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ARES PROJECTS PLAN

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ARES PROJECTS PLAN

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1.1 INTRODUCTION

National Security Presidential Directive (NSPD) 31, the U.S. Space Exploration Policy (USEP), directs NASA to retire the Space Shuttle in 2010 and to replace it with a new generation of space transportation systems for crew and cargo travel to the Moon, Mars, and beyond. Crew transportation to the International Space Station (ISS) is planned for no later than 2014, and the first crewed lunar mission is planned in the 2020 time frame (see Figure 1-1).

Figure 1-1. The Orion crew exploration vehicle (CEV) will rendezvous in low Earth orbit with the Earth Departure Stage (EDS) and Altair lunar lander (artist's concept).

The Project is driven by a desire to reduce the Nation's human spaceflight gap, as well as to begin work on the Ares V and Altair lunar lander as soon as possible. Further contributing to the Project's sense of urgency is the need to rebuild the Agency's capacity as the world's recognized leader in the development of launch systems. This must be accomplished despite severe budget constraints through at least the year 2010, as well as through the uncertainty of forthcoming changes in the Nation's administration in 2009.

Safe, reliable, and cost-effective space transportation is a foundational piece of America's future in space, both strategic and tactical. The Ares Projects Office (APO) will deliver operational capabilities that support the Agency's responsibility to fulfill the USEP and to help ensure United States (U.S.) preeminence in space through assured access, as outlined in the U.S. Space Transportation Policy (January 2005) and as directed by the NASA Authorization Act of 2005 and the Fiscal Year (FY) 2006 Appropriations Act for NASA.

The Ares Projects Office, located at NASA's Marshall Space Flight Center (MSFC), is chartered to provide the new Ares I Crew Launch Vehicle (CLV) (Figure 1-2) and Ares V Cargo Launch Vehicle (CaLV) (Figure 1-3) space transportation systems.

Figure 1-2. Ares I concept.

The Ares management team has developed an aggressive, yet realistic, multiyear plan and has implemented a rigorous systems engineering approach in coordination with, and guided by, the Constellation Program (CxP) and the Exploration Systems Mission Directorate (ESMD). The CxP 70003, Constellation Program Plan, governs this Ares Projects Plan. Change control and approval authority is described in Section 3.11, Information and Configuration Management Plan. Unique Work Breakdown Structure (WBS) numbers are given in Section 2.2, WBS Baseline.

1.1.1 Historical Summary

The U.S. Space Exploration Policy (USEP), announced in January 2004, guides NASA's challenging mission of scientific discovery. With this as the basis for its strategic goals and objectives, in 2005, the NASA Administrator commissioned the Exploration Systems Architecture Study (ESAS), conducted by a team of Government experts who recommended space transportation options that could fulfill the goals and objectives outlined in the USEP within budget guidelines and schedule targets, while meeting safety, reliability, and risk figures of merit (FOMs) in relation to selected design reference missions (DRMs) to various exploration-related destinations.

Figure 1-3. Ares V concept.

As an integral part of NASA's systems engineering approach during the formulation phase, these ESAS recommendations subsequently underwent further engineering analyses, in tandem with independent cost estimating and acquisition strategy discussions, to determine the best approach for the extensive hardware design, development, test, and evaluation (DDT&E) required to deliver new space transportation capabilities. Based on those results and decisions by ESMD, a plan was put in place in early 2006 to effectively accelerate development activities by refocusing on developing Ares I hardware with greater extensibility to the Ares V system.

The management and integrated systems development approach outlined in this Ares Projects Plan offers reduced programmatic and technical risk, a more sustainable funding profile across the years of work ahead, and timely delivery of space transportation capabilities along the exploration path. This will lead to both the first new U.S. human-rated space transportation system and return of astronauts to the Moon in over 30 years.

1.1.2 Development Approach Builds on Legacy Foundation

The human-rated Ares I that will deliver the Orion Crew Exploration Vehicle (CEV) to low Earth orbit (LEO) early next decade is an in-line configuration with a five-segment reusable solid rocket booster (RSRB) based on the Space Shuttle reusable solid rocket motor (RSRM) as the first stage (FS) and a new, clean-sheet designed upper stage (US) powered by a liquid oxygen/liquid hydrogen (LOX/LH_2) J-2X engine, an evolution from the J-2 engines that the Apollo Program's Saturn IB (S-IVB stage) and Saturn V (S-II stage) used (see Figure 1-4).

The heavy-lift Ares V also builds on heritage hardware with a propulsion core consisting of a 10-meter-diameter core tank with a cluster of expendable RS-68 engines and two modified Ares I first stage solid rocket motors (see Figure 1-4). The 33-foot Ares V Earth Departure Stage (EDS), powered by a J-2X engine similar to that used on the Ares I upper stage, will carry the Altair lunar lander.

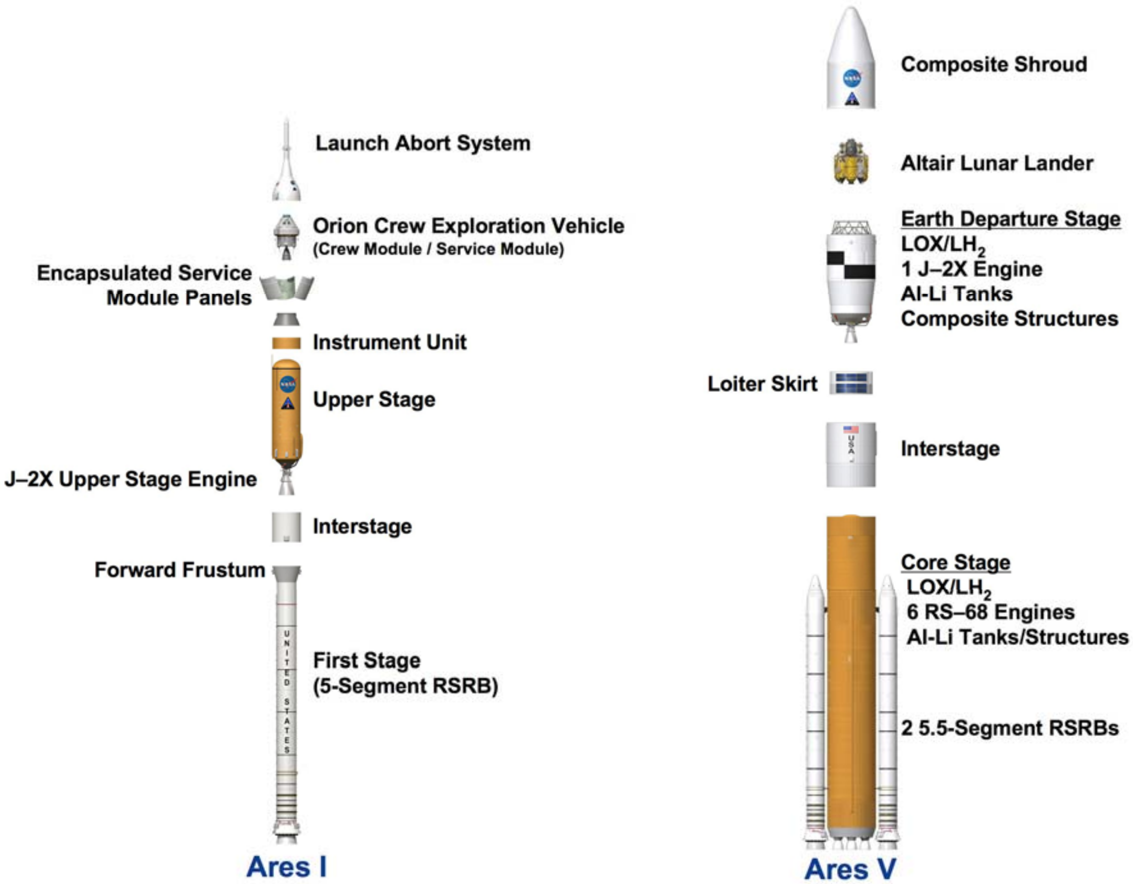


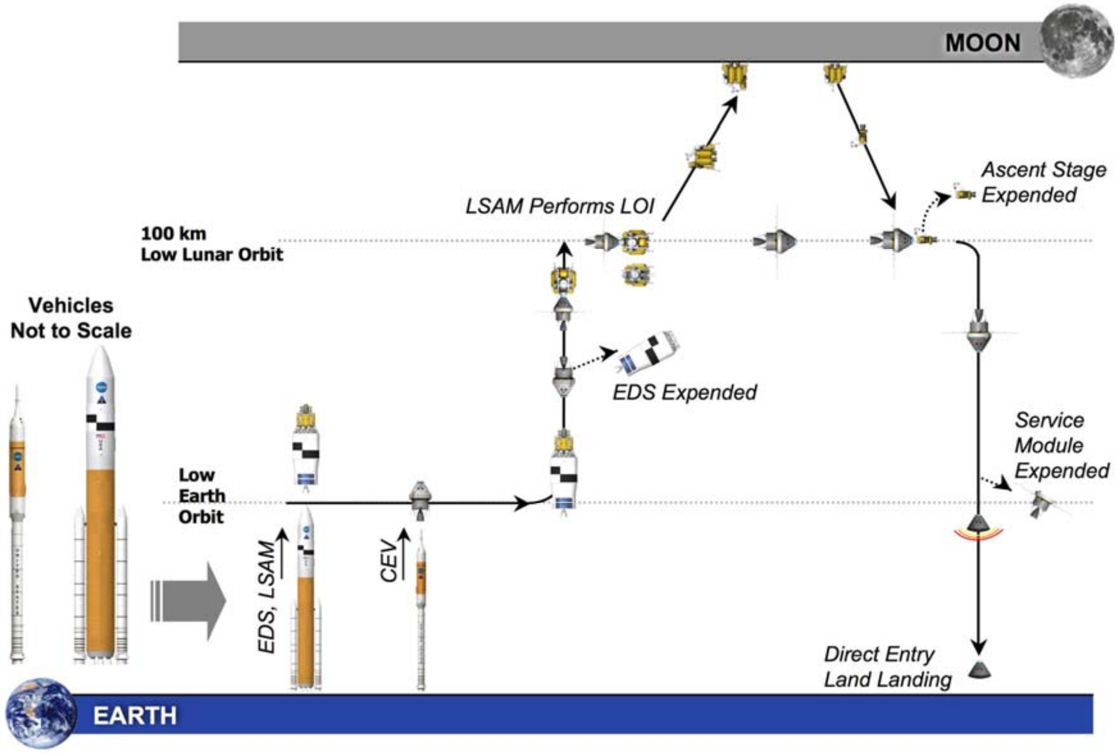
Figure 1-4. Constellation Launch Vehicle elements.

The lunar mission profile (Figure 1-5) is known as the "1.5 launch architecture," with the Ares I delivering the Orion to LEO, where it will rendezvous with the EDS and Altair delivered by the Ares V. Further technical descriptions are given in Section 1.3, Mission Descriptions and Technical Approach, and in Section 1.6, Technical Summary.

The hardware delivery plan to accomplish this and other missions offers multiple benefits, including leveraging the valuable network of aerospace talent and unique infrastructure, while tapping into a vast storehouse of legacy knowledge generated from decades of experience with the Apollo Saturn and Space Shuttle systems. As such, this is a multi-Center and industry partnership, as described in Section 1.4.3, Management Structure; Section 1.4.5, Project Dependencies; and Section 3.4, Acquisition Plan.

While DDT&E tasks are in progress to meet near-term Ares I milestones, the Ares V requirements are being developed and validated, and long-range schedules are being formulated. In addition, Ares V design work, including an integrated vehicle study to refine earlier top-level or stage/element-specific studies, is proceeding in parallel. The Ares Integrated Master Schedule

(IMS) is given in Section 2.3, Schedule Baseline, and the various programmatic and technical reviews that serve as key decision gates are described in Section 3.8, Reviews.



CEV – Crew Exploration Vehicle; EDS – Earth Departure Stage; km – Kilometer; LOI – Lunar Orbit Insertion; LSAM – Lunar Surface Access Module (now the Altair Lunar Lander).

Figure 1-5. Lunar mission profile.

