stakeholder Expectations Definition	SE&I O&TM PM
5.1.2	Requirements Definition	SE&I
5.1.3	Logical Decomposition	SE&I
5.1.4	Physical Solution	SE&I O&TM
5.2	Product Realization Processes	
5.2.1	Product Implementation Process	PM
5.2.2	Product Integration Process	PM
5.2.3	Product Verification and Validation Process	PM, O&TM
5.2.4	Product Transition Process	PM, O&TM
5.3	Technical Management Processes	
5.3.1	Technical Planning Process	SE&I
5.3.2	Requirements Management Process	
5.3.3	Interface Management Process	
5.3.4	Technical Risk Management Process	PP&C
5.3.5	CM Process	PP&C
5.3.6	Technical Data Management Process	PP&C
5.3.7	Technical Assessment Process	SE&I
5.3.8	System Analysis Process	PM

Additional details for each process are included in the following sections.

5.1 SYSTEM DESIGN PROCESSES

5.1.1 Stakeholder Expectations Definition

Purpose:

The ground systems StE definition process is used to elicit and define use cases, scenarios, operational concepts (per GSDO-ACO-1010, EGS Program Architecture and Concept of Operations Document), and other StEs for EGS. Stakeholder Expectations

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are the means to capture user requirements. These user requirements should be baselined before technical solutions are contemplated. Expectations are statements of needs, desires, capabilities and wants that are not expressed as a requirement (not expressed as a "shall" statement). StE can be stated in either qualitative (non-measurable) or quantitative (measurable) terms. Expectations can be stated in terms of functions, behaviors, or constraints with respect to the product being engineered or the process used to engineer the product.

Organization:

The SE&I Division is responsible for the definition and documentation of the EGS StEs. The other EGS functional areas and KSC organizations support the SE&I Division in identifying, assessing, and validating the ground systems StEs. The ground systems stakeholders are identified in GSDO-PLN-1000, Exploration Ground Systems Program Plan.

Process Summary:

The SE&I Division, with support from the EITs and SMEs within the Program, leads the identification of stakeholders and the collection of users' needs and transformation into user requirements. M2M-30007, Artemis Integrated Concept of Operations, provides input for the top-level StEs for the Ground System.

SE&I documents the ground systems StEs and provides them as input to the technical requirements definition process. The EOM is responsible for development of StEs for their respective element. The requirements management process will ensure the expectations are traceable back to the stakeholder statements and down to the associated technical specification or requirements. This ensures that coordination for StEs is performed through SE&I and the EITs inward to other KSC Organizations (NE/IT/SI/SA) to satisfy StEs.

5.1.2 Technical Requirements Definition

Purpose:

The technical requirements definition process is used to translate Needs, Goals, and Objectives (NGOs) into requirements that are analyzed, decomposed, functionally detailed across the entire system, feasible, effective and constructible. This process encompasses defining and refining Program requirements into system, subsystem, and lower-level functional and performance requirements and interfaces to facilitate the design of the overall physical solution. Requirements definition provides measurable and verifiable requirements without specifying technological implementations or solutions.

The Architecture and Concept of Operations (ACO) and the M2M Functional Operational Capabilities are essential aspects of the requirements definition process. A functional analysis is completed to enable the development of lower tier functional and performance requirements that need to be allocated to the system physical architecture.

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Requirements definition is a highly iterative process. This process is complete when the functional architecture is in balance with the stakeholder requirements.

Organization:

The SE&I division has overall responsibility for Program requirements. The roles and responsibilities of the requirements development teams are defined in GSDO-PLN-1079, Exploration Ground Systems Program Requirements Management Plan. The EGS requirements management tool is used to capture and maintain developed requirements.

Process Summary:

These technical requirements are decomposed as defined in the Logical Decomposition process. EGS requirements definition is based in part on flight hardware processing needs as defined in the EGS ACO and applicable ICDs.

The data is analyzed to ensure proper definition and integrity. It is important to note that the GSI and C3 team management have been granted discretionary authority to align funding and execution based on the priority of baselined requirements. This means that the GSI and C3 team can make a change without having to get approval from a higher authority that:

- a. Does not breach the thresholds of the implementation team's allocated technical, schedule, and funding baseline and
- b. Does not affect another EGS implementation team

Members of the EGS Program implementation teams perform requirements definition in response to the needs of an external customer. The process evaluates external customer needs; determines the proper action (i.e., design analysis, services evaluation, or modification of existing KSC architecture) and disposition the data after the initial analyses are complete. The intent is to ensure that the EGS Program has the flexibility to address the requirements of M2M as well as external customers.

5.1.3 Logical Decomposition

Purpose:

The Logical Decomposition process is used to specify and allocate defined technical requirements into their associated set of linked derived technical requirements for input into the Physical Solution Definition process.

Organization:

The SE&I Division is responsible for the definition and execution of the Logical Decomposition process for programmatic requirements. SE&I is supported by the EGS implementation teams and EITs in decomposing and allocating technical requirements to the subsystem level. Additional roles and responsibilities for logical decomposition

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are further delineated in the GSDO-PLN-1079, Exploration Ground Systems Program Requirements Management Plan.

Process Summary:

a. M2M Requirements:

The primary path for M2M Directorate requirements decomposition begins with submission to the EGS Program. At this point the requirements are analyzed and a Program Architecture and Concept of Operations (GSDO-ACO-1010, EGS Program Architecture and Concept of Operations Document) are developed to support further definition. The Concept of Operations is then used to develop and decompose requirements to a set of Program "shall" requirements. The requirements are then further refined using a lower level Concept of Operations from which a functional analysis and requirements derivation is then performed. Decomposition of the M2M requirements may or may not be necessary at all levels in order to allocate all the requirements to the EITs or to an individual subsystem. This is an engineering judgment made during the analysis phase.

b. Commercial/Infrastructure/SLS/Orion Requirements:

Requirements coming into the EGS Program from commercial (external) or other Programs (SLS/Orion) are evaluated and analyzed by SE&I, the implementation teams, EITs, and Design and Operations organizations. After the incoming data is evaluated, SE&I personnel decide as to the degree of decomposition necessary and decompose and allocate the requirements as appropriate.

Note: For commercial customers the data inputs are allocated after Program analysis to the appropriate EIT(s). As a special case the NGOs and requirements may come in at a very granular level of detail or an overall capability that the EGS teams validate or decompose, design, and deliver.

c. Interface Requirements Development

Interfaces between EGS and flight vehicles are identified by the requirements development teams and documented in the EGS Requirements Management tool. The interface requirements are identified through working groups established between EGS and each of the flight Programs or other customers (e.g., working with commercial companies to identify the interfaces to their vehicle). Flight-to-Ground Interface Requirements are owned at the Program level and allocated directly to the appropriate EIT and subsystems.

5.1.4 Architecture Definition and Management Process

Purpose:

Architectures describe the structure of products, their relationships, and the principles and guidelines governing their design and evolution over time. The Architecture Definition and Management process is used to establish and update a baseline

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functional and physical architecture, establish bidirectional traceability to requirements and the operations concepts, identify areas for architectural analysis, and establish architecture alternatives beyond the funded baseline. This process occurs as an integral part of the overall Design Solution.

Organization:

The EGS Architecture is defined to meet the goals designated by Congress, ESDMD/M2M and commercial partners. EGS Architecture Trade Studies are conducted in accordance with GSDO-P-1061, EGS Program Integrated Assessment and Change Procedure. SharePoint is used to track trade studies, including POC, Status, and closure. The EGS architecture is documented in the EGS Technical Baseline as part of GSDO-ACO-1010, EGS Program Architectures and Concept of Operations Document.

5.2 PRODUCT REALIZATION PROCESSES

Although the general principles of these five processes from NPR 7123.1, NASA Systems Engineering Processes and Requirements, will be addressed, certain features of EGS preclude them from occurring in a strictly serial fashion. These features include the use of heritage systems, the use of preliminary designs produced during the Constellation Program (which may be modified), and the use of cross-cutting systems. The Program uses these processes to integrate, verify, and validate “realized” hardware and software and assure that the solutions are systematically transitioned to an operational state.

5.2.1 Product Implementation

Purpose:

The implementation process is used to generate a specified product through buying, making, or reusing existing KSC infrastructure in a manner that satisfies the design requirements. The EITs (under the direction of the C3 and GSI teams) are responsible for the execution of the Product Implementation process and implementation of their respective Element end products. The processes for design implementation, software development planning, and manual writing are listed in Table 5. Element and higher level technical reviews are accomplished according to the plans specified in the annexes of this document.

Organization:

The PM Division is responsible for the development of the Product Implementation process as described in this document and implementation of the ground systems end products is the responsibility of the C3 and GSI Teams.

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Process References:

TABLE 5 PRODUCT IMPLEMENTATION PROCESS REFERENCES

Doc No.	Title
KDP-P-2713	Technical Review Process
KDP-P-2713A	Technical Review Process for Architect and Engineering (A&E) Design and Development
NPR 8820.2G	Facility Project Requirements (FPR)
KSC-DF-107	Technical Documentation Style Guide
GSDO-PLN-1046	EGS Program Software Management Plan
GSDO-PLN-1079	EGS Program Requirements Management Plan
KSC-IT-13550	Comm Development Project (CDP) System Engineering Management Plan
C3-3005	EGS Program Command, Control, and Communications Project Teams Implementation and Integration Plan

Process Summary:

The Product Implementation process is the realization of Element end products (facilities, hardware and software integrated to the Element level) and related work products. The sub-processes listed in Table 5 define approaches for implementation of each of the specific categories of Element products. Reference the following governing documents as background information for the information in Table 3: NPR 8820.2, Facility Project Requirements (FPR), NASA-STD-5005, Standard for the Design and Fabrication of Ground Support Equipment, KSC-DE-512-SM, Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements NPR 7150.2, NASA Software Engineering Requirements.

Engineering Organization Construction of Facilities projects will follow KDP-P-2713, Technical Review Process.

The Engineering Organizations according to their processes as described in KDP-P-2713 or KDP-P-2713A, Technical Review Process for A&E Design and Development, will perform subsystem implementation. IT performs their technical review per a tailored version of KDP-P-2713. For the tailoring criteria, reference KSC-IT-13550, Comm Development Project (CDP) System Engineering Management Plan.

All EGS projects shall continue to implementation per the PTMs that were baselined in accordance with the revision of KDP-P-2713/2713A that was in effect at the time of subsystem SRR. The Program will not retroactively apply subsequent updates to KDP-P-2713 once projects pass the SRR baseline review.

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5.2.2 Product Integration

For EGS, the Product Integration process is used to transform the physical solution into the desired end product or capability through assembly, integration, and testing of end products implemented by the EITs.

Each EIT is responsible for the process of integrating the subsystems into the Element. EITs are responsible for integrating the lower level physical end products to realize the integrated Element end product as follows:

- a. The EIT is responsible for ensuring that end items are integrated into the Subsystems and that the subsystems are integrated into the Element.
- b. The EIT ensures that the subsystem products and all required documentation including OMRSD are developed. The EIT analyzes the products to ensure the subsystem end products have been integrated according to the Element's architecture. For system designs that will transition to more than one operations contract, the EIT ensures that the lines of demarcation and associated product documentation for each operator are developed.
- c. The EIT is responsible for product integration of subsystem end products into the respective Element.
- d. The EIT provides the products to the corresponding Implementation team. The Implementation team analyzes the integrated Element product to ensure the Element and its products have been integrated according to the EGS architecture.
- e. Each Implementation Team is responsible for the physical integration of Element end products into the ground systems end product.

Section 5.2.3 of this document and the EGS Program MVVP, describes the roles and responsibilities between EITs, Implementation Teams, and M2M, SLS and Orion Programs for V&V activities associated with the various multi-system integrated tests.

Integration of the V&V activities of the Elements with external entities (e.g., SLS, Orion, or commercial vehicles) will be achieved through the following methods:

- a. EGS Element-to-Element integration will be achieved through the designs and models maintained by the design organizations.
- b. Integration of Ground Elements with infrastructure or parts of the Ground System will be achieved using the verification testing performed in accordance with the verification methods associated with the relevant interface requirements.
- c. Integration of Elements with other non-EGS entities will be achieved through the verification associated with the interface requirements documented in the external entity ICD, e.g., SLS-to-EGS ICD, Orion-to-EGS ICD and Mission Systems-to-EGS ICD. V&V of joint interfaces will be presented to the LRICB

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Organization:

The EITs are responsible for integration at the EIT level. The GSI team is responsible for delivering an integrated capability to the EGS Program. Overall technical integration is the responsibility of the SE&I Office with technical integration of development efforts performed by the EITs and Implementation Teams. Integration of operations efforts is the responsibility of the Ops team.

The SE&I Division is responsible for the overall Product Integration technical process within EGS. The EGS IMS and the Cross-Program integrated schedule is the responsibility of the PP&C Division.

Process Summary:

The design organization provides an end-to-end subsystem capability to the EIT, which verifies proper integration into the Element. Each implementation team is responsible for planning and executing integration of all Elements under their responsibility. The EIT is responsible for ensuring that all subsystems have gone through V&V, acceptance/certification reviews and are transitioned to the Operations organization as appropriate.

The integration of Element milestones into EGS IMS, and ultimately the Cross-Program schedules to assure that EGS can meet its obligations is the responsibility of the PP&C Division. Integration of schedules is achieved through the coordination of major milestones from all levels using the Primavera scheduling tool, and through negotiation between the various stakeholders. The PP&C Division is responsible for this coordination.

Process References:

The following process references are identified in Table 6 below.

TABLE 6 PRODUCT INTEGRATION PROCESS REFERENCES

Doc No.	Title
GSDO-PLN-1047	EGS Program Schedule Management Plan
GSDO-MVVP-1042-01	EGS Master Verification and Validation Plan Volume 1: Program V&V Policies and Guidelines
GSDO-MVVP-1042-02	EGS Master Verification and Validation Plan Volume 2: Program V&V Plan
C3-3005	EGS Command, Control, and Communications Project Team Implementation and Integration Plan
GSDO-PLN-1174	EGS Program Site Activation Management Plan

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5.2.3 Product Verification and Validation Process

Purpose:

The product verification process is used to demonstrate that an end product conforms to its design requirements as a function of the product life-cycle phase. Each EGS design requirement will have identified one or more associated DVO(s) which identify the specific verification method (inspection, analysis, demonstration, or test) and associated activity/evidence required for satisfaction of the DVO.

The product validation process is used to confirm that a verified end product generated by product implementation or product integration satisfies its defined StEs. Each EGS StE will have identified one or more associated DVaO(s) which identify the specific validation method (inspection, analysis, demonstration, or test) and associated activity/evidence required for satisfaction of the DVaO.

To be the most efficient and affordable, the EGS product V&V efforts will be planned and conducted as an "integrated" process. This integrated V&V process allows for validations to be accomplished during the product verification activities when the proper hardware and software configurations exist. The integrated process allows for parallel V&V activities as well as allowing the "carrying forward" of lower level verifications to be satisfied at an integrated level. This "integrated" process is more fully described in GSDO-MVVP-1042-01, EGS Master Verification and Validation Plan Volume 1, Program Verification and Validation Policies and Guidelines.