1.1.3 Document Overview

In accordance with NASA Procedure and Regulation (NPR) 7120.5D, NASA Space Flight Program and Project Management Requirements, this document provides top-level requirements, goals, objectives, performance measures, mission success criteria, schedule, resources, acquisition strategy, management systems and controls, and other pertinent information related to ensuring customer and stakeholder satisfaction by delivering timely, quality products and services in a fiscally sound manner. Although minor tailoring has been applied, the guidelines stated in NPR 7120.5D are addressed in this Project Plan.

An acronym list can be found in Appendix A and a glossary is provided in Appendix C. The conceptual hierarchy of the Project-level Document Tree is shown in Appendix B. This tree denotes the flow down of Project documentation in the programmatic and technical areas. On the programmatic side, the documents flow from this Project Plan, while on the technical side, documents flow from the Ares I and Ares V System Requirements Documents (SRDs). For a detailed listing of the products being developed for Ares, refer to CxP 72114, Ares Project Documentation Tree.

1.2 OBJECTIVES

The Constellation Program will advance the Nation's scientific, security, and economic interests. The Ares I and Ares V systems being developed by Ares are key to the Program's success. Ares will address the Program's needs through developing safe, affordable, and sustainable launch systems to support human exploration missions.

1.2.1 Needs, Goals, and Objectives

ENGO-01.08-Rev. A, Exploration Needs, Goals, and Objectives, provides needs, goals, and objectives at both the Program and Project level, including rationale and traceability for each target. The major goals of Ares, as outlined in ENGO-01.08-Rev. A, are to:

- Develop a crew launch vehicle to provide transportation to LEO as close to 2010 as possible to minimize the gap with Shuttle retirement.
- Develop a heavy-lift launch capability to support the launch of exploration elements as early as 2018 and no later than 2020.
- Develop an EDS with the propulsive energy needed to transport exploration elements from LEO to trans-lunar injection (TLI) as early as 2018 and no later than 2020.
- Provide a substantial increase in safety and reliability in the launch phase compared to present human transportation systems.
- Provide a launch vehicle system that supports a substantial reduction in total mission operating costs compared to present human transportation systems.
- Provide an extensible and sustainable launch vehicle system that supports expanding human presence in the solar system while successfully meeting interim Program test and mission milestones.

To accomplish these milestones, NASA plans to deploy human and cargo spacecraft and ground systems, including Earth-to-orbit and in-space transportation systems. The following Ares objectives have, therefore, been established to support the development of this capability:

- Ensure flight/ground safety, while meeting system performance requirements and achieving mission objectives.
- Design the Ares I and Ares V to accommodate or exceed Constellation Program requirements.
- Develop and implement designs for the Ares I and Ares V and associated ground systems to achieve efficient and effective operations.
- Simplify the interface design within the Ares I and Ares V, and between the launch vehicles and other Constellation elements, to optimize integration.

- Perform to an established cost, schedule, and technical baseline.
- Utilize current, proven technology in the designs of the Ares I and Ares V.
- Utilize a "zero-based approach"; that is, requirements must earn their way into Project scope.
- Utilize performance-based contracting.
- Certify components, subsystems, and elements by testing, to the maximum extent practical.
- Implement the Integrated Logistics Support (ILS) approach and methodologies at the earliest stages to achieve the lowest ownership cost.
- Utilize to the maximum practical extent common hardware systems and software between vehicle elements, ground and flight support, and between Ares I and Ares V.

1.2.2 Technical Performance Measures

The technical performance measures (TPMs) set forth by the Constellation Program define the top-level performance requirements for the launch systems being developed. Ares tracks the following metrics on a monthly basis, to ensure conformity with Program requirements:

- Ares I mass-to-orbit for lunar missions and ISS missions.
- Performance of five-segment reusable solid rocket motor (RSRMV) and upper stage engine (USE).
- Mass of first stage, upper stage, interstage, and engine.
- Separation and liftoff clearance.
- Guidance, navigation, and control (GN&C) stability margin.
- Orbit insertion accuracy.
- Debris impact footprint.
- Launch probability due to natural environments.
- Vehicle loss of mission.
- Integrated stack processing time.
- Launch pad processing time.
- Maintainability

Monthly updates on these TPMs can be found hosted on Windchill by following this link. Access to the TPM analysis is controlled via Windchill because the detailed analysis is marked as Sensitive But Unclassified (SBU) material.

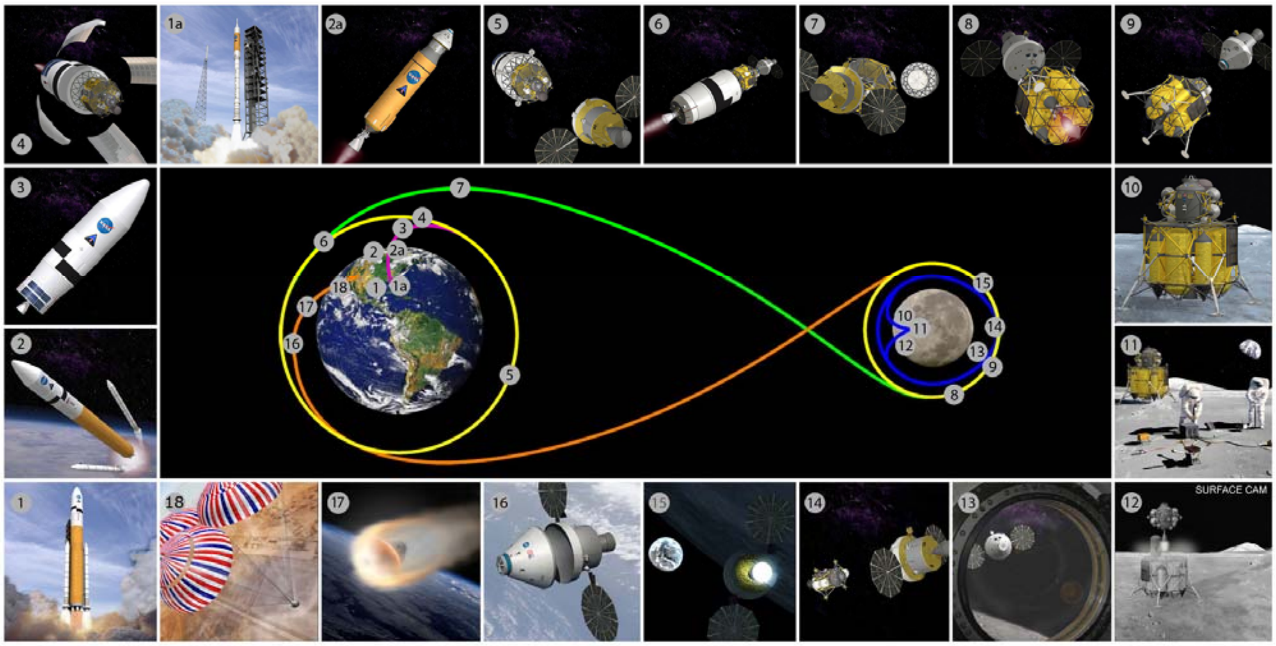
1.3 MISSION DESCRIPTION AND TECHNICAL APPROACH

1.3.1 Mission Description

The Constellation Program defines six basic missions in CxP 70007, Constellation Design Reference Missions (DRMs) and Operational Concepts Document, in which Ares I and Ares V systems will have significant roles. They are:

- Crew to ISS.
- Pressurized Cargo to ISS.
- Lunar Sortie Crew.
- Lunar Outpost Cargo.
- Lunar Outpost Crew.
- Exploration to Mars.

Ares' mission is to deliver safe, reliable human-rated crew and human-ratable cargo launch systems that support USEP to expand America's scientific reach through space exploration. The Project is responsible for DDT&E, as well as for integrating the launch vehicle to the payload, Ground Operations, Mission Operations, and Exploration Communications and Navigation (ECAN). Figure 1-6 provides an overview of the lunar mission architecture. Top-level launch vehicle system descriptions are provided below. Further details are given in Section 1.6, Technical Summary.



1. Ares V liftoff.
2. Solid Rocket Booster (SRB) separation.
3. Earth Departure Stage (EDS) fires for Earth Orbit Insertion (EOI).
4. Payload shroud separates to expose Altair Lunar Lander.
1a. Ares I liftoff.
2a. Upper Stage fires for EOI.
5. Orion docks with Altair/EDS.
6. EDS fires for Trans-Lunar Injection (TLI).
7. Orion and Altair undock from EDS.
8. Altair fires for Lunar Orbit Insertion (LOI).
9. Altair separates from Orion.
10. Altair lands on lunar surface.
11. Conducting activities on the lunar surface.
12. Altair ascent stage liftoff viewed from surface camera.
13. Altair ascent stage prepares to dock with Orion.
14. Altair ascent stage and Orion separate.
15. Service Module (SM) fires for Trans-Earth Injection (TEI).
16. Orion separates from SM.
17. Orion re-enters Earth atmosphere.
18. Chutes open for recovery.

Figure 1-6. Notional lunar mission architecture.

1.3.2 Technical Approach

The Ares I is a two-stage series-burn launch vehicle with interfaces for the Orion payload and the ground systems at the launch site (see Figure 1-7). The first stage has a RSRMV with thrust vector control (TVC) and a separation system. The motor utilizes polybutadiene acrylonitrile (PBAN) propellant. The upper (second) stage is a self-supporting cylindrical system that houses the LOX and LH_2 tanks that feed propellant to the J-2X engine, along with the vehicle's avionics, roll control, and the upper stage thrust vector system. Organizationally, the Ares I hardware elements consist of the First Stage (FS) Element, Upper Stage (US) Element, and Upper Stage Engine (USE) Element. These elements are further discussed in Section 1.6, Technical Summary.

The Ares I can lift an estimated 25.5 metric tons (mT) (56,200 pounds (lb)) to LEO at a –30×100 nautical mile (nmi) 28.5-degree orbit and 23.7 mT (51,500 lb) at a 51.6-degree orbit (see Figure 1-8). The Ares I is estimated to be as much as 10 times safer than the Space Shuttle, primarily due to its in-line design and launch abort system (LAS) for crew escape. The Ares I system is further described in CxP 72070, Ares I Integrated Vehicle Design Definition Document (IVDDD).

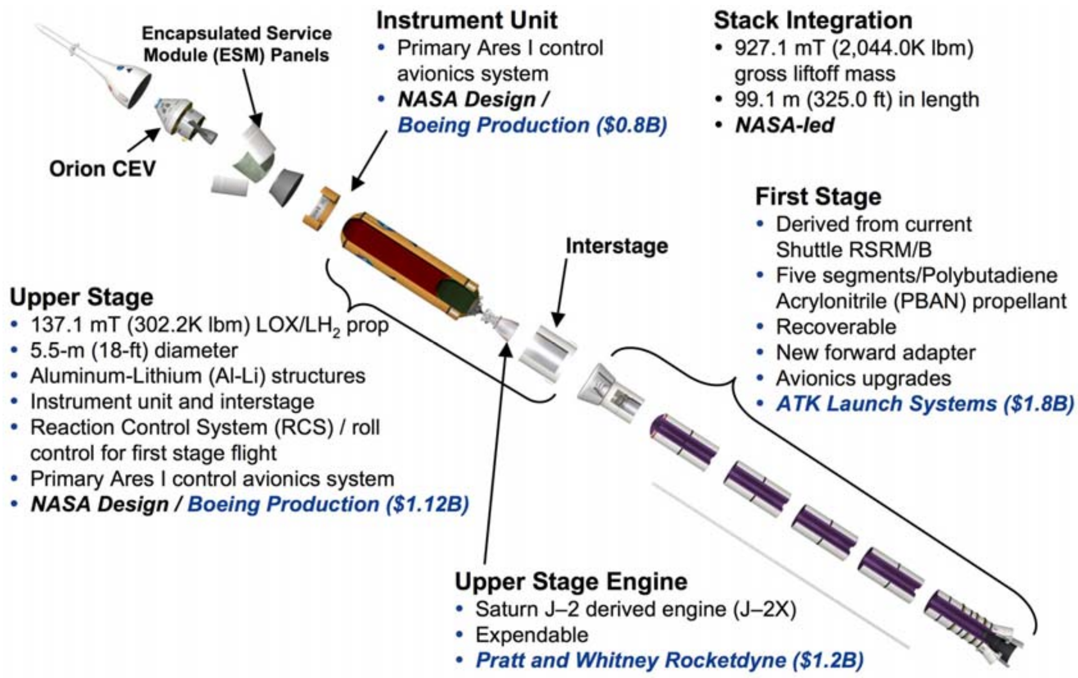


Figure 1-7. Crew Launch Vehicle expanded view.