Nonconformances identified during V&V

During V&V testing, nonconformances may be identified. A nonconformance is a condition of any article or material in which one or more characteristics do not conform to requirements (possible examples include failures, discrepancies, defects, malfunctions, abnormal trends, unusual events, or conditions that are not understood). Nonconformances will be reported through the problem reporting and resolution system (sometimes called a Problem Reporting and Corrective Action [PRACA] system) used by the organization performing the testing. The nonconformances will be dispositioned according to that organization's process.

Unexplained Anomalies (UAs) are a subcategory of nonconformances. UA is the disposition assigned to a nonconformance condition that cannot be explained, repeated, or for which a single/specific cause cannot be determined. All UAs identified during V&V testing of hardware and software will be processed and documented in accordance with KDP-P-5035, System Acceptance Process.

UAs associated with V&V testing will be vetted through and approved by the IERB and the owner of the associated DVO/DVaO(s). For systems requiring a DCR, any associated UAs must be elevated to the EGS PRB for approval. If the owner of the associated DVO/DVaO(s) does not concur that the system under test still meets its

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requirements, then the requirement/DVO/DVaO cannot be closed without a deviation or waiver.

Organization and Process:

The organizational roles and responsibilities and process for ground systems V&V are fully described in GSDO-MVVP-1042-01, EGS Master Verification and Validation Plan Volume 1, Program Verification and Validation Policies and Guidelines and GSDO-MVVP-02 EGS Master Verification and Validation Plan Volume 2, Program Verification and Validation Plan. The MVVP volumes also describe the “integrated” process as referenced in previous paragraphs. Expectations for closure of DVO/DVaO are discussed in section 4.5, which discusses subsystem reviews.

5.2.4 Product Transition Process

The Product Transition Process (or Product Turnover Process) encompasses delivery of verified and validated End Products (such as designs, ADPs, and systems) to EGS (e.g., from other Programs) as well as transitioning the End Product from DDT&E to the operations organization within EGS. This process is used to identify required tasks/activities, key inputs and outputs, products, authority, and roles and responsibilities for coordinating and facilitating product transition to the customer and on to the organization(s) performing operations, maintenance, sustaining engineering and use.

5.2.4.1 Transition Within the EGS Program

The EGS Transition process provides an approach to ensure successful hand-over of responsibility for ground systems between organizations at KSC. Transition is used to describe the process of turning over responsibility (in full or partial) of the Operations, “O”; Maintenance, “M”; Engineering, “E”; and User, “U” for a system from one organization to another. The term “Turnover” is used when referring to the completion of the transition. The transition process capability is described in the GSDO-PLN-1131 EGS Program Transition Plan, which defines the preparation for and management of Systems and Engineering to transition from development to operations or from operations to development. The plan also includes identification of items to be transitioned, transition process summary and details for transition evaluation and execution, tracking and reporting, and roles and responsibilities.

5.2.4.2 Transition of Hardware Between EGS and other Programs

GSDO-PLN-1260, Cross-Program Flight Asset Turnover Plan, documents the process for execution of flight element turnover between the providing Programs (SLS, Orion) and EGS. GSDO-PLN-1027, Cross-Program Ground Hardware/Software Acceptance Data Package Plan, applies to GSE and non-GSE for which accountability transfers, not including rotational GSE, to the EGS Program. GSDO-PLN-1055, Cross-Program Ground Hardware Integration Plan, applies for EURD regarding rotational GSE. GSDO-PLN-1143, Cross-Program Flight Hardware/Software ADP Plan, specifies the minimum set of required data that must be provided to the receiving organizations.

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5.3 TECHNICAL MANAGEMENT PROCESSES

The technical management processes described in this section are intended to supplement the management requirements defined in NPR 7120.5, NASA Space Flight Program and Project Management Requirements, and NPR 7123.1, NASA Systems Engineering Processes and Requirements, provides Program and Project Managers (PM) with the technical activities that they are required to be cognizant of and are responsible for. These processes serve as the bridge between Program/PM and the technical teams by providing the cross-cutting functions and integration required to perform the technical work and activities.

5.3.1 Technical Planning Process

Purpose:

The Technical Planning Process is used to plan and document the implementation and management approaches of the technical processes, including assigned responsibilities, selected methods, procedures, and product requirements.

Organization:

The EGS, under the leadership of the PP&C Division has defined a top-level WBS based on the scope of work to be accomplished under this Program. The scope of work under EGS is determined through the baselined set of ESDMD requirements and validated and approved customer needs and expectations. The scope of work is controlled through the requirements management process.

SE&I is responsible for ensuring that the technical processes are adequately planned via documentation that is maintained over time. The EGS functional areas are assigned responsibility by the Program Manager for development and documentation of processes for their respective areas of functional process application.

SE&I will ensure that the needed level of planning, for the technical processes, is identified, prioritized, and included in the IMS.

Process Summary:

EGS utilizes forecasted resources and the results of Program strategic planning to define the WBS, Work Packages, Schedules, and Budgets. Project and functional area managers support the WBS definition within each Project, as they are relied upon to control schedule and budget within their scope.

Staffing and skill mix requirements are determined (and are refined) through the PPBE process in order to accomplish funded work each year. Required skills are obtained through teaming arrangements with other organizations and through the existing KSC support contracts (KLXS, COMET, etc.).

Technical products required to support compliance with NPR 7120.5, NASA Space Flight Program and Project Management Requirements, and NPR 7123.1, NASA

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Systems Engineering Processes and Requirements, are produced in order to satisfy entrance and success criteria for each life-cycle phase. Checkpoints prior to each review ensure the proper maturity of these products. Metrics related to technical planning are reflected in the metrics for EGS budgets and schedules and successful completion of each required life-cycle phase.

5.3.2 Requirements Management Process

Purpose:

The Requirements Management process is used to manage Program requirements, provide bidirectional traceability, and manage requirement changes over the life-cycle of the system products.

Organization:

The SE&I Division has overall lead responsibility for EGS Program Requirements and for ensuring that requirements are quantitative, measurable, verifiable, and constitute a complete requirements set. Reference document GSDO-PLN-1079, Exploration Ground Systems Program Requirements Management Plan, for details.

Process Summary:

EGS System Requirements development and management is performed in accordance with GSDO-PLN-1079. EGS OMCR development and management is performed in accordance with GSDO-PLN-1142, EGS Program Operations and Maintenance Controlled Requirements Management Plan. EGS Program Support Requirements development and management processes are described in Section 5.4.2 of this document. Cross-Program OMRS development and management is performed in accordance with GSDO-PLN-1076, Cross-Program Operations and Maintenance Requirements and Specifications Management Plan. Overall requirements management is performed by the SE&I Division, and interfaces closely with the CM process and Requirements Development processes.

5.3.3 Interface Management Process

Purpose:

The purpose of the Interface Management Process is to define, establish, and maintain interface definitions and compliance among EGS, SLS, Orion, and Commercial Partners.

The interface management process is used to:

- a. Establish and use formal interface management to assist in controlling system product development efforts when the effects are divided between Government Programs, Contractors, and/or geographically diverse technical teams within the same Program or project.

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- b. Maintain interface definitions and compliance among the end products and enabling products that compose the system as well as with other systems with which the end products and enabling products must interface.

Organizations:

There are internal and external interfaces to EGS.

External Interfaces:

To date, there are four external interfaces to EGS: Mission Systems (MS)-to-EGS, Orion-to-EGS, SLS Engineering Support Center (SESC)-to-EGS, and SLS-to-EGS. Interface documents are developed at a functional Program to Program level. For Orion-to-EGS and MS-to-EGS, the method utilizes IRDs and ICDs. In contrast, SLS-to-EGS and SESC-to-EGS utilizes a two part ICD methodology that consists of Functional allocations for each interface and design implementation of performance parameters for each function. Orion and SLS are the lead Programs (OPRs) on these documents and are responsible for CM and Data Management (DM). EGS, however, has an active role in EGS configuration updates and an equal input in decisions on interface documents via the appropriate Phase Integration Control Board **<TBR 5-1>**.

The IRDs and ICDs are managed by having one technical POC and one Programmatic POC from EGS. The technical EGS POC is external interface specific (either MS-to-EGS, Orion-to-EGS, SESC-to-EGS, or SLS-to-EGS) and works with the other corresponding Program's technical POC via the CPIT ITT **<TBR 5-1>**. The Programmatic EGS POC supports the M2M Interface Functional Area Lead (FAL) and oversees all the external interfaces (MS-to-EGS, Orion-to-EGS, SESC-to-EGS, and SLS-to-EGS).

The Programmatic POC from EGS is known as the EGS Overall Interface POC and is a member of the EGS SE&I office. SE&I is responsible for managing the overall strategy of EGS interface management, ensuring overall internal Program and Cross-Program consistency, managing and coordinating interface tasks, providing recommendation input for both technical and programmatic issue resolution, developing Cross-Program interface agreements related to hardware, software, personnel, integrated testing, etc., and assurance of Programmatic guidance/compliance and reporting to M2M Interface FAL as well as EGS management. **<TBR 5-1>**

The Programs Technical POC is also known as the EGS Interface Lead for specific Interface Task Teams (also known as the Interface Working Group), and also supports out of the SE&I office as the specific ITT co-lead. EGS ITT Interface leads are responsible for the development and definition of flight-to-ground interface functions and documentation for their specific ITTs and coordinating changes after the interfaces have been defined. They also have the responsibility to elevate interface issues in a timely manner if they are not able to resolve within ITT/Working Group (WG). **<TBR 5-1>**

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The ITT/WG consist of each Programs Technical Interface Lead, and they act as equal co-leads. The ITT/WG is also comprised of OPEs, EGS SE&I personnel, and EIT/Subsystem stakeholders. Within the ITT/WG each Program negotiates interface coordination with each other, taking into consideration budget, schedule, and technical constraints.

The EGS Overall Interface POC assist the Interface FAL with any problems or issues that arise at the Functional Area level that are elevated to the CPIT Leadership. Interface Management status is briefed monthly to the EGS Program Manager at the Monthly Program Review (MPR) by the EGS Overall Interface POC.

Internal Interfaces:

Internal interfaces are between EGS EIT to EIT. The EITs negotiate interface coordination with each other along with representatives from the Ground Systems Integration Team and (where appropriate) representatives of the C3 Team, considering budget, schedule, and technical constraints. Specific EGS internal ICDs are in place as follows:

1. GSDO-ICD-1250, EGS Program Element to Element Interface Control Document, describes the ML interfaces with VAB, Pad, CT and ML Park Site as well as the CT/Crawlerway load capabilities
2. GSDO-ICD-1246, EGS Program Command, Control, and Communications Kennedy Ground Control Subsystem Interface Control Document, defines the interfaces for KGCS to the KGCS Local Control Distributors, Communication Racks and other KGCS enclosures that interface with the GSE subsystems. Annexes to this ICD define KGCS interfaces with ML1, Pad, Multi-Payload Processing Facility, and ML2.

Table 7 and Table 8 depict the functional EIT to EIT interfaces.

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TABLE 7 EIT TO EIT INTERFACES BETWEEN LAUNCH VEHICLE PROCESSING AND C3 EITS

	VAB	ML	Pad	CT	E2E-CC	Comm	Range
VAB		X		X	X	X	
ML	X		X	X	X	X	
Pad		X		X	X	X	X
CT	X	X	X			X	
E2E-CC	X	X	X			X	X
Comm	X	X	X	X	X		X
Range			X			X	

TABLE 8 EIT TO EIT INTERFACES BETWEEN SOP AND C3 EITS

	SOP EIT	EI EIT ¹	LVOP EIT	L&R EIT (S/C L&R) ²	E2E-CC	Comm	Range
SOP EIT					X	X	
EI EIT ¹							
LVOP EIT						X	
L&R EIT (S/C L&R) ³						X	
E2E-CC	X					X	X
Comm	X		X	X	X		
Range				X ²			
¹ Environmental and Infrastructure EIT does not interface directly with other EITs; it only provides Infrastructure to the EITs. ² S/C L&R EIT interfaces with the Western Range only							

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5.3.4 Technical Risk Management Process

Purpose:

The technical RM process is included in the overall EGS RM process used to examine the risks of technical deviations from the Program plan on a continuing basis. The RM process is used to identify potential technical problems before they occur so the appropriate risk-handling activities can be planned and invoked.

This RM process continues throughout the life of the product or project to mitigate impacts on achieving product-line life-cycle phase exit criteria and meeting technical objectives.

EGS RM is performed in accordance with the GSDO-PLN-1000, Exploration Ground Systems Program Plan, and GSDO-PLN-1013, Exploration Ground Systems Program Risk Management Plan. These plans implement the Risk Informed Decision-Making process and Continuous RM process described in NPR 8000.4A, Agency Risk Management Procedural Requirements.

The Program Plan and Risk Management Plan (RMP) provide organized, systematic decision-making processes for identifying, analyzing, planning, tracking, controlling, communicating, and documenting risks through all life-cycle phases of EGS's product development and operations. The EGS RM process integrates with the ESDMD, M2M, KSC institution and commercial customers.

Organization:

The EGS PP&C Division is responsible for the definition and execution of the EGS RM process and coordinating with EGS and KSC institutional S&MA offices. EGS Management Divisions, and KSC institutional organizations maintain the definition and disposition of technical risks on the Program. Top risks are reported in accordance with the EGS RMP.

Process Summary:

The EGS RM activities and process flow are included in EGS RMP. EGS risks are identified, analyzed, planned, tracked, controlled, documented and reviewed within EGS in accordance with the EGS RMP by all participating team members. Top risks are presented at the EGS MPR / PCB. Top risks are reviewed as part of major milestone and KSC institutional reviews.

5.3.5 Configuration Management Process

Purpose:

CM provides a consistent set of principles and processes and is a management discipline applied over the product's life-cycle to provide visibility into and control changes to performance, functional and physical characteristics. CM ensures that the configuration of a product is known and reflected in product information, that any

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product change is beneficial and is effected without adverse consequences, and that changes are managed. CM reduces technical risks by ensuring correct product configurations, distinguishes among product versions, and ensures consistency between the product and information about the product.

When applied to the design, fabrication/assembly, system/subsystem testing, integration, operational, and sustaining activities of complex technology items, CM represents the “backbone” of the enterprise structure. It instills discipline and keeps the product attributes and documentation consistent. CM enables all stakeholders in the technical effort, at any given time in the life of a product, to use identical data for development activities and decision-making.

CM principles are applied to keep the documentation consistent with the approved engineering and to ensure that the product conforms to the functional and physical requirements of the approved design. CM audits are the systematic examination of Objective Quality Evidence to determine adequacy, validity, and effectiveness of the activity or documentation under review. FCA and PCA activities will be planned and scheduled to ensure the required documentation is provided, the needed personnel and skills are available, and the location/environment is suitable to enable and facilitate an efficient and effective audit. These may be performed in conjunction with DCRs, ORCs, and KMRs and will include external stakeholders as defined in M2M-30012, M2M V&V Plan and GSDO-PLN-1153, Cross-Program Integrated Physical Configuration Audit Plan. An audit will examine the supporting Technical Data Package to ensure that it adequately describes the Configuration Item (CI) under review. Configuration Audits are performed prior to establishing a product baseline for the item. They confirm that the configured product is both accurate and complete.

CM is also used to identify the configuration of the products and systematically control changes to the configuration. The elements of CM are applied in support of the Program life-cycle to maintain integrity and traceability of the configuration baselines.

Organization:

The EGS PP&C Division is responsible for administering CM processes for EGS.

Process Summary:

CM is accomplished in accordance with the NPR 7123.1, NASA Systems Engineering Processes and Requirements; SAE EIA-649C, Configuration Management Standard; GSDO-PLN-1000, EGS Program Plan; GSDO-PLN-1001, EGS Program Information and Configuration Management Plan. The ICM Plan sets forth the guidelines and methodology for applying the five basic elements of CM planning, configuration identification, configuration change control, status accounting and verification, and auditing (FCA and PCA and Cross-Program Integrated PCA) to establish and control the functional, allocated, and product baselines. Cross-Program PCA plan is documented in GSDO-PLN-1153. CIs include hardware, software and interface products, as well as associated requirements, specifications, ICDs, and drawings.

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Details for CM of software are documented in GSDO-PLN-1046, Exploration Ground Systems Program Software Management Plan.

Configuration data for the EGS Program is stored and managed within the database dependent on its purpose; Program level configuration change data resides in the CMW database, Program level Technical data resides in ICE-E, Technical data for NE resides in a Product Data and Life-Cycle Management (PDLM) application KDDMS, and configuration objects (requirements) reside within the Cradle ® database. SLS interface designs, models and data are accessible via Windchill. Technical data for NE Construction of Facility projects resides in KSC TechDoc. Design engineers and systems engineers use these databases to integrate information across the Programs. Program and business DM are described in the Technical Data Management section.

5.3.6 Technical Data Management Process

Purpose:

The technical DM process is used to plan to acquire access, manage, and use data of a technical nature to support the total life-cycle of a system.

Technical DM will be accomplished in accordance with NPR 7123.1, NASA Systems Engineering Processes and Requirements, the EGS Program Plan, the EGS ICM Plan, and follow the guidelines of EIA-859, Industry Consensus Standard for DM. The ICM Plan establishes the methodology for applying DM for the EGS Program.

Technical data for the EGS Program is stored and managed within the database dependent on its purpose. Technical data resides in a PDLM application (ICE-E and KDDMS) whereas business and business planning data resides in KSC TechDoc. Technical data for NE Construction of Facility projects will reside in KSC TechDoc. Additionally, EGS requirements reside in the Program requirements management tool and schedules reside in the Program scheduling tool. Technical data is identified, managed, and tracked utilizing metadata within the respective system used to maintain the data. Metadata identifies the product to include document number, title, revision, model numbers, CI and/or identification numbers, status, release date and related metadata and is used to maintain history, provide reporting functionality, and maintain closed-loop tracking and verification of technical products.

Organization:

The PP&C Division is responsible for administering Technical DM processes for the EGS Program.

Process Summary:

DM includes the development, deployment, operations and support, eventual retirement, and retention of appropriate technical data beyond system retirement as required per NRRS 1441.1, NASA Records Management Program Requirements.

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5.3.7 Technical Assessment Process

The technical assessment process consists of various activities which measure and track technical progress. It also provides status information to support the development of Program plans, system designs, and technical management decisions. The following sections summarize the review and performance measurement processes used to assess technical status.

5.3.7.1 Technical Assessment Summary

Typical technical assessments include inputs such as technical plans, milestone reviews, technical measures, and various reporting requirements that establish the methodology to measure based on associated risk, cost, or schedule. These inputs outline the necessary technical reviews and assessment approach as well as identify the technical measures that are tracked to determine Program progress.

Further, within EGS, the PM Division is responsible for the development and maturation of its own set of technical measures based upon its unique set of inputs derived from the EITs.

The following sections summarize the review and performance measurement processes used to assess technical status.

5.3.7.2 Technical Milestone Reviews

The Technical Milestone Review process is used to plan for and conduct EGS Program milestone reviews. A separate plan is developed for each EGS Program milestone review and includes:

1. Review objectives, entry criteria, and success criteria.
2. Establishing the process for conducting the review.
3. The process for accepting, screening, and dispositioning comments if comments will be accepted during the review.
4. Establishing the makeup of the review Board.
5. Distributing notifications and providing access to review materials.
6. Identifying, resolving, and closed-loop tracking of action items resulting from the review.

The Technical Review process complies with NPR 7120.5, NASA Space Flight Program and Project Management Requirements, and NPR 7123.1, NASA Systems Engineering Processes and Requirements.

Organization:

The SE&I Division is responsible for leading the planning and execution of technical milestone reviews, coordinating the review, developing the review plan, and conducting

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a successful technical review. The other EGS functional areas and teams are responsible for providing review support and associated review artifacts as required. EGS Discipline Leads associated with products under review are SMEs and lead the review of those products and discipline areas.

Process Summary:

The SE&I Division develops review plans in accordance with NPR 7123.1 and these plans are baselined and released prior to the initiation of review preparation. Refer to each of these specific plans for review process details.

5.3.7.3 Technical Performance Measurement

The GSDO-PLN-1087, EGS Program Technical Performance Measures (TPMs) Management Plan, defines the approach for the management and reporting of the EGS TPMs. The TPM process is used to assess product development progress and achievement against technical and programmatic requirements or objectives by identifying, collecting, and analyzing the degree of technical requirement satisfaction for critical products and/or capabilities. The SE&I Division is responsible for the development and control of the EGS TPM process. Measurement owners as assigned are responsible for measurement planning, conduct, and reporting. The PCB is responsible for TPM assessment. Current TPM assessment values are documented in GSDO-PLN-1087-ANX-01, EGS Program Technical Performance Measures Log.

5.3.8 System Analysis Process

Purpose:

The system analysis processes support technical decision-making and evaluation of system behavior and characteristics, including cost, using various methods. This section summarizes the processes used to perform system analysis, including decision analysis, technical analysis, economic analysis, modeling and simulation, and test and evaluation.

The decision analysis process including data collection (e.g., engineering performance, quality, and reliability data) is used to evaluate technical decision issues, technical alternatives, and their uncertainties to support decision-making. This process is used throughout technical management, system design, and product realization processes to evaluate the impact of decisions on performance, cost, schedule, and technical risk.

Organization:

EGS SE&I is responsible for the trade study process and other system analysis processes used on the Program for the ground systems studies. The PRB has authority over trade study plan approval and study report acceptance.

Process Summary:

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EGS conducts or participates in trade studies and analyses to evaluate technical alternatives, formulate design decisions, and resolve open requirement issues in areas that impact ground processing and launch operations. The purpose of the process is to initiate, approve, document and track these studies.

Refer to GSDO-P-1061, EGS Program Assessment Procedure for further detail.

5.4 COMPLEMENTARY TECHNICAL PROCESSES

This section will be used to document technical processes not typical or part of the 17 Common Technical Processes per NPR 7123.1, NASA Systems Engineering Processes and Requirements. The scope includes the Program, EITs and Ops teams.

5.4.1 Modeling and Simulation to Support Critical Decisions Process

The EGS Program process and standards for documentation of modeling and simulation products used to support critical decisions (NASA-STD-7009, Standard for Models and Simulations) is defined in GSDO-SPEC-1262 – Exploration Ground Systems Program Engineering Model Delivery Standard.

5.4.2 Support Requirements

Support Requirements specify products, commodities, and services, required by the EGS Program in order to perform V&V testing and processing operations. Support requirements are met externally (by other government agencies, contractors, or NASA Centers) or internally (by KSC institutional service providers). Examples of Support Requirements include propellants, fluids and gases, commodity purity testing, ordnance storage and handling, communications network services, photography, security services, emergency services, tracking and telemetry, etc. Unlike development requirements, Support Requirements do not follow the typical design cycle into derived system requirements and designs. Instead, Support Requirements are decomposed as necessary and are satisfied by the generation of one or more Support Requests issued to supplying organizations for a response.

The Exploration Systems Division of the HEOMD together with NASA Programs and the NASA Centers provide the resources (people and processes) which form the Support Requirements System (SRS). The SRS Process is documented in KSC-PLN-6445, Support Requirement System and Automated Support Requirements System Management Plan.

SRS was developed by NASA as an Agency solution to obtain commodities and services through Support Requests. SRS is modeled after the Department of Defense (DoD) Universal Documentation System process for similar support requirements needs of DoD test ranges and to ensure clear communication of requests between NASA and DoD. The SRS is used to receive Support Requirements (from within or external to NASA) and issue support requests (within or external to NASA) as well as controlling and managing the documentation and data associated with the requirement. SRS

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personnel coordinate, document, and obtain commitments from suppliers for support which meet the needs of the NASA organization generating the support requirement.

As detailed in KSC-PLN-6445, support validation and commitment are performed during the request generation and response screening process, which is a function of the SRS organization. The support commitment is verified by an affirmative response (WILCO [Will Comply]), with exceptions or requests for further information (SEE RESPONSE) or by stating that they cannot meet the support request (NOWILCO). Since the support request generation and response process is executed by SRS and the supplier agency can be external to EGS, further detail of how the support requests will be decomposed and verified are not covered by this document.

Organization:

This section describes organizational responsibilities related to generation of Support Requirements, managing the review and approval process within EGS and coordination and integration of EGS Support Requirements with SLS, Orion and other stakeholders.

The EGS O&TM organization is designated as the primary interface to the Space Force ER and the 45th Space Launch Delta and negotiates support requirements from the range. The EGS O&TM organization is also designated as the organization with primary responsibility for EGS Support Requirements needed during launch preparations and operations.

The EGS SE&I organization uses SRS to capture the support needs identified by EGS O&TM for the processing related to test, launch, recovery and deservicing of Artemis. Support needs for processing at KSC (Kennedy-on-Kennedy) are captured into Kennedy Program Support Requirement Documents. Support needs for processing Artemis Launch including ER support and DoD are captured in the Launch and Recovery PRD. Support for Artemis Flight is captured by Flight Operations Directorate at Johnson Space Center into the Flight Operations PRD.

Support Requirements Process Summary:

The EGS Support Requirements process is summarized in Figure 7 below. The initial set of draft EGS Support Requirements is developed, coordinated and vetted by the EGS O&TM organization. SRS personnel and potential suppliers identify any gaps in capabilities. Gaps identified in capabilities may result in negotiation of a modified requirement, procurement of a new capability, or return to the Program for initiation of a new development project. SRS personnel and potential suppliers also assist O&TM in developing cost estimates related to the initial Support Requirements.

The initial set of draft Support Requirements and the cost estimates associated with each requirement are then submitted to the appropriate authority for approval (Baseline).

The Integrated Communications and Navigation ITT team is responsible for reviewing and integrating communications Support Requirements from EGS, SLS, Orion, and

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other NASA organizations. The Support Requirements are apportioned into relevant volumes such as Ground Processing and Launch, Mission Operations, and L&R. The Ground Processing and Launch volume receives Support Requirements from SLS, Orion, or other NASA organizations through the work of this Task Team.

Once all Cross-Program Support Requirements have been integrated and approved they are turned over to SRS for decomposition into support requests, and to perform CM and validation according to SRS processes.

In the event that the EGS Program provides commodities or support services to commercial partners, it is anticipated that a Launch Site Support Plan or other similar document will be developed. Support Requirements identified in these documents will be extracted from the document and likewise managed by the SRS organization to appropriately isolate support cost from Artemis mission support.

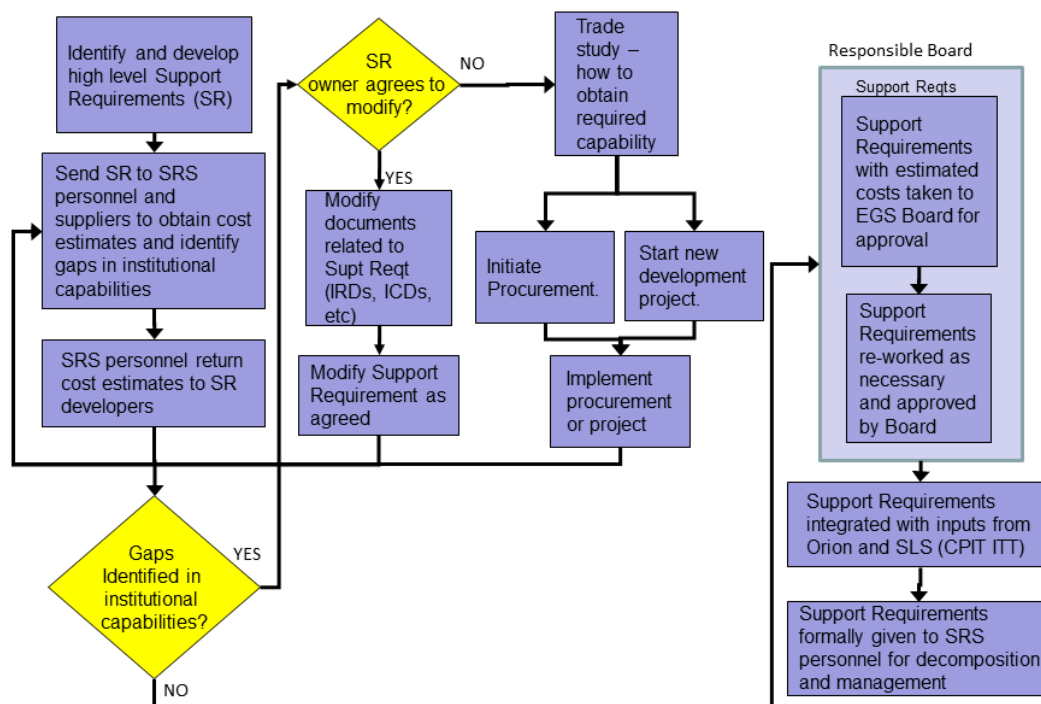


FIGURE 7 EGS SUPPORT REQUIREMENTS GENERATION PROCESS

6.0 TECHNOLOGY INFUSION STRATEGY

The EGS Program is focused on steady-state operations. The program does not have investment funding for new technology development. The program will only infuse new

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technology into system upgrade projects that is already fully matured and demonstrated (NASA Technology Readiness Level 9).

7.0 SPECIALTY ENGINEERING AND OTHER DISCIPLINES

Specialty Engineering describes other key EGS functions that are not specifically addressed in previous sections but are essential for the proper planning and conduct of the overall technical effort. The purpose of specialty engineering is to consult SMEs to verify Program requirements are being accomplished throughout the life-cycle. These disciplines are involved at multiple levels within the Program organization. Specialty Engineering for EGS will include System Safety; HF; Reliability, Maintainability, Availability (RMA); and Logistics Support.