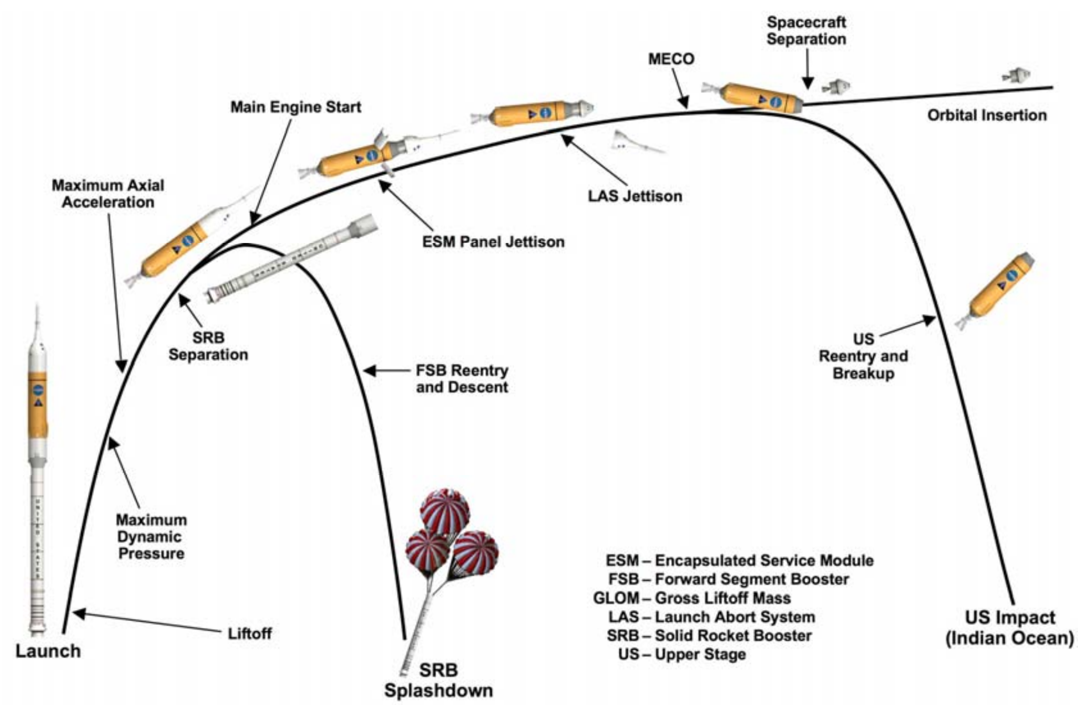


Figure 1-8. Notional Ares I reference missions.

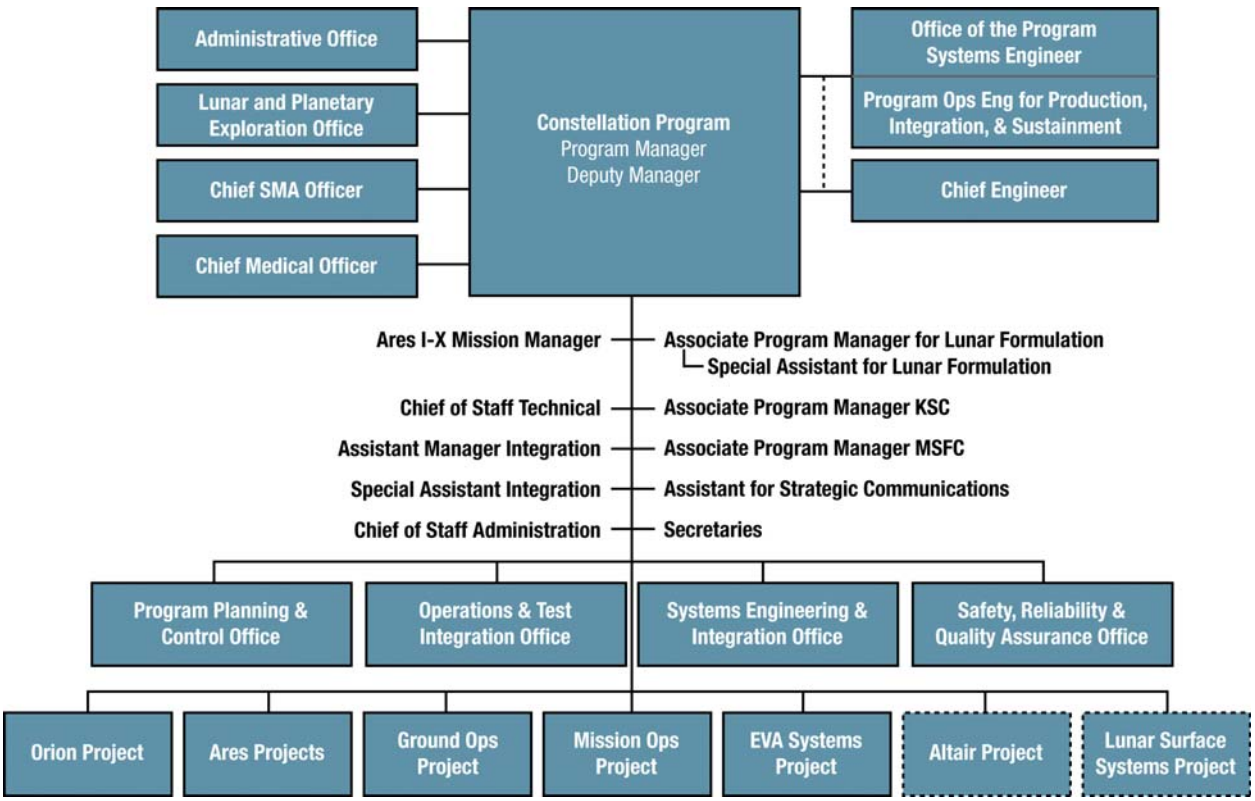
The heavy-lift Ares V, shown in Figure 1-9, is composed of two 5.5-segment RSRBs and a 10-meter-diameter core stage tank supplying LOX/LH_2 to a cluster of six RS-68 engines. The 10-meter-diameter EDS, powered by the J-2X engine, provides final impulse into LEO, circularizes itself and the Altair lunar lander into the assembly orbit where the Orion is joined to the Altair, and provides the impulse to accelerate the Orion and Altair to escape velocity and lunar orbit insertion (LOI). The EDS is planned to have extensive commonality with the Ares I upper stage in the areas of manufacturing, avionics/software, main propulsion system (MPS) components, TVC, J-2X engine, and testing. The Ares organization currently includes an Ares V integration function to coordinate engineering studies, budget planning, and represent the vehicle in Constellation-wide lunar architecture issues. The Ares V configuration can lift an estimated 143 mT to LEO in the dual launch mode with the Ares I, and 63 mT to TLI. Further operational details, including the Ares V flight profile, may be found in Section 3.9, Logistics and Operations.

Figure 1-9. Ares V Cargo Launch Vehicle concept.

1.4 PROJECT AUTHORITY, GOVERNANCE STRUCTURE, MANAGEMENT STRUCTURE, AND IMPLEMENTATION APPROACH

1.4.1 Project Authority

The ESMD Associate Administrator (AA) has full responsibility and authority for the operations and conduct of the Constellation Program. The ESMD AA has chartered the Constellation Program Office, located at the Johnson Space Center (JSC), to provide day-to-day integration and management between the numerous Constellation project offices across the Agency. The Constellation Program Office organization is shown in Figure 1-10.



EVA – Extra-Vehicular Activity; KSC – Kennedy Space Center; MSFC – Marshall Space Flight Center.

Figure 1-10. Constellation Program Office organization.

The MSFC Ares Projects Office leads the management, integration, and direction of Ares activities and assures compliance and consistency with Agency policy and priorities. The Project Manager executes, per the direction of the Constellation Program Manager, all activities required to meet the Project's objectives and NASA's Program-level requirements, as defined in CxP 70003, Constellation Program Plan.

The Ares Projects Office is also responsible for all activities associated with program planning and control (PP&C), including managing and assessing overall project cost, schedule, and procurement status, including earned value management (EVM) implementation and assessments for the entire Project. Additionally, they are responsible for the overall integration and integrated systems engineering for the Ares I and Ares V, among other more specific technical goals.

1.4.2 Governance Structure

NASA's governance structure is outlined in NASA Policy Directive (NPD) 1000.0A, Governance and Strategic Management Handbook. In keeping with that guidance, Ares is governed by the organizational alignment shown in Figure 1-11. The Ares Projects Office Manager and Deputy Manager report on programmatic schedule and budget in relation to technical performance measures to the ESMD and the Constellation Program.

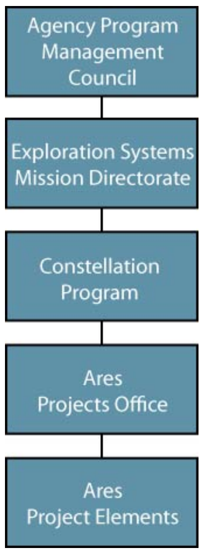


Figure 1-11. Organizational alignment.

In addition, the Ares Manager regularly reports on the Project's technical aspects to the MSFC Program Management Council (PMC) to provide variance reports and projections; this coordinating forum helps ensure that MSFC assets and resources are sufficient and properly aligned to execute the mission both near-term and long-range.

As host Center for the Ares Projects, MSFC's transformation initiatives continue to reshape the organization to position the Center as a responsive Agency partner for mission-focused program and project implementation, as well as to make it competitive within its greater business environment.

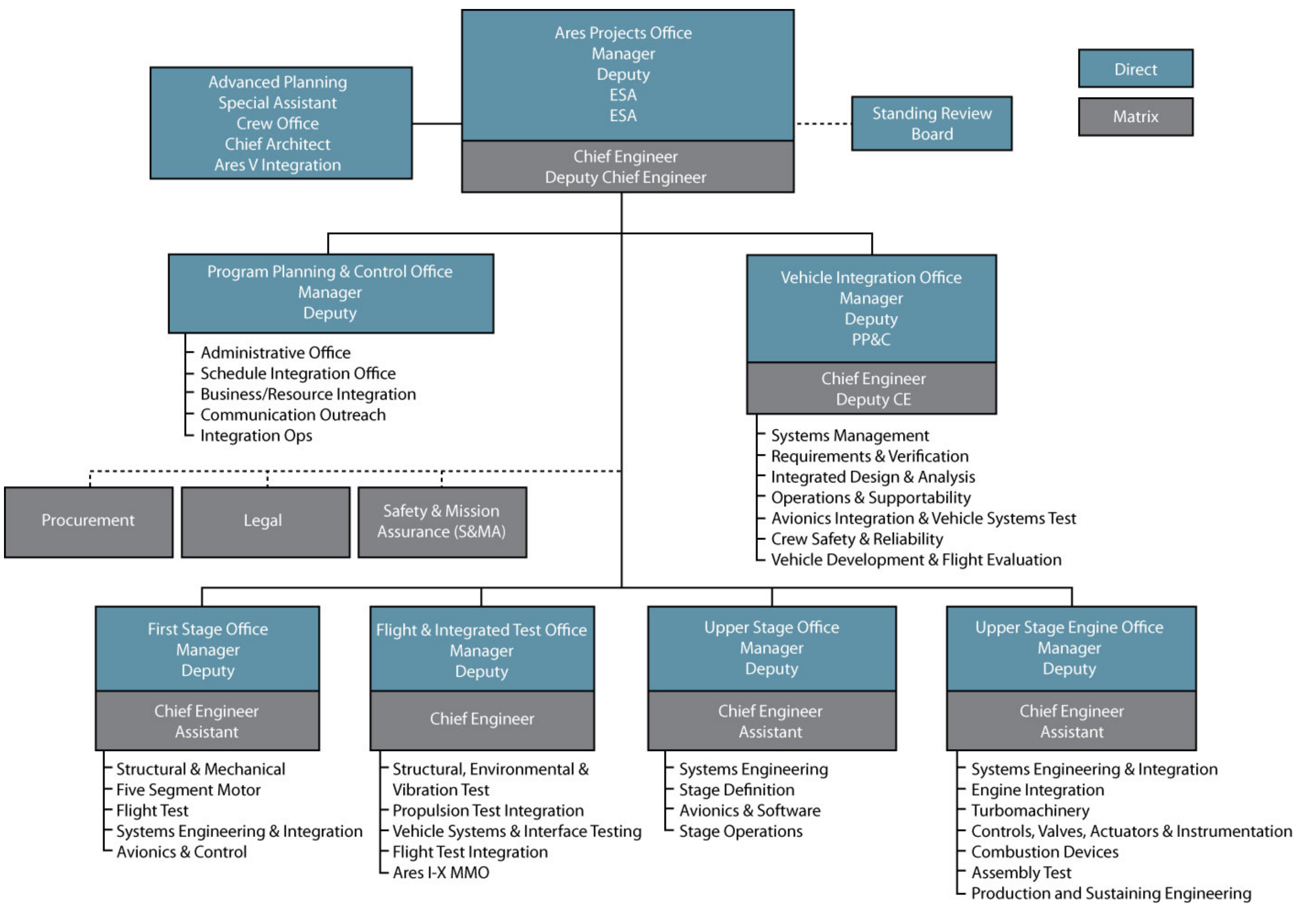
1.4.3 Management Structure

Ares is mission- and customer-focused, product-oriented, and dedicated to successfully achieving well-defined milestones. Ares is organized to empower informed decisions and accountable programmatic and technical results.

Ares is a streamlined, functional organization that employs embedded management systems, processes, and tools designed to enable mission success. While the emphasis is on analytical thinking and resultant action, management systems provide a framework for collaboration and integration across the broad range of work required to deliver the Ares I and Ares V systems. A description of each performing organization follows, along with the integrated management systems that are utilized to accomplish specific functions.

1.4.3.1 Management Roles and Responsibilities

The Ares organization chart is shown in Figure 1-12. Ares organizational elements are divided into (1) programmatic functions, such as acquisition and requirements management, safety and security, and resources management and allocation, and (2) hardware functions, consisting of vehicle integration (VI) and hardware element engineering management. Given below are roles and responsibilities for each Ares office and element.



CE – Chief Engineer; ESA – Executive Support Assistant; MMO – Mission Management Office; PP&C – Program Planning and Control

Figure 1-12. Ares organization.

Project authority and specific responsibilities are delegated to the lowest possible level and systematically reported upward for accountability and control. Issue resolution may be elevated through the chain of command for final disposition.

1.4.3.2 Project Management Office

The Ares Manager and Deputy Manager are responsible to the Constellation Program Office and ESMD for management of the Ares development, production, and sustaining engineering, including validation, approval, and integration of Project- and Program-level requirements and plans of execution. The Manager and Deputy Manager also report to the MSFC Center Director through the MSFC PMC for resource coordination and allocation. Other controls and compliance processes are discussed below.

The Project Management Office serves as the external interface and liaison with NASA Headquarters (HQ) and other Governmental offices and agencies, coordinated through NASA HQ. It is responsible for all programmatic business activities and overall operations; integrates and monitors activities; manages acquisition, budget formulation, and resource allocations; defines and manages Project management systems, including risk management databases; and integrates resource utilization for accountability, discipline, and innovation throughout the Ares.

1.4.3.3 Standing Review Board (SRB)

NPR 7120.5D, NASA Space Flight Program and Project Management Requirements, introduces the concept of a single review team called a Standing Review Board (SRB) to conduct all independent reviews throughout a Project's life cycle. The concept integrates the existing comprehensive Independent Review Team (IRT) reviews with the more technically focused life cycle SRB reviews. There are three reasons for conducting Independent Life Cycle Reviews: first, for the Program/Project to receive independent assurance that they are implementing according to Agency policy and using best practices for effective results; second, NASA senior management needs to understand that the Program/Project is on the right track, is performing according to plan, and that externally-imposed impediments to its success are being removed; and third, the Agency needs to provide our external stakeholders assurance we are compliant with our commitments. Benefits of the new SRB approach include providing senior management with a single independent review and lowering the burden of multiple independent reviews imposed on Programs and projects. The ESMD is using the Independent Program Assessment Office (IPAO) to organize SRBs per NPR 7120.5D and to conduct independent reviews of the Constellation Program and projects. The Ares Projects utilizes this SRB structure and process in accordance with guidance set forth in CxP 70003-ANX04, Constellation Program Plan: Standing Review Board Coordination Plan for Life Cycle Reviews.

1.4.3.4 Advanced Planning

The Advanced Planning function includes both strategic planning and operational execution. Advanced Planning is the focal point for planning future systems beyond the Ares I, including the Ares V and EDS. Advanced Planning represents the Ares on Constellation Program lunar and Mars exploration trade studies and participates in or leads special studies as assigned. A special technical assistant and astronaut representatives are included in the Advanced Planning function.

1.4.3.5 Ares V Integration

Ares V Integration is a staff function of the Ares Projects, headed by an integration manager and drawing support from the Ares Projects, as well as from the engineering organizations of several NASA field centers. The Integration mission is to advance the original Constellation architecture and early pre-design analysis cycle (DAC) studies and resolve major design issues regarding the Ares V in order to provide a smooth transition to a formal DDT&E phase following Authority to Proceed (ATP) and better articulate vehicle requirements for a DDT&E contract. A key function in that effort is to maintain insight into current activities involving developments including Ares I, Orion, Altair, and the RS-68 engine, and use those to inform ongoing internal design iterations related to Ares V structures, materials, trajectory, interfaces, etc. These activities over the next 3 years will position NASA for ATP into formal development of the Ares V in 2011.

Top-level goals and objectives of the integration effort include the following:

- Developing a sound set of requirements for the Ares V that will facilitate the further development of the core stage, core stage engine, EDS, USE, and shroud requirements.
- Designing, developing, and incorporating changes to the current RS-68 to improve engine performance, reliability, and safety to meet the Ares V mission requirements.
- Ensuring that the core stage and core stage engine do not preclude human rating and to perform the human-rating tests and analyses, if needed.
- Minimizing life cycle cost (LCC) of the integrated Ares V vehicle.

The Ares V schedule is organized to perform a variety of risk reduction activities through the fourth quarter of fiscal 2011 when they will culminate in an ATP decision targeted at a fiscal 2017 launch of the Ares V-Y flight test. Coinciding with those pre-ATP activities will be pre-DAC concept studies and DAC–0 architectural concept studies. Technology Prioritization Planning (TPP) tasks will establish priorities for technology needs such as large composite manufacturing and long-term cryogenic storage.

Risk reduction assessments encompass all aspects of the launch vehicle and its mission. Ongoing activities include support to lunar architecture, lunar lander, and Orion work. Based on findings of the Lunar Capabilities Concept Review in 2008, a sixth RS-68 engine was added to the Ares V core stage and an additional half-segment was added for the solid rocket boosters (SRBs). Performance options being assessed include composite case SRBs, booster nozzle extension, hydroxyl terminated polybutadiene (HTPB) propellant, and expanding the use of composite structures. Assessment of the temperature, pressure, and acoustic loads on a 10-meter (m) shroud, as well as manufacturing, logistics, and deployment issues will be performed. Studies also are underway on 4-day loiter period for the EDS, including issues such as meteoroid debris shielding and Orion/Ares power and thermal requirements. The ability of existing test and operations facilities to support Ares V is also under study.

Upcoming activities include a Programming, Planning, Budgeting, and Execution (PPBE) cycle, continued risk assessment and creation of risk mitigation plans, integrated vehicle engineering study plans, manufacturing risk mitigation study, and assessment of transportation and logistics infrastructure requirements. Ares V Integration has the flexibility to modify or assign new risk reduction activities as requirements mature.

1.4.3.6 Program Planning and Control Office

The Program Planning and Control (PP&C) Office is responsible for resources and budget requirements identification and business management activities. It performs the following functions:

- Implements and manages Project business management activities as a representative of the ESMD Ares Management Team.
- Follows the programmatic direction of ESMD management and assists in developing strategies for acquiring, designing, and producing the Ares I and Ares V systems.
- Implements Project planning, budgeting, scheduling, engineering design, development, testing, and cost control of assigned systems.
- Exercises authority for planning and directing business management activities in a manner judged to produce the optimum results in terms of quality, efficiency, economy, effectiveness, and timeliness.
- Maintains control of systems by monitoring current business management activities to ensure requirements are met in accordance with approved schedules and plans.
- Assures adequate resources are applied to the Project for mission success, including controlling management reserves.

The PP&C Office is organized as shown in Figure 1-13.

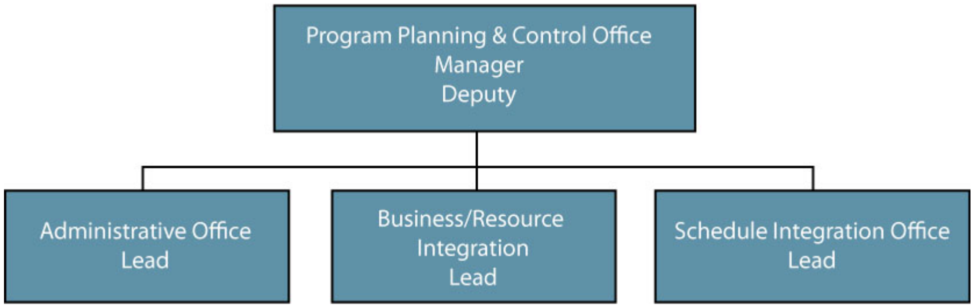


Figure 1-13. Project Planning and Control Office organization.

The Project uses EVM processes to relate cost, schedule, and performance to the established Program baseline. EVM performance metrics, such as the cost performance index (CPI), schedule performance index (SPI), and variance at completion (VAC), are used as indicators by the Elements to report back to the Ares. Earned value management is required by the Program on all cost-plus prime contracts and includes the following:

- Compliance with NASA policy and the corporate EVM system description.
- Integrated Baseline Reviews (IBRs) as standard practice.
- Reporting at the task level on a monthly basis.
- Utilization of the wInsight tool for trend analysis of prime contracts to report significant differences between planned and actual schedule performance and planned and actual cost performance.
- Summary of data elements and associated variances according to the WBS, along with cause and resolutions, will be provided.
- Management action to correct any difficulties indicated by EVM data.

Project Integration is a service-oriented function, with personnel who are responsible for a number of programmatic integration activities. It is responsible for communications planning and support and integrates with the Office of Strategic Analysis and Communications (OSAC) at the Center and HQ levels. Project Integration representatives:

- Coordinate the Project Control Board (PCB) and other Project-level boards.
- Coordinate internal/external reviews and communications.
- Integrate with the Education Office at the Center and HQ levels.
- Support the programmatic interface to the Project for coordinated planning.
- Are Responsible for communications planning and implementation.
- Work with the Information Management (IM), Scheduling, and Configuration Management (CM) leads to help develop an integrated picture of Project health and status.
- Serve as the interface for the Independent Project Review Team (IPRT).

In addition to managing systems and processes, the Project Integration function provides information technology (IT) tools for Project applications, working with HQ, the MSFC Chief Financial Officer (CFO), and the MSFC Office of the Chief Information Officer (CIO) as service providers. Section 3.12 provides an overview of IT management and security and physical security. Section 3.13 provides Export and Data Control guidelines.

The PP&C Office is also responsible for the planning, budgeting and execution of Construction of Facilities (CoF) projects for Ares. Government facilities include Government-owned buildings and structures, as well as utility systems. Repairs, alterations, modifications, or new construction costing more than $500,000 require CoF funding appropriations.

Refer to Section 3.1, Technical, Schedule, and Cost Control Plan, for more information.

1.4.3.7 Technical Authority (TA) Implementation

The Project will implement Ares Technical Authority per Integrated Management Systems Board (IMSB)-Plan-7123.1, MSFC Technical Excellence and Technical Authority Implementation Plan. Ares technical authority includes Chief Engineers (CEs) and Chief Safety Officers (CSOs) working in partnership with the Ares Project and discipline technical authorities. The Center Director is responsible for implementation of technical excellence and is the Level III technical authority at MSFC. The Center Director has assigned the functional responsibility for technical excellence and technical authority to the Engineering and Safety and Mission Assurance (S&MA) Directors. The Engineering Director has established a Chief Engineers Office. In tandem, the S&MA Director has established the positions of Ares CSO and a network of Ares Vehicle Integration (VI) and Element CSOs who are peers to their respective Chief Engineers.