7.1 SYSTEM SAFETY

The KSC S&MA Organization (SA) is responsible for documentation and surveillance of system safety engineering, assurance, and consultation processes contained in GSDO-PLN-1036, Exploration Ground Systems Program Safety and Mission Assurance Plan. This plan is applicable to all onsite and offsite EGS-related activities including functions delegated to other organizations by the EGS Program. This document describes the responsibility for implementing identified tasks, and how each task will be performed in accordance with identified procedures. The approach contained in the EGS S&MA Plan assures ground systems meet the established safety requirements and properly communicates the residual risks due to hazards affecting operators and other assets to stakeholders by performing oversight and insight activities throughout the design and development phases. The established safety requirements will be verified at the ground subsystem level.

EGS S&MA also employs internal and in-work documentation for surveillance activities, particularly GSDO-PLN-1267, EGS Program Safety Assurance Surveillance Plan. This plan establishes the approach for S&MA to perform effective and systematic safety surveillances of EGS operations and managed facilities supporting EGS activities. The surveillances support verification of compliance with applicable Federal, State, and Local safety and health statutes/regulations and NASA S&MA requirements, as well as analyze and assess the safety components related to the EGS CoFR process.

S&MA functions in support of the EGS CoFR process are further developed and defined in SA-F documentation, particularly KTI-1036, KSC Safety Mission Assurance Exploration Ground Systems Division Certification of Flight Readiness Implementation Plan. This document describes the process and products that the EGS SMA Division will use to assess the readiness of each mission for flight and to certify that the SMA requirements for launch and landing have been met.

7.2 HUMAN SYSTEMS INTEGRATION

The EGS Program implementation of HSI is defined and detailed in GSDO-PLN-1276, EGS Program Human Systems Integration Plan. This plan is applicable to all onsite and

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offsite EGS-related activities including functions delegated to other organizations by the EGS Program.

HSI incorporates human considerations in the design and development of tasks, tools, systems, and work environments in the human-to-system interface to enhance the ability of ground crews to assemble, operate, and maintain systems. Additionally, identifying and accommodating the limitations of the ground and flight crews reduces the risk of personnel injury, human error, damage to flight and ground hardware, and life-cycle cost of operations. EGS HSI functions are performed by LX, NE, HMTA, S&MA, Cross-Program partners, and contractor human factor analysts as detailed in GSDO-PLN-1276.

The HSI function is distributed across M2M, Orion, SLS, and EGS. The EGS Program supports these functions through the appropriate cross-program ITTs and this effort is integrated through the EGS HF/HSI lead. The EGS support of enterprise-level (Cross-Program) HSI activities is in accordance with M2M-30016, M2M Human Systems Integration Plan.

7.3 HUMAN RATING

NPR 8705.2, Human-Rating Requirements for Space Systems, provides specific guidance for how NASA develops and certifies systems for human space exploration. This NPR prescribes three fundamental human-rating tenets that have been embodied in the Program's development approach:

1. Human-rating is the process of designing, evaluating, and assuring that the total system can safely conduct the required human missions
2. Human-rating includes the incorporation of design features and capabilities that accommodate human interaction with the system to enhance overall safety and mission success
3. Human-rating includes the incorporation of design features and capabilities to enable safe recovery of the crew from hazardous situations

The SLS, Orion and EGS programs utilize ESD 10009, ESD Human Rating Certification Package, as a single, integrated Human Rating Certification Package (HRCF) for the Artemis II crewed space system. The HRCF is a compilation of information contained in various M2M, Orion, SLS, and EGS Program documents to enable review and determination that the Programs meet the requirements of NPR 8705.2 and the NASA-STD-8719.29, NASA Technical Requirements for Human Rating. EGS has an assigned lead to support the M2M HRCF development, who ensures that EGS provides all required deliverables and supports the Human Rating Working Group (HRWG) . Human Rating support within EGS is led by the SE&I HSI functional lead and focuses on areas where there are EGS to Flight Crew interfaces. Other areas of ground processing activities may also be analyzed as integrated systems. See GSDO-PLN-1276, EGS Program HSI Plan, for applicable Human Rating products by EGS Element/subsystem.

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Additional information about the integrated HRCP, ITT and associated efforts are found in M2M-30003, M2M Systems Engineering Management Plan. The HRCP acts as a 'guide' to point stakeholders to what products and how programs are meeting the intent of the NPR 8705.2. Post-Artemis II, Deep Space Missions are subject to the Human Rating Requirements of HEOMD-003, Crewed Deep Space Systems Human Rating Certification Requirements and Standards for NASA Missions. While HEOMD-003 is not directly applicable to EGS, it is possible that requirements for EGS support and engagement at some level may be expected, funded, and implemented.

NPR 8705.2 requires the provision of compliance data for each of the programs applicable technical and process-related requirements contained within the document. The EGS Program demonstrates compliance of each of the applicable requirements by providing inputs into the integrated HRCP or otherwise addresses these requirements as directed by the HRWG.

NPR 8705.2 specifies Human Health and Performance (HH&P) standards (e.g., NASA STD 3001, Spaceflight Human-System Standard) for flight hardware designs that affect ground crew assembly, vehicle integration, ground processing, and maintenance of flight vehicles (i.e., access panels, removal and replacement of components, etc.) as well as hardware that the flight crew interfaces with or items such as medical capabilities and during L&R (refer to the HRCP for details). EGS allocates applicable requirements to designs as appropriate through the Cradle® requirements tool. Human Rating products like Human Error Analysis, Human in the Loop Evaluation, and Workload Assessment are identified in the PTM for EGS subsystems. Additionally, some HH&P requirements are implemented as services (refer to GSDO-RPT-1096, GSDO Support Services Requirements Report, and/or M2M-30016, M2M HSI Plan).

NPR 8705.2 requires demonstration of compliance at key Program milestone reviews. The M2M milestones for which the HRCP will be delivered and endorsed are tailored as milestones and are defined in the HRWG Task Agreement. The Program's traceability reports are produced from the Cradle® tool that starts initially with the objective evidence for the requirements flow down and finally with providing evidence and material history for the verification of those human rating requirements. A configuration-controlled version of the compliance package will be produced for each major milestone review. This compliance package will be matured over time as the system matures within and across the Program Phases. Success criteria for each major Program milestone review will be the agreement by the Technical Authorities and Office of Safety and Mission Assurance Chief that the compliance data provided in the HRCP satisfies the requirements in NPR 8705.2.

EGS provides a status of the development of products to support the HRCP at appropriate program milestones as part of this process. The HRWG lead (Orion) will integrate inputs from all the programs and maintain configuration control of the joint document.

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7.4 RELIABILITY, MAINTAINABILITY, AVAILABILITY - RMA

Purpose:

The purpose of EGS RMA analysis is to reduce life-cycle cost by effectively identifying limitations within a system design that may cause a failure and contribute to a launch scrub. Reliability is the probability that a system will perform its intended function without failure during a given period of time under specified operating conditions. Maintainability is the probability that describes the ability of a system to be restored or repaired to an operational state within a given time period. Reliability and maintainability are a function of availability, which is the probability that a repairable subsystem will operate satisfactorily during a specified time interval.

The EGS RMA goal is to ensure that the elements and subsystems are operationally available, successfully perform their intended functions, and can be operated and maintained efficiently. RMA support includes the quantitative and qualitative analysis of EGS subsystems to determine their contribution to the overall launch availability for ground systems. The analysis includes assessing failure rate and repair data for subsystem components and highlighting components that contribute to a decrease in reliability, maintainability, and availability.

Organization:

The EGS RMA team is located within the EGS S&MA organization. The S&MA team, in collaboration with the O&TM, GSI, and C3 teams, including Logistics Specialty Engineers and SE&I, works on optimizing subsystem RMA. The RMA team interfaces with the EITs and other EGS teams; while analysis is performed in parallel with NE, LX, IT, and SI design activities.

The EGS RMA team is responsible for supporting Inherent Launch Availability and Operational Availability goals and working with subsystem teams to help achieve those goals. The team also provides inputs to trade studies and other NASA projects related to reliability, maintainability, and availability. RMA analysis is also available for, trade studies, subsystem component verification testing, and subsystem certification.

Process Summary:

GSDO-PLN-1044, EGS Program Reliability, Maintainability, and Availability Plan, documents the RMA availability goals, analysis methodology, and EGS RMA TPM reporting requirements.

GSDO-RPT-1099, EGS Reliability, Maintainability, and Availability Subsystem Report, provides a summary of all subsystems analyses for the Artemis I Mission including system operating assumptions, component lists with associated failure and repair data, RMA results, cut set analysis, importance measures analysis (if required), and design issues or recommendations. RMA analyses evaluate proposed designs in order to influence future modifications, operational concepts, LCC, logistics decisions, and maintenance planning for efficiency and effectiveness of operations.

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For Artemis II and beyond, RMA analyses will establish availability goals for Operational Availability and Inherent Launch Availability. The EGS availability goals are not requirements that must be reached for an Artemis launch to occur, but rather they are a benchmark that the combined EGS subsystems designs should look to achieve. They also assist management in the decision-making process of giving the go-ahead for a launch campaign by providing numbers to compare to in order to access the technical health status of the combined EGS subsystems. The EGS Inherent Launch Availability and Operational Availability goals for Artemis II and beyond are captured as TPMs in GSDO-PLN-1087-ANX-01, Exploration Ground Systems Program Technical Performance Measures Log.

7.5 LOGISTICS SUPPORT

Purpose:

The EGS overall logistics goal is to reduce life-cycle cost by influencing design to reduce cost of operations, maintenance, support, and disposal; by establishing a consolidated, but flexible, reliable and highly responsive logistics and maintenance support infrastructure.

Organization:

The EGS Program Logistics Branch provides EGS functional leadership for life-cycle logistics support. Logistics management and integration functions interface with EGS through the EGS PMT and the EGS PP&C Division. Logistics is matrixed across the GSI Team, the C3 Team, and the Ops Team to provide logistics services to support team mission deliverables. Logistics engineers interface with EGS through the EITs for project design and development activities. Logistics is responsible for logistics and maintenance support for existing systems and GSE as Operations assumes responsibility for each system. In addition, Logistics serves as the primary KSC interface for integrated logistics planning to support the ISS, Orion, and SLS Programs.

Process Summary:

GSDO-PLN-1070, Cross-Program Logistics Integration Plan, provides guidance to the member programs (EGS, Orion and SLS) for the integration of logistics support within and across the M2M Enterprise.

GSDO-PLN-1024, Exploration Ground Systems Program Integrated Logistics Support Plan, outlines the overall logistics requirements for sustaining the EGS elements throughout the Program life-cycle, describes what criteria are essential to support planning for the development of an integrated logistics support structure, and describes supportability plan requirements and objectives. Subsystem-level LSAs are developed using the maintenance and supportability concepts identified in GSDO-PLN-1024.

Logistics supports EITs to ensure operability, supportability and maintainability are incorporated into the design. Logistics efforts during the design process focus on identification of obsolete parts and assemblies, verifying vendor viability, increasing

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product reliability, and decreasing maintenance costs and logistics footprint by maximizing commonality of parts, use of common tooling and maintenance procedures, and reducing the need for specialized maintenance training and test apparatus. Data produced by these analyses result in recommended spare parts lists, maintenance task outlines, or maintenance task analysis as applicable, and identification of long-lead procurement items.

In addition, Logistics engineering plays a key role in the assessment of heritage equipment for re-use by EGS. Logistics engineering determines the supportability of the equipment including availability of spare parts and vendor support as well as analysis of PRACA data (history of failures, etc.). This information feeds into the overall assessment of heritage equipment reuse performed by EGS.

7.6 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS ENGINEERING

Control of Electromagnetic Interference is a complex task, necessitating a balance between Programmatic concerns of cost and schedule, and strict technical compliance with Electromagnetic Compatibility requirements. In many cases, requirements may need to be tailored to fit a specific need or application, while in other cases a strict technical compliance is the only acceptable alternative to the desired amount of risk reduction. The purpose of the Electromagnetic Environmental Effects (E3) discipline is to review E3 related issues and provide solid, well thought-out engineering and physics-based assessments for the Program.

The EGS Program receives its E3 design requirements through the SLS, Orion, EGS E3 requirements, flight-to-ground IRDs/ICDs and by levying NASA design standards on hardware designs. EGS also utilizes a considerable amount of heritage hardware and systems which may not comply with current E3 design requirements. Issues related to the operational use of this heritage hardware must be assessed and addressed appropriately.

GSDO-PLN-1094, EGS Program Electromagnetic Environmental Effects Control Plan, addresses the issues described above and documents how EGS performs the required analyses and address these issues either through operational controls or design modifications.

7.7 TRAINING

The EGS Program draws on a number of organizations and personnel across KSC in support of the activities required to accomplish the work it is responsible for. In order to ensure all personnel are trained appropriately and consistently so that personnel are safe and successful in performing all EGS-related activities, the Program has developed an integrated approach to training across all phases of the program. SMEs within design and development organizations and EITs determine training requirements and collaborate with O&M organizations to identify cost effective training solutions. Identified training solutions are assigned to personnel by individual organizations and supervisors proactively task employees to complete required training resulting in a highly-capable,

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flexible workforce. Managers attest to the training and certification readiness of their personnel to safely and effectively accomplish EGS activities as required by preparatory review boards, task team leaders, and KDP-P-2713. GSDO-PLN-1130, EGS Program Integrated Training Plan, provides the direction and Program-level requirements that all EGS supporting organizations are required to follow. It is expected that each supporting organization will have training plans to address this.

7.8 PARTS TRACEABILITY AND TRACKING

NPD 8730.2, NASA Parts Policy, defines NASA's requirements for selection, management, and control for EEE parts. KSC implements these requirements in KSC-PLN-5406, Design and Development of EEE Parts Plan. Designs receive the EEE parts requirements through the allocation of a requirement to comply with KSC-DE-512-SM Facility Systems, Ground Support Systems, and Ground Support Equipment General Design Requirements. The EGS Program will trace and track both EEE and mechanical parts as follows:

Note: In the following paragraphs, Tracking is defined as the ongoing ability to know both a part's current location and engineering's requirement for usage of a part. Traceability is defined as the ability to identify and trace the history, distribution, location, and application of products, parts, materials, and services. A traceability system records and follows the trail as products, parts, materials, and services come from suppliers and are processed and ultimately distributed as final products and services through to disposal (end of life).

Components or assemblies that are subject to periodic checkout, test, calibration, servicing, maintenance or inspection, limited shelf life items, and items under warranty shall be tracked. Tracking will be performed by the organization having O&M responsibility for the equipment of which the component or assembly is a part.

Critical components or assemblies (as opposed to entire subsystems) identified as criticality categories 1, 1R, 2, and 1S high-risk, significant-risk or safety system risk items, and limited life-items such as batteries shall be traced. High-risk and significant-risk items equate to heritage criticality 1, 1R, and 2 items; safety system-risk items equate to heritage criticality 1S items.