1.4.3.8 Chief Engineer

The Project includes a principal Chief Engineer and a network of hardware Element-level Chief Engineers who are appointed by the MSFC Director with concurrence by the Agency Chief Engineer. These personnel are assigned and funded from the MSFC Engineering Directorate (ED) and are supported with appropriate technical expertise and resources by MSFC and the NASA Engineering and Safety Center (NESC). The term "Chief Engineer" in this section applies to any appointee within this context, knowing that the principal Chief Engineer is the final technical authority for flight readiness of the Ares I and Ares V systems. The Agency's technical authority flow is shown in Figure 1-14.

The Ares Chief Engineer is responsible for communicating technical excellence and exercising technical authority for the activities to which assigned. The Chief Engineer evaluates the validity of all requirements and requirements changes, and assures that the proper control board (CB) is involved in all decisions involving requirements or implementation of requirements. Ultimately, the Ares Chief Engineer, who is a peer to the Project Manager for making technical decisions, assessing launch readiness from the standpoint of safe flight and ground operations, and indicating approval by signing off on Flight Readiness Review (FRR) documentation. The appeal process incorporates an independent path through the technical chain of authority to the Office of the Chief Engineer (OCE) for issue resolution. Given below are specific roles and responsibilities leading up to FRR.

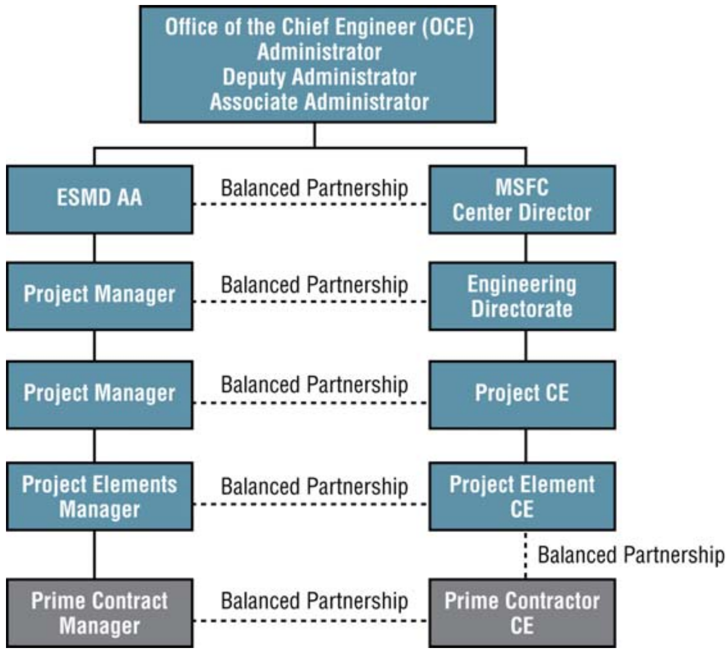


Figure 1-14. Technical authority flow.

The Chief Engineer ensures that the Project has identified and imposed appropriate technical requirements and that the functional system is safe and operationally reliable. The Chief Engineer signifies approval by signature on instruments such as change requests (CRs), waivers/variances documents, and Certificates of Flight Readiness (CoFRs). Paramount criteria for carrying out these duties include both an in-depth understanding of the system and an up-to-date knowledge of Ares technical work in progress to make sound, responsible technical decisions and to determine whether the appropriate technical requirements and resources are being applied. While the Chief Engineer is responsible for ensuring that suitable specifications and standards have been integrated and adopted by the Project, the MSFC Engineering Directorate leaders and personnel are actively engaged in helping determine that requirements and associated standards are appropriate to ensure safe flight. This approach provides a framework for checks and balances between the Project's hardware elements and the independent engineering function, in partnership with the Project and S&MA.

The Chief Engineer, in addition to the Chief Safety Officer, is responsible for approving all variances written against approved technical requirements, or any technical process or method that may affect safety, by signing documents provided by the Chief Engineer Review Board (CERB). When a variance is written against a technical requirement, the Chief Engineer engages the appropriate engineering leaders and institutional engineers through the CERB and the Engineering Management Council (EMC). As an independent voice within Ares, the Chief Engineer draws on the technical expertise of engineering leaders when requirements are in question and at any time it is deemed appropriate to ensure flight safety through the Vehicle

Integration Control Board (VICB), as well as the EMC. These processes are documented in IMSB-Plan-7123.1, MSFC Technical Excellence and Technical Authority Implementation Plan.

The Chief Engineer is responsible for determining whether the resultant launch vehicle design satisfies stated technical requirements. This requires a solid understanding of the design; an in-depth comprehension of the failure scenarios, Failure Modes and Effects Analyses (FMEAs), Critical Items Lists (CILs), and hazard analyses; and the ability to perform trend analyses and risk assessments and incorporate the results into a final technical product that includes the associated technical risk. Products such as FMEA and hazard reports are delivered to the Chief Engineer for review and approval. These are archived in the Project's Windchill database.

The Hazards, FMEA, CIL, and Ascent Risk Analyses go through the established approval process that includes the Crew Safety and Reliability Team (CSRT), CERB, VICB, and PCB. The Chief Engineer, in conjunction with the Chief Safety Officer and Project Office representative, provides final approval of the analyses. The Chief Engineer influences decisions about the requirements at all major Project design reviews—e.g., System Requirements Review (SRR), Systems Definition Review (SDR), Preliminary Design Review (PDR), Critical Design Review (CDR), Design Certification Review (DCR), and FRR—and attests that the design and system configuration to that date meets the technical requirements for safe flight by signing off instruments such as pre-board and/or board decision documents, FRR statements, and the CoFR.

The Chief Engineer provides timely day-to-day judgments on a range of technical issues pertaining to the Project. This input is provided to Program- and Project-level Engineering Review Boards (ERBs), at Technical Interchange Meetings (TIMs), and for special technical issue topics to ensure that safety is an integral factor in the vehicle design. The Chief Engineer enforces the concept that FMEA and hazards analyses are an integrated part of the design process, not developed after the design is complete. The Chief Engineer maintains real-time communications with the Project and MSFC engineering resources to ensure timely access to Project information, impending decisions, and analysis or verification results by the technical authorities, including the Program and Project Chief Engineers, Chief Safety Officers, and the MSFC Director. The Chief Engineer documents all methodologies, actions/closures, and decisions. Signatures of all parties participating in the decision-making process should appear on the review board documentation signature sheets, which are used to track concurrence or nonconcurrence. Records of decisions and information on which the decisions were based must be maintained. The Project Data Management (DM) and CM processes and systems are used for archival purposes.

The Chief Engineer is responsible for ensuring that the Project provides documents to the appropriate party, including both decisions and lessons learned. (See CxP 72027, Ares Knowledge Management Plan, for more details.) All precedent-setting decisions are documented (e.g., expanded technical envelopes, sensitivity data, and technical requirements that supersede other imposed requirements). The Chief Engineer ensures that efforts are made to communicate the experience gained and results obtained to other technical experts. Included in the documentation are the circumstances surrounding the issue, technical positions (including dissenting opinions), and the logic used for final decision making. Lessons learned and associated recommendations form the basis for changing or improving technical requirements that may be applicable to other programs and projects.

In some cases, the Chief Engineer may request that the Project 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 complex issue. These investigations are negotiated with the Project and draw upon institutional engineering support through the original funding channel. In special cases, the Chief Engineer may request that the NESC lead independent investigations.

As stated earlier, the Chief Engineer works with engineering managers to define the resources necessary to support all required technical excellence/technical authority activities, providing budget and working agreement input to the Project and the Engineering Directorate. The Chief Engineer also relies on the work of MSFC engineers, S&MA personnel, and other Agency experts who perform the Project's technical work in order to understand the system requirements and the vehicle design for informed decisions. These "doers" are the most important information sources for the Chief Engineer, as they perform the necessary evaluations, analyses, tests, and process evaluations that identify safety risks.

1.4.3.9 Chief Safety Officers (CSOs)

The Ares Project includes a CSO for the Project and for each of the Elements, including Vehicle Integration. These CSOs have been delegated Technical Authority (TA) from the MSFC S&MA Director. These CSOs are responsible for assuring appropriate S&MA support, requirements development and flow-down analysis, and reporting necessary to meet all Program and Project requirements within acceptable safety risk. The CSOs are cognizant of the programmatic objectives and work with the institutional S&MA support to establish Project and Element technical requirements and approve any exceptions to those requirements. The CSOs work with the MSFC S&MA Department Managers and Branch Chiefs to assure the appropriate S&MA discipline support is provided to the Project/Element.

The Ares Project and Element CSOs maintain close communication with the Constellation Program CSO on issues and assessments associated with areas of responsibility, particularly those having the potential of becoming integrated Program issues. Ares CSOs support higher level CSOs in briefing the Office of Safety and Mission Assurance (OSMA), Constellation Program CSO, MSFC S&MA Director, and Program organizational management on significant technical issues.

The Project and Element CSOs represent MSFC S&MA as the S&MA TA on Project/Element ERBs, configuration control boards (CCBs), milestone reviews, and attest to system readiness by signature on the project and element control gates such as SRR, SDR, PDR, and CDR, and Element/Project FRRs. The CSOs will facilitate, develop, and maintain risk items in the Ares integrated risk management database. The CSOs are responsible for preparation, integration, and delivery of flight readiness assessment documentation packages and signed CoFR statements to the MSFC Center Director and appropriate Constellation Program and S&MA management representatives in support of flight milestone reviews.

The Ares Project and Element CSOs, in addition to the Chief Engineers and Project/Element Office representatives, provide final approval of the applicable hazard analysis, FMEA, CIL, and ascent risk analyses through the established approval process that includes the CSRT, CERB, VICB, and PCB.

MSFC Safety and Mission Assurance Management, including Department Managers and Branch Chiefs, are responsible and accountable for the performance of the systems safety, reliability engineering, quality assurance, and software assurance technical work of the Center. These managers will support the CSOs in their duties as technical authorities, and will serve as the S&MA technical authority in the absence of the CSO.

1.4.3.10 Procurement

The MSFC Office of Procurement provides acquisition and business support to deliver the contractual vehicles required to meet the Project's needs. It also provides support and contractual documents for all requirements to be contracted, ensures adherence to applicable laws and regulations, and assists in making sound business decisions to ensure Ares gets the best value for the Government. Ares coordinates all acquisition strategies with the Constellation Program and all appropriate organizations at NASA HQ. The Project's acquisition management strategy is discussed in Section 3.4.

1.4.3.11 Legal

The MSFC Chief Counsel's Office provides legal support to Ares on a variety of matters, such as procurement law, intellectual property rights, fiscal law, and standards of ethical conduct, that arise during the course of developing and delivering aerospace products and services. A senior attorney from the MSFC Chief Counsel's Office is assigned to support the Project to ensure responsiveness. The Chief Counsel's Office will coordinate legal issues with the NASA HQ General Counsel's Office as necessary.

1.4.3.12 Safety and Mission Assurance

Ares includes both safety and reliability technical functions, as well as mission assurance functions. MSFC S&MA leads these activities with support from applicable Center S&MA offices. MSFC S&MA also provides Independent Technical Authority (ITA) for the Ares Project and Elements through CSOs. NASA S&MA policies, plans, techniques, procedures, and standards provide the basis for establishing the Project's safety and mission success requirements and processes. One of S&MA's primary functions is to assure program and project compliance with the established critical technical requirements. To affect this important function, S&MA engineers are active participants in each of the Elements in order to positively influence Ares I design development. S&MA is represented by the CSOs on the Project, Vehicle Integration, and

Element-level control boards; and participates in the Project, Vehicle Integration, and Element-level risk management process. S&MA also supports the Project in preparing for Program/Project milestone reviews and safety panel reviews. Ares has developed and documented its plans and processes for safety and mission assurance in CxP 72020, Ares Project System Safety, Reliability, and Quality Assurance (SR&QA) Plan. Additional discussion of S&MA may be found in that document.