Traceable items will be identified by the organization having engineering responsibility for the hardware and documented accordingly on the drawings, bill of materials, parts lists, associated design models, etc. Procurement of traced items will require lot or serial numbers (traceability information) and applicable Certificate of Conformity. Components shall be traced during all phases of the item's lifecycle: procurement, storage (logistics), issuance/kitting, fabrication (assembly and subassemblies), installation, operations, maintenance, repair, refurbishment, sustainment to retirement/disposal.

Note: Refer to KSC-PLN-5406 and NPD 8730.2 for definitions of terms used in this such as criticality category 1, 1R, 2, and 1S.

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Heritage Hardware

Hardware accepted through the Heritage Assessment process (including its documentation) is accepted “as-is” with the level of parts traceability and tracking that existed for that hardware under the Program from which the hardware originated (e.g., Space Shuttle Program).

The EGS S&MA organization assesses single failure points in each heritage hardware item in the EGS Heritage Assessments. The S&MA assessment is approved by the EGS PRB and the results provided to design and maintenance organizations. The results of the S&MA assessment are used as follows: When an item of heritage equipment is maintained, repaired or upgraded, any limited life items or parts associated with single failure points installed in the heritage hardware will comply with the traceability/tracking requirements described for new hardware in this section.

8.0 TECHNICAL RESOURCE ALLOCATION

Purpose:

The purpose of the Technical Resource Allocation Process is to identify and prioritize EGS needs, formulate and properly execute EGS’s budget and describe the process for allocation of resources required when changes occur.

Organization:

The EGS PP&C office leads the formulation of and monitors execution of the EGS budget. The PP&C office is also involved in the approval process for re-allocation of resources between EGS teams.

Process Summary:

1. Identifying Prioritized Needs:
 - a. The EGS mission area is defined based on NASA HQ direction; Cross-Program coordination; Commercial User NGOs; President’s Budget and Congressional Authorization/Appropriation; and US National Space Policy
 - b. The EGS assesses how well their mission area is addressed
 - c. The EGS prioritizes deficiencies/new requirements that must be addressed to optimize the defined mission
 - d. The EGS proposes solutions to address deficiencies
2. Prepare PPBE Submission:
 - a. EGS agrees on prioritized list of deficiencies
 - b. EGS functional teams agree on actions (cost, schedule, personnel) to address deficiencies

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- c. EGS teams build cost/schedule for proposed design solutions
 - d. PM supports EGS teams with design estimates
 - e. Operations personnel O&TM support with O&M estimates
 - f. EGS teams roll up required resources
 - g. PP&C orchestrates PPBE process to request resources and establish a baseline
3. Execution:
- a. EGS allocates resources to execute new developments to overcome deficiencies
 - b. EGS teams are responsible for execution
 - i. EGS EITs execute designs
 - ii. O&TM is responsible for O&M expenditures
 - c. If changes in resources are required, the EGS teams determine if they can handle internally with their resources.
 - d. If EGS teams do not have sufficient resources to address the change, they elevate issues to the EGS PRB. If changes are outside scope of EGS, Program elevates to the Agency for resources or to request relief from requirements.

9.0 SUSTAINING ENGINEERING

The EGS Program receives GSE and SE from SLS and Orion to be used in ground processing operations. GSDO-PLN-1075, -Program Ground Support Equipment Sustaining Engineering Plan provides guidance to the sustaining engineering of hardware received from SLS and Orion.

GSDO-PLN-1229, EGS Program Sustaining Engineering Plan, describes the process used by EGS to identify, assess, prioritize and approve Sustaining Engineering projects. The plan also describes roles, responsibilities and expectations for sustainment governance and sustainment execution. The EGS Operations contractor addresses Sustaining Engineering in OP-0031, Design Modification Process.

EGS Sustaining Engineering project oversight and approval are managed in GSDO-CHTR-1303, Ground Configuration Control Board, and GSDO-CHTR-1296, Software Configuration Control Board respectively.

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10.0 WAIVERS, TAILORING AND COMPLIANCE

10.1 WAIVERS TO TECHNICAL REQUIREMENTS

10.1.1 Institutional Waivers

Waivers to institutional requirements are governed by KDP-KSC-P-1865, Technical and Institutional Requirement Deviation/Waiver Process or KNPR 8715.3-1, KSC Safety Procedural Requirements Volume 1, Safety Procedural Requirements for Civil Servants/NASA Contractors. As stated in GSDO-PLN-1001, EGS Program ICM Plan, the governing KDP requires institutional waivers to be approved through the IERB. The EGS Program has representation on the IERB and this representation gives EGS the opportunity to participate in disposition of institutional waivers. Institutional waivers are processed using the KDDMS tool and KDDMS provides notification to the Element GIE that a waiver is being processed. As described in Section 3.6.2.2.1, Table 2 GSI Element Integration Team Roles & Responsibilities, the Element GIE is responsible for EGS awareness of institutional waivers by ensuring that they are incorporated into the EGS Technical Baseline. When the Element GIE receives notification that an institutional waiver is being processed, the Element GIE contacts the EGS Technical Baseline Manager upon notification to ensure identification of the waiver in the Technical Baseline. Upon final disposition of the waiver, the Element GIE follows-up with notification of disposition to the Technical Baseline Manager and verifies the incorporation of the waiver into the baseline if it is approved. Adding the waiver into the EGS Technical Baseline also ensures the PRB is aware of the waivers when they approve the change to the Technical Baseline.

10.1.2 EGS Program Waivers/Deviations

Requests for authorization to depart from, or to permit noncompliance with, requirements defined in the EGS technical baselines and/or program documentation require stakeholder review and PRB approval. A Program **Deviation** is the formal authorization for a departure from a particular program requirement for a specific period of time. A Program **Waiver** is the formal authorization of acceptance of a noncompliance with a program requirement.

Requests for Deviation/Waiver to an EGS program requirement that implements or derives from a Cross-Program ICD requirement must obtain concurrence from the ICD-owning program. Approval authority for these ICD requirement deviation/waiver requests is the appropriate Phase Integration board and/or M2MCB. When the need for an ICD deviation/waiver is discovered, the responsible GIE will notify the ICD-owning program of the need for waiver. The ICD-owning program will initiate and sponsor the waiver request within their CM system. EGS will provide the technical details needed for the ICD waiver form. The GIE and the ICD-owning program will work collaboratively to present the request for waiver to the Phase Integration board and/or M2MCB if required. Upon approval of the ICD waiver, the approving board will issue a directive action to EGS to implement the ICD waiver within the EGS requirements management system via the directive action.

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Requests for Deviation/Waiver will utilize GSDO-FM-1122, EGS Program Request for Deviation/Waiver Form, to document proposed Deviations/Waivers for submission to the appropriate CB for approval. Request for Deviation/Waiver (RDW) forms will be prepared by the Element GIE, who will serve as Change Package Engineer. The RDW form will identify the requirement, specification(s), policy, plan, drawing(s) and/or CIs for which the deviation or waiver is requested, impacts to correct the problem, and long-term impact(s) if the waiver condition is not corrected. Impacts may include operational limitations/workarounds, development impacts, safety/risk posture changes and logistics impacts. Detailed instructions for completing the RDW form are provided in GSDO-FM-1122. RDW are submitted for processing to the KSC-GSDO-ICM-HUB. RDW forms will be reviewed and processed as CRs in accordance with GSDO-PLN-1001, EGS Program ICM Plan.

10.1.3 Cross-Program Waivers

Deviations and waivers to Cross-Program requirements and specifications affecting EGS require review and recommendation by KSC IERB prior to concurrence by the EGS PRB per direction of the EGS Chief Engineer. These reviews will be conducted using the CR process.

OMRS and LCC deviations and waivers will be managed within their own systems, unless a deviation or waiver affects an EGS system design requirement, which would then require submittal of an EGS Program Deviation/Waiver request.

10.2 WAIVERS, TAILORING, AND COMPLIANCE OF SYSTEMS ENGINEERING NPR REQUIREMENTS

The EGS Program is required to meet all requirements in regards to waivers, tailoring, and compliance specified in NPR 7123.1, NASA Systems Engineering Processes and Requirements. The EGS Program Compliance Matrix can be found in Appendix A of this document.

The compliance matrix fulfills the requirement showing that any tailoring of the requirements from NPR 7123.1 is identified and approved by the Center Director. The EGS Program compliance matrix is combined with the other programs/projects and submitted to Office of the Chief Engineer upon request or as changes to the processes and/or requirements occur.

While overall management of this document is the responsibility of the EGS Program Manager, the EGS PRB serves as the Designated Governing Authority (DGA) with final approval signature to ensure independent assessment of waiver authorizations that pertain to NPR 7123.1.

11.0 OPERATIONS

With the completion of developmental and sustainment activities for a given mission flow, the Program transitions into the operational phase. The EGS SEMP governance is supplemented by specific program plans that define the conduct of the operations

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phase activities. During a mission's operational phase, the SEMP will continue to provide governance for ongoing development and sustainment projects across the EGS architecture. Key supplemental EGS operations plans include:

GSDO-PLN-1195, Cross-Program Processes and Agreements for Launch Site Ground Operations, describes the major cross-program roles and responsibilities in support of operations processing, from ground/flight hardware/software turnover to EGS operations (post-DD250) through L&R Operations. The primary intent is to lay out, at a high level, the methods that M2M and the Programs use to ensure ground operations are conducted in a safe and efficient manner while also ensuring the Cross-Program community retains the appropriate insight, integration responsibility, and DA during launch site processing. The document is intended to be an overarching guideline for Cross-Program support of key components (e.g., Work Authorization Document authoring, modification kit and field engineering changes, design center support, and, nonconformance resolution support) of the launch site and L&R operations and discusses the integrated efforts to ensure success.

GSDO-PLN-1183, EGS Ground Operations Management Plan, establishes the EGS management approach for operations processing activities. GSDO-PLN-1183 describes the overall activities required for ground operations processing. This includes those activities required to plan for and execute ground operations processing, the roles and responsibilities of the key organizations and personnel that partake in these activities, and the business systems and processes required to support the planning and processing activities. Successful implementation of GSDO-PLN-1183 results in consistent use of processes as well as clarity of expected roles and responsibilities of players in ground operations, establishes the framework for how the Program and supporting organizations integrate operational activities. Successful execution of processes outlined within GSDO-PLN-1183, and those referenced within it, ensure that KSC and EGS are ready to sign the agency CoFR as described in GSDO-PLN-1088, KSC & EGS Program CoFR Plan.

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APPENDIX A
NPR 7123.1D COMPLIANCE MATRIX
TABLE A-1 NPR 7123.1D COMPLIANCE MATRIX

Req. ID	NPR Section	Requirement Statement	Rationale	Comply?	Justification
SE-06	6.1.5	The ETA shall approve the SEMP, waiver or deviation authorizations, and other key technical documents to ensure independent assessment of technical content.	This requirement ensures that the ETA has reviewed and approved of key systems engineering documents.	Tailored (T)	DGA for the EGS SEMP is the PRB, with ETA participation on the board
SE-07	3.2.2.1	Program/Project Managers shall identify and implement an ETA-approved Stakeholder Expectations Definition process to include activities, requirements, guidelines, and documentation, as tailored and customized for the definition of stakeholder expectations for the applicable product layer.	This requirement ensures that the program/project and the ETA identifies how they will gather and address stakeholder expectations. This ensures that the program/project will gain a thorough understanding of what the customer and other stakeholders expect.	Fully Comply (FC)	EGS Stakeholder Expectations definition process documented in SEMP and implementation detailed in EGS Requirements Management Plan (GSDO-PLN-1079).
SE-08	3.2.3.1	Program/Project Managers shall identify and implement an ETA-approved Technical Requirements Definition process to include activities, requirements, guidelines, and documentation, as tailored and customized for the definition of technical requirements from the set of agreed upon stakeholder expectations for the applicable product layer.	This requirement ensures that the program/project and the ETA identifies how they will select and gain agreement on the technical requirements.	FC	EGS Technical Requirements definition process documented in SEMP and implementation detailed in EGS Requirements Management Plan (GSDO-PLN-1079).
SE-09	3.2.4.1	Program/Project Managers shall identify and implement an ETA-approved Logical Decomposition process to include activities, requirements, guidelines, and documentation, as tailored and customized for logical decomposition of the validated technical requirements of the applicable product layer.	This requirement ensures that the program/project and the ETA identifies how they will take the technical requirements for the program/project and glean from them what is needed to accomplish them (e.g., functional block diagrams, timing, architectures). This places the requirements into context and ensures they are understood well enough to begin the design process.	FC	EGS Logical Decomposition process documented in SEMP and implementation detailed in EGS Requirements Management Plan (GSDO-PLN-1079).

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SE-10	3.2.5.1	Program/Project Managers shall identify and implement an ETA-approved Design Solution Definition process to include activities, requirements, guidelines, and documentation, as tailored and customized for designing product solution definitions within the applicable product layer that satisfy the derived technical requirements.	This requirement ensures that the program/project and the ETA identifies how they will take the information from the stakeholder expectations, requirements, and logical decomposition and perform the design function. Since all designs are unique, this will describe the general steps that are taken. The specifics for each of the program/projects will be documented in the SEMP or other equivalent program/project documentation.	FC	EGS Design Solution definition process documented in SEMP and implementation execution conducted using center processes (KDP-P-2713).
SE-11	3.2.6.1	Program/Project Managers shall identify and implement an ETA-approved Product Implementation process to include activities, requirements, guidelines, and documentation, as tailored and customized for implementation of a design solution definition by making, buying, or reusing an end product of the applicable product layer.	This requirement ensures that the program/project and the ETA identifies how they will execute the designs, whether through buying items off the shelf or contracting to have them built, building/coding them within the Center, or reusing products already developed by another program/project. The specifics for how each program/project will make this determination for the various components/assemblies within the product hierarchy are documented in the SEMP or other equivalent program/project documentation.	FC	EGS Product Implementation process documented in SEMP and implementation execution conducted using center processes (KDP-P-2713).
SE-12	3.2.7.1	Program/Project Managers shall identify and implement an ETA-approved Product Integration process to include activities, requirements, guidelines, and documentation, as tailored and customized for the integration of lower level products into an end product of the applicable product layer in accordance with its design solution definition.	This requirement ensures that the program/project and the ETA identifies how they will approach the integration of products within successive levels of the product hierarchy. This ensures that planning is performed that will enable a smooth integration of products into higher level assemblies.	FC	EGS Product Integration process documented in SEMP.
SE-13	3.2.8.1	Program/Project Managers shall identify and implement an ETA-approved Product Verification process to include activities, requirements/specifications, guidelines, and documentation, as tailored and customized for verification of end products generated by the product implementation process or product integration process against their design solution definitions.	This requirement ensures that the program/project and the ETA identifies how they will verify that the end products will comply with each of the technical requirements.	FC	EGS Product Verification process documented in SEMP and implementation execution detailed in EGS Master V&V Plan (GSDO-MVVP-1042).

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SE-14	3.2.9.1	Program/Project Managers shall identify and implement an ETA-approved Product Validation process to include activities, requirements, guidelines, and documentation, as tailored and customized for validation of end products generated by the product implementation process or product integration process against their stakeholder expectations.	This requirement ensures that the program/project and the ETA identifies how they will show that the end products will meet the stakeholder expectations in the intended environment. This is in addition to verifying they meet the stated requirements and ensures the stakeholder is getting what was expected.	FC	EGS Product Validation process documented in SEMP and implementation execution detailed in EGS Master V&V Plan (GSDO-MVVP-1042).
SE-15	3.2.10.1	Program/Project Managers shall identify and implement an ETA-approved Product Transition process to include activities, requirements, guidelines, and documentation, as tailored and customized for transitioning end products to the next higher level product layer customer or user.	This requirement ensures that the program/project and the ETA identifies how they will handle the end products as they move from one location to another. This includes shipping, handling, transportation criteria, physical security, cybersecurity, and receiving facility storage needs. It ensures that receiving facilities are ready to accept the product and that no damage occurs to the product during handling and transportation.	FC	Product transition process described in EGS SEMP and implementation execution detailed in the EGS Program Transition Plan (GSDO-PLN-1131).
SE-16	3.2.11.1	Program/Project Managers shall identify and implement an ETA-approved Technical Planning process to include activities, requirements, guidelines, and documentation, as tailored and customized for planning the technical effort.	This requirement ensures that the program/project and the ETA identifies how they will perform and document all the technical planning for the program/project. This includes all plans developed for the technical effort —Systems Engineering Management Plans, risk plans, integration plans, and V&V plans. This ensures that the program/project teams are thinking ahead for the work to be performed and capturing that information so it can be communicated to the rest of the team, customers, and other stakeholders.	FC	EGS Technical Planning process documented in SEMP and the EGS Program Plan (GSDO-PLN-1000).
SE-17	3.2.12.1	Program/Project Managers shall identify and implement an ETA-approved Requirements Management process to include activities, requirements, guidelines, and documentation, as tailored and customized for management of requirements throughout the system life-cycle.	This requirement ensures that the program/project and the ETA identifies how they will handle tracking and changes to the baselined set of requirements. It defines who has authority to submit and approve changes and how requirements are tracked as they flow down to other elements in the product breakdown structure. This ensures that changes to requirements are evaluated and that their impacts are understood and communicated to the rest of the team.	FC	EGS Requirements Management process documented in SEMP and implementation detailed in EGS Requirements Management Plan (GSDO-PLN-1079).

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SE-18	3.2.13.1	Program/Project Managers shall identify and implement an ETA-approved Interface Management process to include activities, requirements, guidelines, and documentation, as tailored and customized for management of the interfaces defined and generated during the application of the system design processes.	This requirement ensures that the program/project and the ETA identifies how they will manage the internal and external interfaces of their end product. This will ensure compatibility when the various parts of the system are brought together for assembly/integration.	FC	EGS Interface Management process documented in SEMP.
SE-19	3.2.14.1	Program/Project Managers shall identify and implement a Technical RM process to include activities, requirements, guidelines, and documentation, as tailored and customized for management of the risk identified during the technical effort.	This requirement ensures that the program/project and the ETA identifies how they will handle the technical portions of the program/project risks and report them for inclusion with the cost and schedule risk portions. It ensures that the technical aspects of risks to the program/projects successful execution are captured and reported to program/PM who will be developing the overall risk posture.	FC	EGS Technical RM process documented in SEMP and implementation detailed in EGS Risk Management Plan (GSDO-PLN-1013).
SE-20	3.2.15.1	Program/Project Managers shall identify and implement an ETA-approved CM process to include activities, requirements, guidelines, and documentation, as tailored and customized for CM.	This requirement ensures that the program/project and the ETA identifies how they will perform CM of the end products, enabling products and other work products key to the program/project. The technical products to be controlled are identified and tracked to ensure that the team knows what the configuration of their system is at all phases of the life-cycle.	FC	EGS CM process documented in SEMP and implementation detailed in EGS Information and Configuration Management Plan (GSDO-PLN-1001).
SE-21	3.2.16.1	Program/Project Managers shall identify and implement an ETA-approved Technical DM process to include activities, requirements, guidelines, and documentation, as tailored and customized for management of the technical data generated and used in the technical effort.	This requirement ensures that the program/project and the ETA identifies how they will handle all the technical data that is generated by the program/project. This will include all data needed to manage, operate, and support the system products over the life-cycle. It ensures that the data is available and secure when needed.	FC	EGS Technical DM process documented in SEMP and implementation detailed in EGS Information and Configuration Management Plan (GSDO-PLN-1001).
SE-22	3.2.17.1	Program/Project Managers shall identify and implement an ETA-approved Technical Assessment process to include activities, requirements, guidelines, and documentation, as tailored and customized for making assessments of the progress of planned technical effort and progress toward requirements satisfaction.	This requirement ensures that the program/project and the ETA identifies how they will assess the progress of the program/project's technical efforts, including life-cycle reviews. It ensures that the program/project team, customers, and other key stakeholders know how the effort is progressing and if additional actions are needed to resolve issues prior to becoming too costly.	FC	EGS Technical Assessment process documented in SEMP.

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SE-23	3.2.18.1	Program/Project Managers shall identify and implement an ETA-approved Decision Analysis process to include activities, requirements, guidelines, and documentation, as tailored and customized for making technical decisions.	This requirement ensures that the program/project and the ETA identify how they will make and document key technical decisions. It helps to ensure that all team members know who can make decisions, what their authority levels are, and where to go to gain an understanding of what key decisions have been made.	FC	EGS Decision Analysis process documented in SEMP.
SE-24	4.2.1	The NASA technical team shall define the engineering activities for the periods before contract award, during contract performance, and upon contract completion in the SEMP or other equivalent program/project documentation.	It is important for both the Government and contractor technical teams to understand what activities will be handled by which organization throughout the product life-cycle. The contractor(s) will typically develop a SEMP or other equivalent program/project documentation to describe the technical activities in their portion of the project, but an overarching SEMP (or other equivalent program/project documentation) is needed that will describe all technical activities across the life-cycle whether contracted or not.	T	EGS SEMP discusses technical activities and lifecycle activities for the Program and addresses these topics. EGS does not have a single prime contract for development but does have a prime contract for execution of the program operations phase (COMET).
SE-25	4.2.3	The NASA technical team shall establish the technical inputs to the solicitation appropriate for the product(s) to be developed, including product requirements and Statement of Work tasks.	The technical team's participation in the development of the solicitation is critical to enabling a successful contracted effort. Ensuring that the proper application of the common technical processes into the contracted effort will enhance the chances for success.	T	Implementation of the Common Technical Processes are described in the EGS SEMP. RFPs are developed by institutional design organizations in coordination with the EGS Program according to their organization's design processes.
SE-26	4.2.4	The NASA technical team shall determine the technical work products to be delivered by the offeror or contractor, to include contractor documentation that specifies the contractor's SE approach to the scope of activities described by the 17 common technical processes.	The technical team is in the best position to determine what kind of work products from the technical effort will need to be delivered. These products will eventually be used by the technical team to determine the suitability of the contracted effort in its ability to meet requirements, satisfy the stakeholder expectations, and perform as planned.	T	The EGS SEMP outlines what technical work products will be provided by both the customer and the contractor
SE-27	4.2.5	The NASA technical team shall provide the requirements for technical insight and oversight activities planned in the NASA SEMP or other equivalent program/project documentation to the contracting officer for inclusion in the solicitation.	In addition to the work description and products to be delivered, how the technical team will gain an adequate understanding of the contracted work, what authority (if any) they will have to direct or influence the work, and their participation at key life-cycle reviews. In the end the technical team needs enough information to advise the Program/Project Manager and ETA as to the adequacy of the technical work.	T	The EGS SEMP outlines the various technical teams and what products they are responsible for
SE-28	4.2.7	The NASA technical team shall participate in the evaluation of offeror proposals in accordance with applicable NASA and Center source selection procedures.	Technical personnel will need to be involved in reviewing the proposals and providing advice/guidance on their merits. These personnel may or may not be part of the technical team that will execute the program/project.	T	OP is the OPR for ensuring compliance with applicable NASA and Center source selection procedures. Acquisition strategies in Program Plan

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SE-29	4.3.1	The NASA technical team, under the authority of the contracting officer, shall perform the technical insight and oversight activities established in the contract including modifications to the original contract.	After the contract is awarded, the contracting officer will depend on the technical team to execute the oversight/ insight of the technical work as defined in their SEMP (or other equivalent program/project documentation) and the contract.	T	The NASA technical team Insight/oversight responsibilities are documented in the Insight/Oversight Appendix of the GSDO Program Plan
SE-30	4.4.1	The NASA technical team shall participate in the review(s) to finalize Government acceptance of the deliverables.	Per the agreement in the SEMP (or other equivalent program/project documentation) and the contract, the technical team will participate in the life-cycle reviews. Ultimately, this knowledge will enable the technical team to provide advice to the program/project and ETA as to the suitability of the product for acceptance.	T	NASA technical team participation in milestone reviews is documented in the Insight/Oversight Appendix of the GSDO Program Plan.
SE-31	4.4.2	The NASA technical team shall participate in product transition as defined in the NASA SEMP or other equivalent program/project documentation.	In accordance with the SEMP (or other equivalent program/project documentation), the technical team will participate in the execution of the final aspects of the end product—either its transference in whole to the program/ project customer, its operations, and/or the final decommissioning and disposal. These activities may be performed by the same team that was involved in its development or by other technical teams.	FC	Product transition approach is described in EGS SEMP and the EGS Program Transition Plan, GSDO-PLN-1131.
SE-32	5.2.1.1	The technical team shall develop and document plans for life-cycle and technical reviews for use in the program/project planning process.	Each of the life-cycle reviews, as well as any other technical status reviews, needs to be identified and documented so that all stakeholders will know how the program/ projects progress will be assessed. This will typically be captured within the SEMP, in a separate Review Plan or other equivalent program/project documentation.	FC	Milestone Review Plans have been included as annexes to the EGS SEMP (i.e., SRR Plan, PDR Plan, etc.) or implemented in standalone documents (EGS Post Flight Assessment Plan)
SE-33	5.2.1.5	The technical team shall participate in the life-cycle and technical reviews as indicated in the governing program/PM NPR.	The technical team will be responsible for generating and presenting many of the technical topics during a life-cycle and technical review.	FC	EGS Program life cycle review strategy is documented in the SEMP and Program Plan
SE-34	5.2.2.1	The technical team shall participate in the development of entrance and success criteria for each of the respective reviews.	The entrance and success criteria in Appendix G are provided as guidelines (not requirements). It is expected that they will be modified as needed by the program/project according to their size, complexity, type of end product being produced, formality, and risk acceptance posture. Specific names of documents may be provided for clarity, non-applicable products eliminated, and new products added as needed for clarity and completeness.	FC	Entrance & Success Criteria are defined for each EGS Program Life Cycle review and documented in the associated review plan.
SE-35	5.2.2.2.a (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: Mission Concept Review (MCR): Baseline stakeholder identification and expectation definitions.	For an MCR one of the key products is capturing the stakeholder expectations. These may be identified as NGOs, or other methods for capturing their expectations. These are captured in a document or a database/model. After all comments from the MCR are dispositioned, the set of stakeholder expectations are updated with the approved comments and then baselined.	FC	GSDO MCR baselined program stakeholder expectations
SE-36	5.2.2.2.a (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MCR: Baseline concept definition.	Presenting one or more feasible ways of accomplishing the stakeholder expectations is a key product of the MCR. These are captured in a document or a database/model. After all comments from the MCR are dispositioned, the concept(s) are updated with the approved comments and then baselined.	FC	GSDO MCR baselined program concept of operations

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SE-37	5.2.2.2.a (3)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MCR: Approved Measures of Effectiveness (MOE) definition.	The MOE capture the stakeholders' view of what would be considered the successful achievement of each expectation. These will help in the later identification of requirements, criteria for trade studies and in the success criteria for the validation efforts.	FC	GSDO MCR baselined MOE for program.
SE-38	5.2.2.2.b (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: SRR: Baselined SEMP (or other equivalent program/project documentation) for projects, single-project programs, and one-step AO programs.	The SEMP is a key document for the technical effort in a similar manner that the program/project plan captures the programmatic efforts. These are captured in a document or a database/model. For projects, single-project programs, and one-step AO programs after all comments from the SRR are dispositioned, the SEMP (or other equivalent program/project documentation) is updated with the approved comments and then baselined. The SEMP (or other equivalent program/project documentation) is baselined in a later phase for the other types of programs and so will be a "Not Applicable" in this line for uncoupled, tightly coupled, and loosely coupled programs.	FC	A baselined SEMP was provided at the combined SRR/System Definition Review (SDR) for program IOC. The SEMP has been updated for subsequent EGS Program Mission Capability Upgrade projects.
SE-39	5.2.2.2.b (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: SRR: Baselined requirements.	The program/project requirements are a key product for the SRR. These are captured in a document or a database/model. After all comments from the SRR are dispositioned, the requirements are updated with the approved comments and then baselined.	FC	Program Requirements for IOC were baselined as a result of the combined GSDO SRR/SDR. Requirements are maintained/updated in the EGS CRADLE tool.
SE-40	5.2.2.2.c (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: Mission Definition Review (MDR)/SDR: Approved TPM definitions.	A key product at the SDR is the set of TPMs that the program/project has identified as the important measures to track for their efforts. These may be associated with the key driving requirements, key performance parameters, leading or lagging indicators, or other measures that are important to periodically measure and track.	FC	TPM definitions were presented at SRR/SDR, and are documented in the EGS Program TPM Management Plan.
SE-41	5.2.2.2.c (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MDR/SDR: Baselined architecture definition.	One of the key products of an SDR is the proposed architecture that will accomplish the requirements. These are captured in a document or a database/model. After all comments from the SDR are dispositioned, the architecture description is updated with the approved comments and then baselined.	FC	EGS ACO document was baselined prior to SRR/SDR and is updated for EGS Program capability upgrades/modifications.
SE-42	5.2.2.2.c (3)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MDR/SDR: Baselined allocation of requirements to next lower level.	Now that the overarching architecture has been defined, it is important to show how the requirements are allocated to the architecture elements of the next lower level of the product hierarchy. These are captured in a document or a database/ model. After all comments from the SDR are dispositioned, the allocation is updated with the approved comments and then baselined.	FC	Requirements allocation down through Element level for IOC were baselined as a result of the GSDO combined SRR/SDR.
SE-43	5.2.2.2.c (4)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MDR/SDR: Initial trend of required leading indicators.	The trend is presented for the leading indicators that have been identified by the Agency as required for each program/project. These will typically be in graphical form but could also be tabular or other form appropriate for the project. At SDR this will be the initial set of trends that have been captured since SRR. Since final hardware has not been produced at this point, the trends will be on the estimated parameters.	FC	Leading indicator trends were presented and reviewed at the GSDO combined SRR/SDR.