1.4.3.13 Vehicle Integration Office

The Vehicle Integration Office (VIO) provides the Systems Engineering & Integration (SE&I) function for the Ares Projects Office. This is a Government-led effort utilizing civil service workforce and support contractors to execute the SE&I function. The roles and responsibilities for VI reflect those performed by most traditional SE&I teams. The VIO is organized as shown in Figure 1-15. The VI effort is led by Ares personnel, with the resources for executing the majority of the technical effort residing in the MSFC Engineering Directorate. The safety, reliability, and quality functions reside in the MSFC S&MA Office.

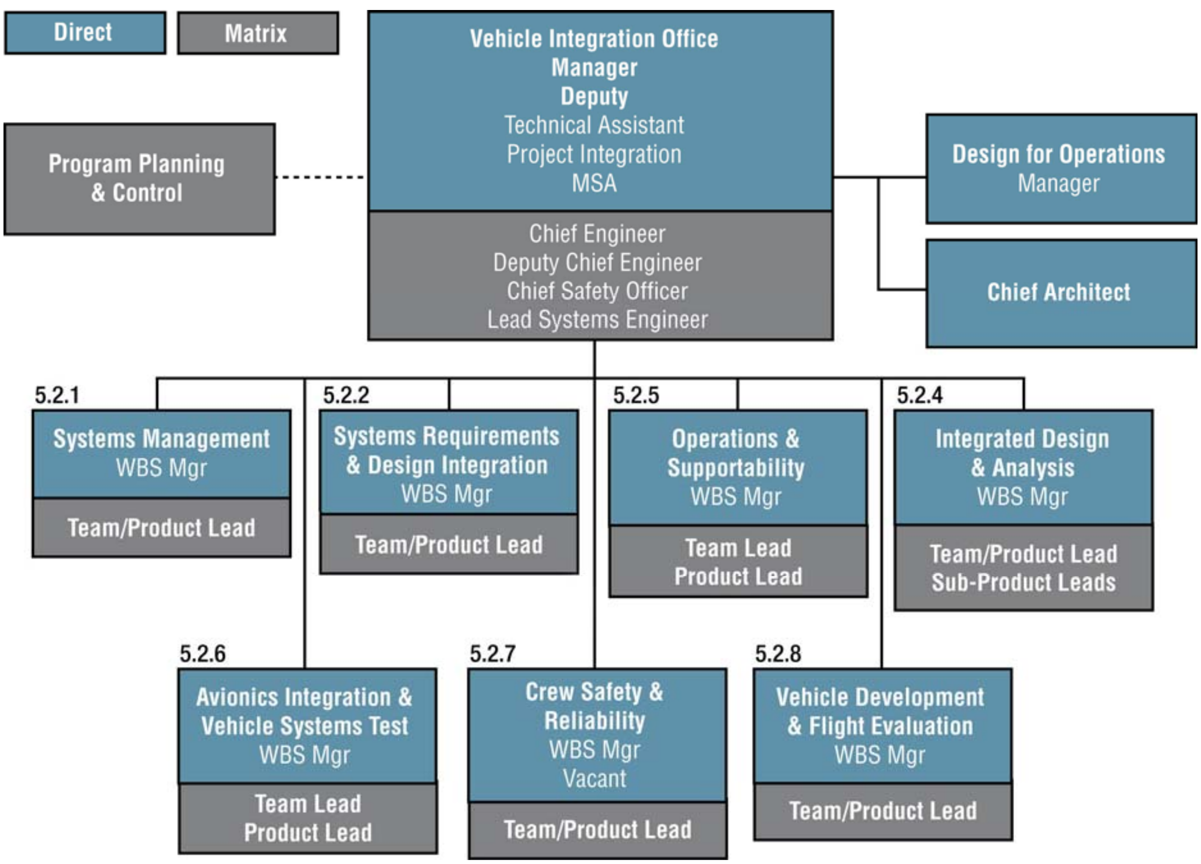


Figure 1-15. Vehicle Integration Office organization.

The primary Project Office responsibility is setting the execution plans and priorities, technical oversight, and budget planning and monitoring. The VIO utilizes systems engineering management tools for planning and control. The Constellation Integrated Risk Management Application (CxIRMA) tool is used to log risks and mitigation approaches within the database. The Microsoft Project application is used as the VIO scheduling tool until Primavera becomes available, and the VI team is trained and ready to use this tool.

The VI team also utilizes panels and working groups (WGs) within Engineering and S&MA for reviewing integration technical issues within specific disciplines. These WGs report the results of their reviews to the appropriate Product Teams (and/or Integration Groups) so the issues can be elevated to the next level for resolution. For this purpose, VI teams utilize the VICB or consult the VI Manager to resolve issues or problems. Also, if a problem is not resolved to an individual or organization's satisfaction, they may talk with the Chief Engineer or CSO to use the Technical Authority route for appeal.

The VI team interfaces with their Program-level counterparts in the Constellation Program SE&I office for upward vertical integration, with their Element-level counterparts in the Element SE&I teams for downward vertical integration, and with their Project-level counterparts in the Orion, Mission Operations, and Ground Operations Projects for horizontal integration. The VI teams also interface with the MSFC Resident Office at Kennedy Space Center (KSC) to support integration with the Constellation Ground Operations Project at KSC.

The VIO is responsible for the following:

- Systems Management.
  - Development and implementation of Ares configuration and data management.
  - SE&I processes and plans (including CxP 72018, the Ares Systems Engineering Management Plan (SEMP)).
  - Integration among the VI WBS functions.
  - Technical performance measures, figures of merit, and other measures of effectiveness.
  - Risk management.
  - Trade study integration across the VI Element and hardware Elements.
  - Chair of Systems Integration and Control Group.
- System Requirements and Design Integration.
  - Responsible for the development of the launch vehicle SRDs and internal interface requirements documents (IRDs).
  - Development of the Master Test and Verification Plan.
  - Responsible for assuring identification of all applicable requirements and design and construction standards for the vehicle.

- Verification planning and integrated verification closeout to the SRD and interface control documents (ICDs).
- Chair of the Systems Requirements and Interfaces Integration Group (SRIIG).

- Integrated Design and Analysis.
  - Development of the tools and models required to analyze the integrated launch vehicle performance.
  - Integrated performance analysis from rollout through ascent and reentry (mass properties, up-mass performance, loads, etc.).
  - Development of the outer mold line and baseline control through the VICB/PCB.
  - Guidance, navigation, and control (GN&C) design.
  - Aerodynamic analysis and wind tunnel testing.
  - Co-chair of the Level II Ascent Flight Systems Integration Group (AFSIG).
  - Loads Panel.
    - Aerodynamics Panel.
- Operations and Supportability.
  - Operations development to assure operability, supportability, logistics, and maintainability. Development of the concepts and plans for design implementation via requirements.
  - Development of the Operations Concept document(s).
  - Reliability analysis and modeling.
  - Implementing a risk-based design approach for improvements in reliability for high-risk items.
  - Oversight and support for the development of the Environmental Impact Statement (EIS) effort.
- Avionics and Software (A&S) Integration.
  - Development of the end-to-end A&S architecture.
  - Avionics performance analysis.
  - Chair of the Avionics and Software Integration Groups.
  - Charter the Avionics and Software Engineering Panels and WGs.
- Crew Safety and Reliability (CSR).
  - Perform safety analyses (Hazards and Fault Tree Analyses).
  - Reliability analyses, predictions, and allocations (hardware FMEA, reliability modeling, fault tolerance modeling).
  - Charter and co-chair the Crew Safety and Reliability team, panels, and WGs.
- Vehicle Development and Flight Evaluation.

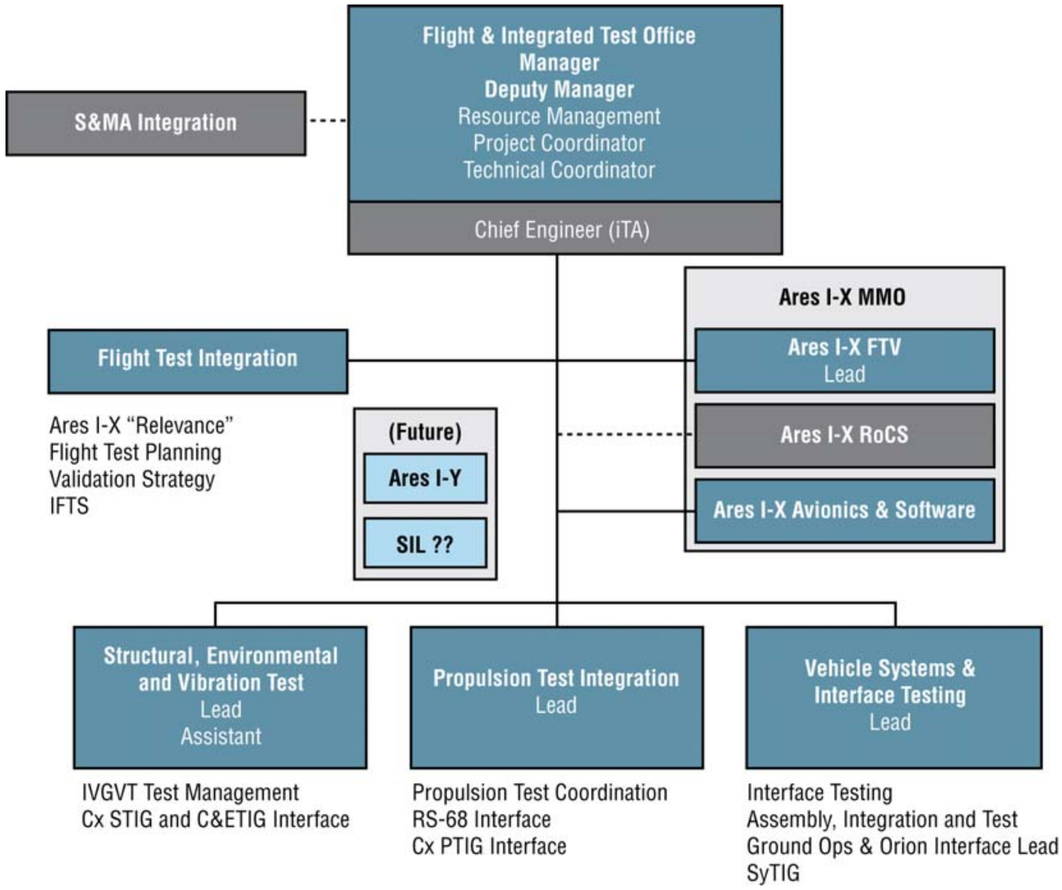
- Establish project performance metrics.
- Review and report performance.
- Control change requests.
- Manage programmatic and technical risk.
- Provide communication and reporting to the Ares Projects Office and ESMD.

The VIO is responsible for ensuring that consistent engineering practices and assumptions are implemented, in addition to solving technical issues. The VIO also is responsible for confirming that requirements have been correctly validated, decomposed, and verified, and that the verification requirements are properly defined to ensure that the system design meets stakeholder and customer needs. CxP 72018, Ares Systems Engineering Management Plan (SEMP), describes how the VIO validates and integrates all system design aspects of the Ares I and Ares V systems. In addition, CxP 72018 provides more information about VI roles and responsibilities, including organization of the Project's various product teams and integration groups. See Section 3.6, Systems Engineering Management Plan, for more details.

1.4.3.14 Flight and Integrated Test Office (FITO)

The FITO organization is shown in Figure 1-16. FITO is responsible for developing system-level integrated test plans to include both Ares I and Ares V development through initial hardware qualification, flight testing, vehicle design certification, and initial operational capability (IOC). This support includes integration of Level IV test plans for structural, environmental, and propulsion testing. FITO is also responsible for conducting risk assessments and identifying potential gaps in integrated system and interface test requirements that are needed to fly the vehicle safely. Integration with Ares hardware elements and VIO is accomplished through a Systems Test Integration Group (SyTIG). In addition, FITO is responsible for the execution of identified system-level tests, including the Ares I Integrated Vehicle Ground Vibration Test (IVGVT). FITO is responsible for the integration of facility utilization and readiness plans to support test requirements, manufacturing, and assembly to support Ares I and V DDT&E. FITO maintains interfaces with Level II test integration groups (TIGs), the Flight Test Working Group (FTWG), and the Constellation Assets Management Panel (CxAMP).