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SE-44	5.2.2.2.c (5)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: MDR/SDR: Baseline SEMP (or other equivalent program/project documentation) for uncoupled, loosely coupled, tightly coupled, and two-step AO programs.	The SEMP is a key document for the technical effort in a similar manner that the program plan captures the programmatic efforts. These are captured in a document or a database/model. For uncoupled, loosely coupled, tightly coupled, and two-step AO programs, after all comments from the MDR/SDR are dispositioned, the SEMP (or other equivalent program/project documentation) is updated with the approved comments and then baselined. The SEMP (or other equivalent program/project documentation) is baselined in an earlier phase for projects and single-project programs and so will be a "Not Applicable" in this line for those types of programs.	FC	EGS Program SEMP was baselined prior to GSDO SRR/SDR.
SE-45	5.2.2.2.d (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: PDR: Preliminary design solution definition.	The key product of a PDR is the preliminary design itself. The design is captured in one or more documents, models, databases, drawings, and other means. Comments from the PDR will be captured in the final design for the next review.	FC	All preliminary designs for IOC were provided and reviewed at GSDO PDR. Upgrade preliminary designs will be provided at associated project PDR milestones.
SE-46	5.2.2.2.e (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: CDR: Baseline detailed design.	The key product of a CDR is the final design. The design is captured in one or more documents, models, databases, drawings, and other means. The final design is updated with approved comments from the review, and the design is updated to represent the design that will be implemented.	FC	All final designs for IOC were provided at GSDO CDR. Final designs for capability upgrade projects will be provided at associated project CDR milestones.
SE-47	5.2.2.2.f (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: SIR: Updated integration plan.	A key product of an SIR is the updated integration plans. These will describe how the products associated with this review will be integrated.	FC	Updated integration plans for IOC were provided at EGS SIR. Integration plans for capability upgrades will be provided at program SIR-equivalent reviews as required.
SE-48	5.2.2.2.f (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: SIR: Initial V&V results.	Another key product of an SIR is the initial V&V results from any of the lower level products that are associated with this review. With the recursive nature of the SE engine, products will be integrated and verified/validated from the bottom of the product layer to the top. So, prior to integration into larger assemblies, lower level products will have been through their V&V activities. This ensures that, when they are assembled into the higher product layers, they will work as intended. Programs/projects may decide to perform V&V only at assembly levels—as captured in their SEMP (or other equivalent program/project documentation)—and so initial V&V results may or may not be available.	FC	Preliminary V&V results for IOC were provided at EGS SIR. Preliminary V&V results for capability upgrades will be provided at program SIR-equivalent reviews as required.
SE-51	5.2.2.2.g (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: ORR: Preliminary decommissioning plans.	At ORR it is important to describe how the product will ultimately be decommissioned when it has accomplished its mission. This is to ensure that decommissioning will be feasible before the product is put into use. These are captured in a document or a database/model. After all comments from the ORR are dispositioned, the plan is updated with the approved comments and then baselined.	T	EGS Program capabilities provide ground systems infrastructure to support recurring missions. The EGS Preliminary Decommissioning plan will be baselined at an appropriate EGS PSR milestone based on the mission manifest.
SE-52	5.2.2.2.g (3)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: ORR: Baseline disposal plans.	At ORR it is also important to describe how the product will ultimately be disposed of when it has accomplished its mission. This is to ensure that disposal will be feasible before the product is put into use. These are captured in a document or a database/model. After all comments from the ORR are dispositioned, the plan is updated with the approved comments and then baselined.	NA	EGS program infrastructure does not contain expendable elements. Expendable materials are disposed in accordance with KSC Environmental plans.

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SE-53	5.2.2.2.h (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: FRR: Baseline V&V results.	At FRR, the baselined V&V results for the product are presented and any remaining open work identified. This is to ensure that the product is ready for flight. Note that for some programs/projects the V&V results may need to be baselined at ORR per Center policies/procedures. Maturing and presenting a product earlier than required in the Agency NPR is at the discretion of the program/project/Center and does not require a waiver.	FC	Baselined V&V results are provided at EGS SAR/ORR milestones. Mission Integrated Test and Checkout results will be provided at each FRR.
SE-54	5.2.2.2.h (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: FRR: Final certification for flight/use.	The key product at the FRR is the certification that the product is ready for flight/use. This gains agreement with all key stakeholders that the product is ready to put into the operational phase. Any remaining open items are identified and plans for closure are developed.	FC	At FRR for each mission, a final CoFR will be provided
SE-55	5.2.2.2.i (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: DR: Baseline decommissioning plans.	The key product at the DR is the plan on how the product will be removed from service. The approved comments from the DR are used to baseline the plan.	FC	At EGS DR, an updated Decommissioning Plan will be provided
SE-56	5.2.2.2.j (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: DRR: Updated disposal plans.	The key product of the DRR is the plan on how the product will be disposed of after it has been decommissioned. The approved comments from the DRR are used to update the plan.	FC	At EGS DRR, an updated Disposal Plan will be provided
SE-57	5.2.2.7	Technical teams shall monitor technical effort through periodic technical reviews.	In addition to the life-cycle reviews, the technical teams need to periodically monitor the technical progress of their program/project. These may be held formally or informally with relevant personnel.	FC	At the Program level, technical effort is statused at the MPR. At element and subsystem implementation level, design reviews are conducted at 30/45/60/90 percent complete. Periodic checkpoint reviews are also held between major program milestones.
SE-58	6.2.3	The technical teams shall define in the program/project SEMP how the required 17 common technical processes, as tailored, will be recursively applied to the various levels of program/project product layer system structure during each applicable life-cycle phase.	The SEMP is the key document that lays out the work that the technical team needs to perform and the manner in which they will perform it. This requirement ensures that each of the 17 common technical processes is addressed and how it will be applied to the various levels in the end-item product hierarchy and their associated enabling products.	FC	The EGS SEMP addresses the 17 Common Technical Processes.
SE-59	6.2.5	The technical team shall ensure that any technical plans and discipline plans are consistent with the SEMP (or equivalent program/project documentation) and are accomplished as fully integrated parts of the technical effort.	Since the SEMP is the primary planning document for the SE effort, all subsequent planning documents are in alignment and consistent with the SEMP.	FC	The EGS SEMP points to lower level technical plans and those lower level plans point back to the SEMP for compliance.
SE-60	6.2.6	The technical team shall establish TPMs for the program/project that track/describe the current state versus plan.	The measures that the program/project will use to track the progress of key aspects of the technical effort are identified and documented. These TPMs will include the required leading indicators described in other requirements of this NPR and also any project-unique measures deemed necessary to track the key performance parameters.	FC	EGS TPMs are documented in the EGS Program TPM Management Plan

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SE-61	6.2.7	The technical team shall report the TPMs to the Program/Project Manager on an agreed-to reporting interval.	The selected TPMs need to be measured periodically and their trends reported to the program/project manager at the agreed-to interval as documented in the SEMP (or other equivalent program/project documentation). This ensures the PM and ETA are kept up to date on these key parameters so that decisions can be made in a timely manner.	FC	EGS TPMs are statused to PM periodically at MPR.
SE-62	6.2.8. a	The technical team shall ensure that the set of TPMs include the following leading indicators: Mass margins for projects involving hardware.	If the program/project has hardware elements, tracking of the remaining margins associated with their mass is a required leading indicator measure by the Agency. This is especially important for flight projects. For ground or other projects in which mass is not relevant, a waiver to this requirement can be documented in the SEMP or other equivalent program/project documentation.	FC	Any ground projects with mass margins are tracked in the TPM Management Plan
SE-63	6.2.8. b	The technical team shall ensure that the set of TPMs include the following leading indicators: Power margins for projects that are powered.	If the program/project has elements that require power, tracking of the remaining margins associated with their power consumption is a required leading indicator measure by the Agency. This is especially important for flight projects. For ground or other projects in which power consumption is not relevant, a waiver to this requirement can be documented in the SEMP or other equivalent program/project documentation.	FC	Any ground projects with power margins are tracked in the TPM Management Plan
SE-64	6.2.9	The technical team shall ensure that a set of review trends is created and maintained that includes closure of review action documentation (RIDs, RFAs, and/or Action Items as established by the project).	During life-cycle reviews, comments from the reviewers are captured on forms, databases, spreadsheets, or other manner. Depending on the program/project, these may be called RFAs, RIDs, Action Items, or other terminology. Whatever they are called, the disposition and closure of these comments—typically called their burndown—are required indicator trends by the Agency. This ensures that the approved comments are incorporated into the designs and plans in a timely manner.	FC	Open Items resulting from EGS reviews are identified at the review board with assigned constraints, due dates, and owners. Open Items are actively tracked and statused to completion with trend charts provided at EGS PMT/MPR.
SE-65	5.2.1.3	The technical team shall develop and document an approach to Human Systems Integration (HSI).	The HSI approach ensures that system aspects that interface with humans (e.g., crew, operators, users, maintainers, assemblers, and ground support personnel) have been considered and that HSI requirements will be met.	FC	Process described in SEMP and fully documented in EGS Program Human Systems Integration Plan (GSDO-PLN-1276)
SE-66	5.2.2.2.b (3)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: SRR: Baseline Human Systems Integration approach	An important product of the SRR is a baselined approach to HSI. This ensures that human interfaces with the products of the project have been considered and that the HSI requirements from this review will be addressed.	FC	Process described in SEMP and fully documented in EGS Program Human Systems Integration Plan (GSDO-PLN-1276)
SE-67	5.2.2.2.d (2)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: PDR: Baseline integration plans	A key product of an SIR are the integration plans. These will describe how the products of this project will be integrated. Depending on the complexity of the project this may be a stand-alone plan or incorporated into another document like the SEMP or the V&V Plan.	FC	Integration plan articulated in EGS Program Architecture and Concept of Operations document (GSDO-ACO-1010). Integration processes articulated in SEMP and Cross-Program Policies and Agreements for Launch Site Ground Operations Plan (GSDO-PLN-1195)

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Req. ID	NPR Section	Requirement Statement	Rationale	Comply?	Justification
SE-68	5.2.2.2.d (3)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: PDR: Baselined Verification and Validation Plan	At PDR, the plan of how the requirements of the project products will be verified and how the stakeholder expectations of those products will be validated is baselined. This ensures that the project and its stakeholders are in agreement of how the V&V will proceed and that the results will provide adequate information to decide upon the acceptability of the design.	FC	Program V&V plans are documented in EGS Master V&V Plan (GSDO-MVVP-1042) and its associated mission-specific annexes.
SE-69	5.2.2.2.g (1)	The technical team shall provide the following minimum products at the associated life-cycle review at the indicated maturity level: ORR: Preliminary V&V results	At ORR, the project should have at least preliminary results from the V&V activities. Any remaining requirements or expectations that have not been verified or validated should be discussed at the ORR	FC	Program V&V results documented in Cradle © and associated linked products and reported at Program ORR milestones.

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APPENDIX B REVIEW STRATEGY PATH TO ARTEMIS I

Figure B-1 depicts the EGS Program Review Strategy that was executed for the Artemis I mission. The path provided an incremental build-up of evidence throughout the initial Program DDT&E life-cycle phases to demonstrate EGS operational readiness to support processing, launch and recovery of the Artemis I mission.

This path began with subsystem-level design reviews performed by the design engineering organizations (e.g., NE, IT) that had participation from the EITs and stakeholders from EGS, SLS, and Orion as appropriate. The EITs integrated the subsystems into the Element and provided additional analysis to support reviews at higher levels prior to the Program-level technical milestone reviews (PDR and CDR). This path continued with a System Integration Review (SIR) to ensure all components were ready leading to integrated V&V activities and continued through certification of subsystems design functionality through a progression of confidence building milestones. This path also included ground systems certification of readiness through the EGS Integrated SAR/ORR (illustrated in Figure B-1) to support Ground Operations. After conducting the final SAR/ORR increment EGS passed into Phase E – Operations and Sustainment which was confirmed at Key Decision Point-E.

The incremental CoFR approach consisted of major milestone reviews (e.g., various SAR/ORRs, ESD Integration Review, EGS Launch Readiness Review, ESD Pre-FRR, NASA Agency FRR, L-2 Review) and key milestone reviews (e.g., roll-out review).

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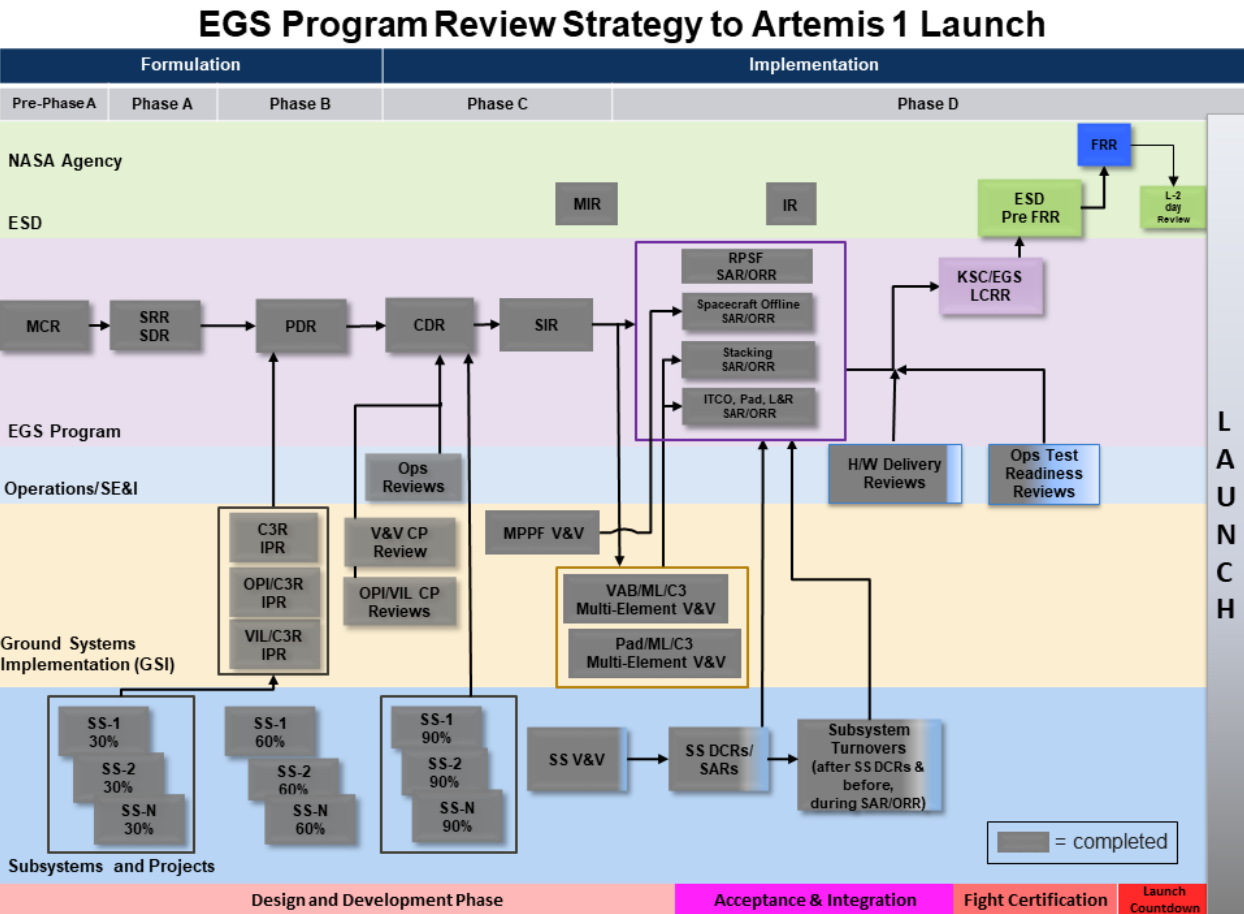


FIGURE B-1 EXPLORATION GROUND SYSTEMS PROGRAM REVIEW STRATEGY PATH TO ARTEMIS I LAUNCH

B1.0 Mission Concept Review

The EGS Program began with Mission Concept Review. This foundational review was conducted according with GSDO-PLN-1002-ANX-01 (Retired), the GSDO MCR Review Plan.

B2.0 System Requirements Review/System Definition Review

The EGS Program entered into Phase A with a combined System Requirements and System Definition Review. This review was conducted according with GSDO-PLN-1002-ANX-02 (Retired), the GSDO SRR/SDR Review Plan.

B3.0 Integrated Product Team Preliminary Review

The EGS Program was initially organized by IPT. The IPRs were reviews of IPT capabilities. EGS has discontinued the use of IPTs in its governance structure. These reviews formed a basis for proceeding to EGS PDR. More details can be found in the

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GSDO-PLN-1002-ANX-03 (Retired), GSDO SEMP Annex 3: IPT Preliminary Review Plan.

B4.0 Preliminary Design Review

The EGS Program conducted a PDR in compliance with NPR 7120.5 and NPR 7123.1. The PDR plan was documented in GSDO-PLN-1002-ANX-04 (Retired), GSDO Program SEMP Annex 04: Preliminary Design Review Plan.

B5.0 Critical Design Review

The EGS Program conducted a CDR in compliance with NPR 7120.5 and NPR 7123.1. The CDR plan was documented in GSDO-PLN-1002-ANX-05 (Retired), GSDO Program SEMP Annex 05: Critical Design Review Plan. The Program held informal checkpoints to ensure subsystems integration and maturity was on track to meet CDR milestones.

The CDR ensured that subsystem designs were at the proper maturity and that proper integration of the subsystems into a complete capability was performed.

B6.0 System Integration Review

Following the EGS CDR, a SIR was executed in compliance with the applicable NPRs. The EGS SIR review plan was documented in GSDO-PLN-1002-ANX06 (Retired), EGS Program SEMP Annex 06: SIR Review Plan.

B7.0 Subsystem Reviews

All subsystems satisfying EGS requirements underwent an "acceptance and/or certification" process. The type of review or approval necessary depended upon the end use of the subsystems as well as whether a subsystem or piece of equipment was new or heritage. The EGS acceptance/certification process is further described in Section 4.5 of this document including details of the subsystem SAR, DCR, and their entrance and success criteria.

B8.0 EGS Integrated System Acceptance Reviews and Operational Readiness Reviews

EGS implemented the program requirement for SAR and ORR by conducting a series of combined incremental-capability integrated SAR/ORRs. Each EGS Integrated SAR/ORR was conducted in accordance with the relevant life cycle review requirements defined in NPR 7123.1 and NPR 7120.5. For planning and scheduling purposes (as shown in Figure B-1) EGS divided the SAR/ORR content into four reviews:

- a. Rotation, Processing & Surge Facility
- b. Spacecraft Offline
- c. Stacking
- d. Integrated Test & Checkout, Pad, L&R.

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The review plan for conducting EGS SAR/ORRs was documented in GSDO-PLN-1002-ANX-07 (Retired), EGS Program Systems Engineering Management Plan Annex 07; System Acceptance Review/Operational Readiness Review Plan.

Each integrated SAR/ORR included all program-level products necessary to demonstrate Program-level compliance with NPR 7123.1 review criteria for both SAR and ORR. The SAR portion of the review ensured that all relevant design requirements had been satisfied and verified or there existed a plan to close all open items or issues. Program and interface requirements (i.e., Multi-Element V&V) were closed as a result of EGS Integrated SAR/ORR.

The ORR portions of the integrated EGS SAR/ORR examined the EGS program readiness to support upcoming relevant flight processing operations. This review ensured that all systems and support hardware, software, personnel, procedures, and user documentation were ready to support the relevant EGS-related operations (i.e., ground processing, launch, L&R, etc.).

Upon completion of each SAR/ORR board, the EGS Program certified that EGS personnel, hardware, software, procedures, and processes were in place to support normal and contingency operations for Artemis I for that segment of the EGS architecture. Successful conclusion of the SAR/ORR board served as the ORD for IOC of that segment of the total program architecture.

Conclusion of the final Artemis I SAR/ORR provided the evidence for EGS to enter Phase E – Operations and Sustainment phase per NPR 7120.5.

B9.0 EGS Pre-Flight Readiness Review

EGS in conjunction with KSC Center Directors office conducted the KSC/EGS LCRR for Artemis I to serve as the EGS Program-level FRR in accordance with NPR 7123.1.

B10.0 EGS Post-Flight Assessment

After successful launch and recovery operations for the Artemis I mission, EGS conducted a PFAR in accordance with NPR 7123.1 for the Artemis I mission to review the observed performance of ground systems and processes in support of flight element receipt, servicing, integration, checkout, launch and recovery. Problems encountered and lessons learned were reviewed with emphasis on ground system performance. EGS PFAR provided identification and analysis of modifications to ground systems and processes needed to be accomplished in the subsequent Artemis II mission turnaround phase prior to conducting subsequent mission-flow operations. Output reports contributed to the closure of functional operational capability validations at the Enterprise level.

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APPENDIX C ACRONYMS AND ABBREVIATIONS

A&E	Architecture and Engineering
ACO	Architecture and Concept of Operations
ACPR	Alternate Certification Plan Review
ADP	Acceptance Data Package
BDEALS	Bilateral Data Exchange Agreements, Lists, and Schedules
BOSS	Base Operations and Support Services
BSHEALS	Bilateral Software and Hardware Exchange Agreements, Lists, and Schedules
C3	Command, Control, and Communications
CB	Control Board
CDR	Critical Design Review
CER	Chief Engineers Review
CHMO	Chief Health and Medical Officer
CI	Configuration Item
CIL	Critical Items List
CM	Configuration Management
CMO	Chief Medical Officer
CMW	Change Management Workflow
CoFR	Certification of Flight Readiness
COMET	Consolidated Operations Management Engineering and Test
CPIT	Cross-Program Integration Team
CR	Change Request
CSO	Chief Safety Officer
CT	Crawler-Transporter
DA	Decision Authority
DAA	Deputy Associate Administrator
DCR	Design Certification Review
DCRB	Design Certification Review Board
DDT&E	Design Development Test, and Evaluation
DGA	Designated Governing Authority
DM	Data Management
DoD	Department of Defense

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DR	Decommissioning Review
DRR	Disposal Readiness Review
DVaO	Detailed Validation Objective
DVM	Design Verification Matrix
DVO	Detailed Verification Objective
E2E-CC	End-to-End Command and Control
E3	Electromagnetic Environmental Effects
EEE	Electrical, Electronic, and Electromechanical
EGS	Exploration Ground Systems
EHP	Extravehicular Activity and Human Surface Mobility Program
EIT	Element Integration Team
EOM	Element Operations Manager
EPM	Element Project Manager
ER	Eastern Range
ERB	Engineering Review Board
ESD	Exploration Systems Development
ETA	Engineering Technical Authority
ETM	Element Technical Manager
ESDMD	Exploration Systems Development Mission Directorate
EURD	End-User Reference Data
FAL	Functional Area Lead
FCA	Functional Configuration Audit
FMB	Facility Management Board
FMEA	Failure Modes and Effects Analysis
FWD	Forward Work
FRR	Flight Readiness Review
GIE	Ground Integration Engineer
GSI	Ground Systems Implementation
GSDO	Ground Systems Development and Operations
GSE	Ground Support Equipment
HA	Hazard Analysis
HEOMD	Human Exploration and Operations Mission Directorate
HF	Human Factors
HH&P	Human Health and Performance
HLS	Human Landing System

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HMTA	Health and Medical Technical Authority
HQ	Headquarters
HRCP	Human Rating Certification Package
HRWG	Human Rating Working Group
HSI	Human Systems Integration
ICD	Interface Control Document
ICM	Information and Configuration Management
IERB	Integrated Engineering Review Board
IMS	Integrated Master Schedule
IOC	Initial Operational Capability
IPR	IPT Preliminary Review
IPT	Integrated Product Team
IRD	Interface Requirements Document
IT	Information Technology
ITT	Integration Task Team
ITV&V	Integrated Test, Verification, and Validation
KDDMS	KSC Design Data Management System
KGCS	Kennedy Ground Control Subsystem
KLXS	Kennedy LX Support Services Contract
KMR	Key Milestone Review
KSC	Kennedy Space Center
L&R	Landing and Recovery
LCC	Launch Commit Criteria
LCS	Launch Control System
LDE	Lead Design Engineer
LE	Lead Engineer
LETF	Launch Equipment Test Facility
LPE	Launch Pad EIT
LRCB	Launch and Recovery Control Board
LRICB	Launch and Recovery Integration Control Board
LSA	Logistics Support Analysis
LSRR	Launch Site Requirements Review
LUTE	Limited Use Test Equipment
LVOP	Launch Vehicle Offline Processing
M2M	Moon-to-Mars

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M2MCB	Moon-to-Mars Control Board
M&S	Modeling and Simulation
MAVRIC	Modeling Architecture, Verification, Requirements, Interfaces, and Conops
MCR	Mission Concept Review
MDR	Mission Definition Review
ML	Mobile Launcher
MOE	Measure of Effectiveness
MPR	Monthly Program Review
MVVP	Master Verification and Validation Plan
MS	Mission Systems
MSL	Master Subsystems List
NASA	National Aeronautics and Space Administration
NGO	Needs, Goals, and Objectives
NOM	NASA Operations Manager
NOWILCO	Will Not Comply
NPR	NASA Procedural Requirements
O&M	Operations and Maintenance
O&TM	Operations and Test Management
OEM	Original Equipment Manufacturer
OERB	Operations Engineering Review Board
OMCR	Operation and Maintenance Controlled Requirement
OMRS	Operations and Maintenance Requirements and Specifications
OMRSD	O&M Requirements and Specifications Document
OPE	Operations Project Engineer
OPPR	Operations Processing Project Review
OPR	Office of Primary Responsibility
Ops	Operations
ORC	Operations Readiness Checkpoint
ORD	Operational Readiness Date
ORPR	Open Requirements Permission Review
ORR	Operational Readiness Review
P2P	Program-to-Program
P&P	Plans and Processes
PCA	Physical Configuration Audit
PCB	Program Control Board

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PCE	Program Chief Engineer
PDLM	Product Data and Life-Cycle Management
PDO	Partnership Development Office
PDR	Preliminary Design Review
PIR	Program Implementation Review
PM	Project Manager
PMT	Performance Management Team
POC	Point of Contact
PP&C	Program Planning and Control
PPBE	Planning, Programming, Budgeting, and Execution
PRACA	Problem Reporting and Corrective Action
PRB	Program Review Board
PRD	Program Requirements Document
PSR	Program Status Review
PTM	Product Tailoring Matrix
PTB	Pre-Test Briefing
RDW	Request for Deviation/Waiver
RFA	Request For Action
RFP	Request For Proposal
RID	Review Item Discrepancy
RM	Risk Management
RMA	Reliability, Maintainability, Availability
RMP	Risk Management Plan
RSAR	Reliability and Safety Analysis Report
S/C	Spacecraft
S&MA	Safety and Mission Assurance
SAR	System Acceptance Review
SDR	System Definition Review
SE	Systems Engineer
SE&I	Systems Engineering and Integration
SEI&O	Systems Engineering, Integration, and Operations
SEMP	Systems Engineering Management Plan
SESC	SLS Engineering Support Center
SI	Spaceport Integration and Services Organization
SIR	System Integration Review
SLS	Space Launch System

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SME	Subject Matter Expert
SOO	Spacecraft Offline Operations
SOP	Spacecraft Offline Processing
SOW	Statement of Work
SPM	System Project Manager
SRR	System Requirements Review
SRS	Support Requirements System
StE	Stakeholder Expectation
STIM	Senior Technical Integration Manager
TBD	To Be Determined
TBR	To Be Resolved
TD	Technology Development
TPM	Technical Performance Measure
TRD	Test Readiness Document
TRR	Test Readiness Review
UA	Unexplained Anomaly
UFS	Unmodified Facility Subsystems
V&V	Verification and Validation
VVWG	V&V Working Group
VAB	Vehicle Assembly Building
VSR	V&V Status Review
WBS	Work Breakdown Structure
WG	Working Group
WILCO	Will Comply

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APPENDIX D OPEN WORK

D1.0 TO BE DETERMINED

Table D-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. The TBD item is numbered based on the section where the first occurrence of the item is located as the first digit and a consecutive number as the second digit (i.e., **<TBD 4-1>** is the first undetermined item assigned in Section 4 of the document). As each TBD is solved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

TABLE D-1 TO BE DETERMINED ITEMS

TBD	Section	Description
<TBD 3-1>	3.6.3.1	M2M Requirements V&V Plan is not currently baselined

D2.0 TO BE RESOLVED

Table D-2 lists the specific To Be Resolved (TBR) issues in the document that are not yet known. The TBR is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. The TBR issue is numbered based on the section where the first occurrence of the issue is located as the first digit and a consecutive number as the second digit (i.e., **<TBR 4-1>** is the first unresolved issue assigned in Section 4 of 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 D-2 TO BE RESOLVED ISSUES

TBR	Section	Description
<TBR 5-1>	5.3.3	M2M processes for interface management will replace CPIT established processes. Need to revisit ICD ownership and responsibility in section 5.3.3 when all remaining Phase Integration issues regarding Interface Management / ownership / processes are resolved..

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D3.0 FORWARD WORK

Table D-3 lists the specific forward work items identified during this document's CR review and evaluation. Each item is given a sequential number (i.e., **<FWD 001>**). For each item, in the CR/CE field enter the specific number of the CR followed by the comment number from the Change Evaluation (CE) i.e., GSDO-C0345/CE-10, GSDO-C0345/CE-27. Do not include a placeholder for forward work items in the body of the document; list them only in Table D-3.

TABLE D-3 FORWARD WORK

FWD	CR/CE	Description

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