FITO supports the Ares I-X Mission Management Office (MMO) through the Ares I-X Avionics & Software, Roll Control System (RoCS), Ares I-X PP&C, and the Ares I-X MMO Deputy. The schedule and budget for the Ares I-X flight test vehicle (FTV), as related to technical performance, is reported to the Constellation Program and to the ESMD through the Ares I-X MMO. This reporting path may be delegated to the FITO manager or his representative for day-to-day operations or when the Ares Manager or Deputy Manager designates. The Ares Project Manager and the Ares Chief Engineer, who resides in the MSFC Engineering Directorate and functions as the TA, regularly report on technical aspects to the MSFC PMC to provide variance reports and projections as part of the overall Ares Project. This PMC forum helps ensure that MSFC assets and resources are sufficient and properly aligned to execute the mission both near-term and long-range.



IFTS – Integrated Flight Test Strategy CxSTIG – Constellation Structural Test Integration Group; CxETIG – Constellation Environments Test Integration Group; CxPTIG – Constellation Propulsion Test Integration Group; SIL – Systems Integration Laboratory

Figure 1-16. FITO organization.

1.4.3.15 First Stage Element

The FS Element organization chart is shown in Figure 1-17. Staffing is accomplished through a combination of Project direct and collocated/matrixed personnel that support each of the noted product lines and functions. The role of technical authority is represented by the Chief Engineer, who is accountable for assuring the proper technical requirements are set for safe operation of the first stage. In selected component areas (e.g., nozzle, internal insulation, propellant, TVC), the necessary skills are leveraged from existing RSRB subsystem manager (SSM) resources. Existing RSRB Resident Office personnel collocated with the prime contractor and at the KSC launch site are being utilized to effect proper integration.

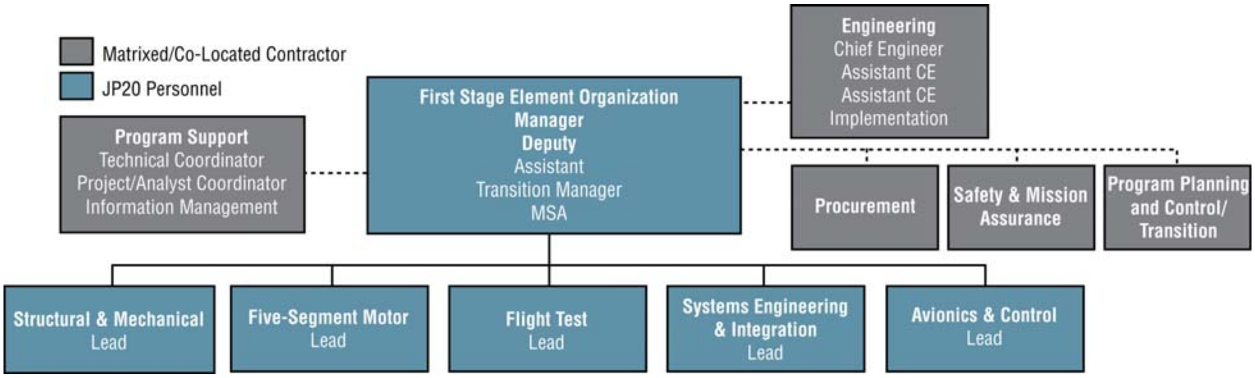


Figure 1-17. First Stage Element organization chart.

The FS Element mission is to provide sufficient boosters, line replaceable unit (LRU) spares, and technical launch support to fulfill the Ares I and Ares V manifests in a safe, reliable, and cost-efficient manner. In order to accomplish this task, the overall design philosophy is to take maximum advantage of heritage hardware through a highly leveraged design process via minimal design changes to the Space Shuttle Program (SSP) RSRB hardware.

The FS Element WBS is structured to reflect the design and systems engineering requirements of the Project and identify the tasks and deliverable products of each area beneath the FS Element Office, as summarized below:

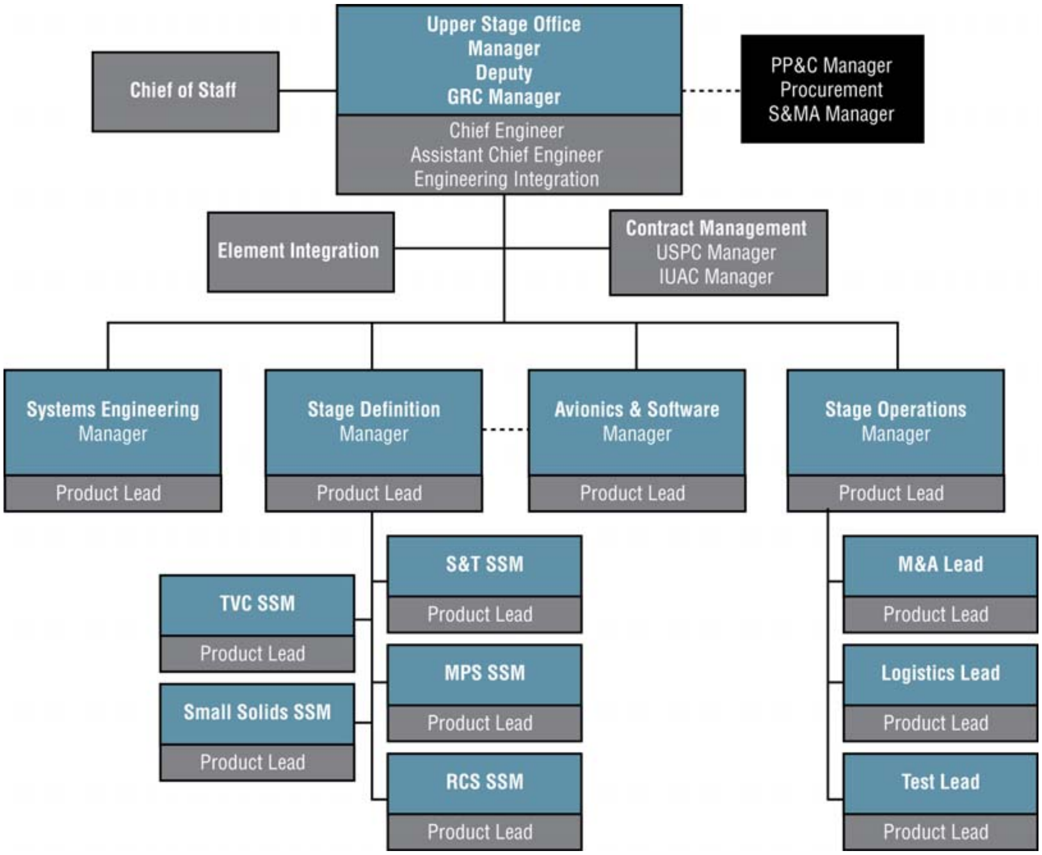
- Structural and Mechanical Systems.
  - Separation and Pyro Subsystems.
  - Structural Subsystem.
  - Recovery Subsystem.
  - Structural/Mechanical Manufacturing.
- Five-Segment Motor.
  - Booster Tumble Motor/Propellant.
  - Metal Components and Seals.
  - Final Assembly.
  - Nozzle.
  - Ballistics/Motor Performance.
  - Internal Insulation.
- Flight Test.
  - Integration.
  - Avionics.

    - Manufacturing Integration.
    - Ground Tests.
- Systems Engineering and Integration (SE&I).
    - First Stage Integration.
    - Requirements and Verification.
    - Systems Integration Analysis.
    - Operations and Ground Tests.
    - Project Control.
    - Loads and Environments.
    - Risks.
- Avionics and Control.
    - Electrical Integration.
    - Thrust Vector Control System.
    - Thrust Vector Control Development.
    - Avionics.
    - Flight Termination System/Range Safety.
- Booster Deceleration Motor (BDM).

Planning and control of the FS Element will consist of both existing controls and procedures currently utilized on the Space Shuttle (RSRM Project, as well as implementation of new systems developed specifically for Ares I including risk management, cost reporting, and approval processes (VICB, CERB, PCB). See Section 3.1 for additional detail relative to these requirements.

1.4.3.16 Upper Stage Element

The Ares I US is a new "clean sheet" element that is being designed and developed in-house at NASA. Per USO-CLV-MA-25000, Upper Stage Office (USO) Management Plan, the NASA Design Team (NDT), as implemented within the Cost Center, Integrated Product Team (IPT), and Analysis and Integration Team (AIT) structure, is responsible for performing the DDT&E phase of the program. NASA is responsible for all design, development, and test, including technical and programmatic integration of the US system. The development process begins with component tests and advances to more integrated testing as the design matures. The design is managed in DACs that provide coordinated decomposition, detailed design at the component level, and reintegration of the system. The DACs are scheduled to support design reviews. The organization of the US Element is shown in Figure 1-18.



GRC – Glenn Research Center; IUAC – Instrument Unit Avionics Contractor; M&A – Manufacturing and Assembly; MPS – Main Propulsion System; RCS – Reaction Control System; S&T – Structures and Thermal; SSM – Subsystem Manager; USPC – Upper Stage Production Contractor

Figure 1-18. Upper Stage Element organization.

The US Element intends to use existing technologies to the maximum extent practical. NASA selected The Boeing Company as the Upper Stage Production Contractor (USPC) prime contractor to provide the fabrication, assembly, checkout, delivery, and ongoing logistics support of the completed integrated upper stage(s). NASA also awarded an Instrument Unit Avionics (IUA) contract to The Boeing Company to fabricate, assemble, and checkout the avionics hardware and systems into the Instrument Unit (IU).

The NDT is responsible for development of the US systems requirements, external and internal IRDs, contract end item (CEI) specifications, and the definition of the avionics and software architectures. The NDT manages the upper stage systems integration, integrated logistics support and operations, software systems, propellant tanks, ground support equipment (GSE), avionics hardware, structural elements, MPS, RCS, and TVC system and component development programs, including the potential for early procurement of long-lead critical hardware for advanced development, as required.

Due to the size and complexity of the US effort, the NDT is based out of MSFC with support from other Centers, with the manufacturing and assembly at Michoud Assembly Facility (MAF), testing at MSFC and Stennis Space Center (SSC), and launch operations as KSC. The Upper Stage Office (USO) will staff Resident Offices at MAF and KSC. The Element has implemented the Design and Data Management System (DDMS) as the baseline tool package to support the complex management structure, so that the remote sites have full access to the required infrastructure.

The US Element also fully supports the Project Management boards, VICB, PCB, and CERB, providing voting members to each, and voting members to each product team, integration group, and panel required by the Project.

The US Element is responsible for delivering Ares I US hardware and software. The office ensures that the US requirements are verified and validated, that trade studies are appropriate and documented, and the end product meets safety, reliability, supportability, performance, and cost targets. To implement the most efficient structure to meet these targets, the office is organized along product lines and functions. The product lines equate to deployed Cost Centers, with each Cost Center managed by a Subsystem Manager (SSM), as shown in Figure 1-18. Matrixed engineering support is implemented through IPTs and an AIT. Each Cost Center is supported by one or more IPTs, as documented in USO-CLV-MA 25000, the USO Management Plan. Each IPT corresponds to a Cost Center in the USO that is delegated budget, schedule, and requirement constraints. The IPT will be co-led by SSMs assigned from the USO and Product Leads (PLs) assigned from the engineering organizations. The USO is responsible for providing necessary support to the Ares VIO for integration and verification of the delivered launch vehicle. In this support role, the USO is responsible for integrating the upper stage engine into the upper stage design and operations. As part of the US management role, the office is also tasked with developing the initial planning for the EDS, ensuring the maximum extensibility from the Ares I US to the Ares V EDS.

The US Element manages the overall US effort by deploying the needed resources to assess and track risk aspects and control Element schedule, technical efforts, and budget constraints. The office includes the Element Manager, Deputy Manager, Assistant Manager, Glenn Research Center (GRC) Manager, and Project Coordinator, with matrixed support from the Chief Engineer's Office, the Office of Procurement, the PP&C Office, and S&MA. For a detailed description of each USO function, see the USO Management Plan.

The Structures and Thermal (S&T) IPT is responsible for development of the structural elements of the US, including the IU, core stage, and interstage. The S&T IPT manages the DDT&E insight to sustainability engineering and operations efforts for the primary and secondary structures and thermal considerations, including the thermal analysis for the thermal protection system (TPS), for the US Element.

The Main Propulsion System IPT is responsible for filling and draining propellant tanks, thermally conditioning the US and USE, feeding the engine during the mainstage operation, providing pressurization to meet engine conditions, providing helium for control of valves, controlling the flow of purges and drains to and from the engine interface panel, and providing hydrogen to power the TVC turbine pump assembly (TPA). The MPS manages the DDT&E insight to sustaining engineering and operations efforts for these activities.

The Reaction Control Systems (RCS) IPT is responsible for two systems. The upper stage reaction control system (ReCS) subtask encompasses the necessary performance capabilities and associated hardware to perform attitude control operations during active US flight operations, including main engine operation. The first stage RoCS subtask encompasses the necessary performance capabilities and associated hardware to perform vehicle roll control during active first stage flight operations. The US RCS IPT manages the DDT&E insight to sustaining engineering and operations efforts for these activities.

The Avionics and Software (A&S) IPT is responsible for electronic hardware required for GN&C, communication, instrumentation, electrical power and distribution, and range safety. The A&S IPT manages the DDT&E insight to sustaining engineering and operations efforts for the avionics hardware, software, and services management and distribution.

The Logistics Support Infrastructure (LSI) IPT is responsible for GSE development, production, and availability; maintenance, environmental compliance, and development of facilities; and other support equipment and packaging, handling, storage, and transportation (PHS&T). The LSI IPT is also responsible for the Human Factors Engineering discipline, which receives, develops, and defines the relevant human-equipment interface requirements for Ares I assembly and on-ground maintenance by the ground staff, as well as those requirements for Ares I ground systems equipment at KSC. The LSI IPT manages the DDT&E insight to sustaining engineering and operations and production efforts required to implement the supportability requirements and operations functions of the Element.

The Test IPT is responsible for special test equipment (STE) needed to integrate and test development test articles such as large structural components and assemblies, and provides test engineering staff for supporting test operations. The Test IPT manages the DDT&E efforts required for the testing of Element systems and components necessary to verify and certify those items.

The Manufacturing and Assembly (M&A) IPT is responsible for fabricating assembly tooling and test and checkout hardware, as well as for certification of all processes, including material forming, welding, and TPS application. The M&A IPT manages the DDT&E and production efforts insight to sustaining engineering and operations for these activities.

The Thrust Vector Control IPT is responsible for electrohydraulic servoactuators to provide engine gimbaling for US vehicle steering, and a single-fault-tolerant system up to the actuators. The system consists of two independent hydraulic power strings, each powered by separate TPAs. Hydraulic locking valves will be used to hold engine null during first stage ascent. The

TVC IPT manages the DDT&E insight to sustaining engineering and operations for these activities.

The Small Solids IPT is responsible for the ullage settling motor (USM) system for the US. The Small Solids IPT manages the DDT&E insight to sustaining engineering and operations efforts for these systems.

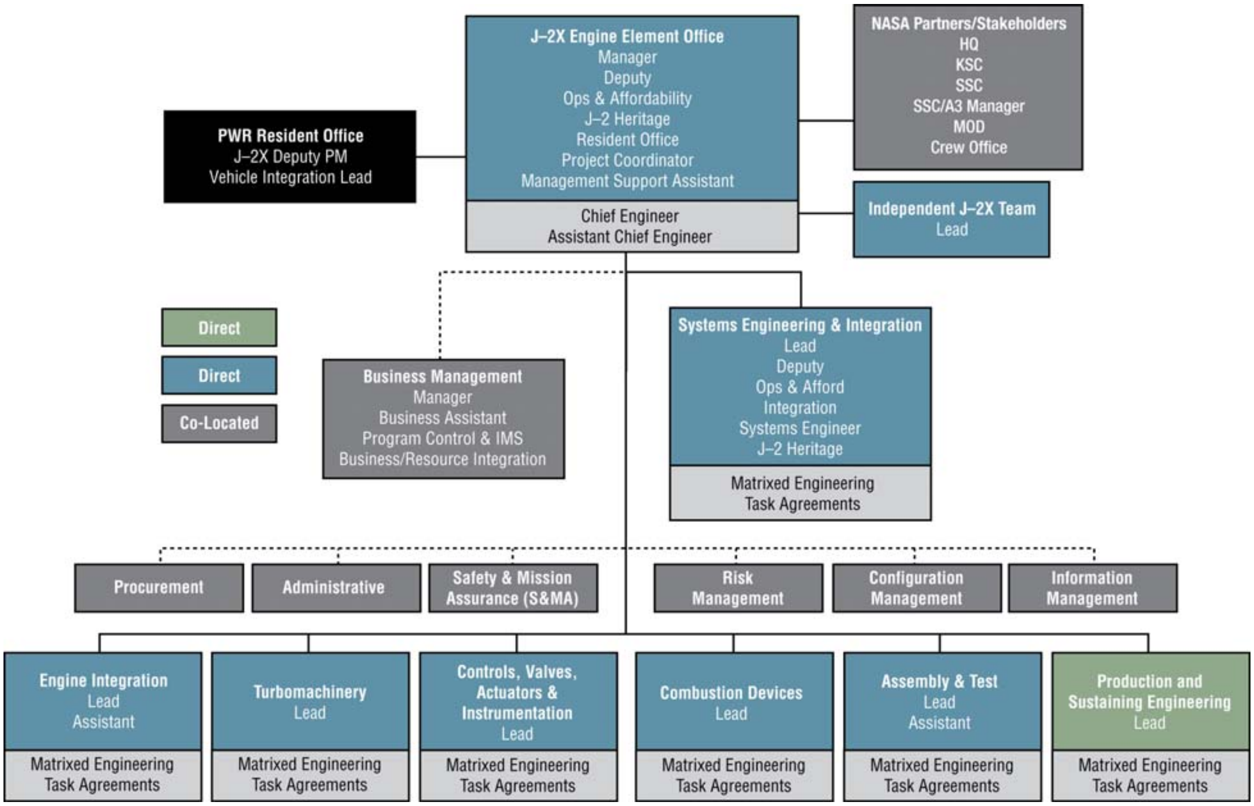
The SE&I function is to coordinate the Element efforts via crosscutting analysis. SE&I is responsible for the integrated design of the US and the development and management of processes that make up the Element system.

The US Element meets technical and programmatic challenges by:

- Assembling and empowering a team with the right skill mix.
- Utilizing NASA-wide skills and assets to their fullest.
- Identifying, tracking, controlling, and reporting risks to mission success.
- Integrating both technically and programmatically with the Ares Projects Office and the VIO, as required, to assure mission success.
- Procuring a skilled contractor team for production of the US hardware and software, sustaining engineering, and operations support.

1.4.3.17 Upper Stage Engine Element

The USE Element organization chart is shown in Figure 1-19. The USE Element mission is to deliver the J-2X engine that can meet Ares I and Ares V technical performance parameters on time and within budget. The USE Element interfaces with other Ares I and Ares V Elements and with the VI Element office. Technical support is primarily matrixed from the MSFC Engineering Directorate.



HQ – Headquarters; IMS – Integrated Master Schedule; KSC – Kennedy Space Center; MOD – Mission Operations Directorate; PWR – Pratt & Whitney Rocketdyne; SSC – Stennis Space Center

Figure 1-19. Upper Stage Engine Element organization.

The USE Element WBS includes three main categories: (1) NASA management with insight into high-risk areas, (2) Government-furnished items, and (3) prime contract (full-scale development, production, and flight support), with the following subcategories for one-to-one mapping of products:

- Project Management.
- SE&I.
- Engine Integration, Assembly, and Checkout.
- Engine System Testing.
- Engine System Hardware.
- Valves and Actuators.
- Control Systems.
- Turbopumps.

- Turbine Drive and Injectors.
- Main Combustion Chamber.
- Nozzle.

The USE Element includes the USE Manager and Deputy Manager, who are responsible for:

- Building a team with the right skills for the task.
- Serving as the Contracting Officer's Technical Representative (COTR) and Alternate COTR.
- Chair of J-2X Element Control Board (ECB) and J-2X representative at the PCB.
- Primary interface with other Ares I and Ares V offices, including project management, element offices, and VIO.
- Planning technical scope, schedule, budget, and manpower resources.
- Planning and documenting the management responsibilities and approach for the J-2X Element Office.
- Managing overall J-2X performance of prime contractor, NASA management and insight (NM&I), and government furnished items (GFI).
- Managing and reporting technical, cost, and schedule performance.
- Managing and reporting risks.

The USE Element also includes:

- Chief Engineer and Assistant serving as the technical authority, chair of the J-2X Engineering Review Board, and J-2X representative at the CERB.
- System and Subsystem Managers (shown in Figure 1-19) responsible for managing performance of prime, NM&I, and GFI for their WBS areas of responsibility that are mapped to NASA/Prime IPTs. Includes SE&I Manager responsible for J-2X seat at the VICB.
- Prime contractor responsible for performing to the contract, Statement of Work (SOW), and Data Requirements Description (DRD).
- Systems engineers, matrixed from MSFC/ED, responsible for insight into prime contractor technical work, participation in IPTs and element reviews, and primary responsibility for NASA insight into technical documentation.
- Systems engineers, matrixed from SSC, GRC and MSFC/ED, responsible for performing GFI work in accordance with Government task agreements.

- Safety and Mission Assurance representatives responsible for support to NM&I and GFI activities.
- Procurement manager responsible for contract management support.
- Business manager and support specialists responsible for coordination and tracking of budget, cost, and schedule.
- Configuration and data management support specialist responsible for coordination of configuration management activities, management of delivered data and documentation, and support for J-2X boards.
- Information manager responsible for coordination of information systems.
- Resident Management Office responsible for NASA representation at prime contractor site with authority to disposition nonconformances.

The J-2X problem reporting and decision-making processes include closed-loop accountability for reporting, analyzing, and correcting problems or anomalies. These processes are documented in RD06-142, the J-2X Project Management Plan, and include identification of problems and anomalies, reporting to alert/advisory systems, reporting to management based on mission criticality, recurrence research, decision making and investigation based on mission criticality and phase of engine development, and corrective action planning and implementation.

1.4.4 Implementation Approach

This section provides a top-level implementation approach from an acquisition planning and management perspective, as well as the Project WBS that reflects the associated work packages. An overview of the Ares WBS can be found in Section 2.2, and a complete WBS Dictionary is located in Appendix K of the Ares SEMP.

Acquisition planning and management is an integral part of the Ares implementation approach. Acquisition schedules and milestones are based on MSFC Office of Procurement guidelines. The Ares I acquisition plan will be executed in two phases, as described below. The Ares V acquisition plan is <**TBD-001**>.

Phase 1 leverages existing Space Shuttle contracts for procuring the first stage, which will be comprised of a Space Shuttle-legacy RSRB in a five-segment configuration, and the J-2X upper stage engine, which will be a derivative of the Apollo-era J-2 engine. The Ares I first stage five-segment solid rocket booster will be procured under a non-competitive separate contract. The J-2 engine is manufactured by Pratt & Whitney Rocketdyne (PWR), which also manufactures the Space Shuttle Main Engine (SSME). The acquisition approach for the J-2X upper stage engine involves noncompetitive contracts with PWR for the DDT&E effort. There will be a new contract for the J-2X manufacturing and production.

Phase 2 covers the upper stage system, which begins as an in-house NASA-led activity that will be handed off to a competitively selected prime contractor. The US Element Request for

Proposal (RFP) solicited offers in accordance with the Federal Acquisition Regulation (FAR) and NASA FAR supplement via a formal Source Evaluation Board (SEB) process. Proposals were based on an SOW, WBS, SRD, DRD, and model contract that were included in the RFP. This performance-based contract was awarded to Boeing, and will be conducted with Government insight.

1.4.5 Project Dependencies

The success of the Ares relies on effectively managing several dependencies, not the least of which is a smooth transition between it and the SSP in terms of hardware, infrastructure, and workforce.

A major dependency is that the SSP will continue obsolescence mitigation efforts (e.g., asbestos replacement) and resolve ongoing Shuttle flight issues. Additionally, the flight manifest must accommodate the Ares' ramp-up and first flight following Shuttle retirement in 2010. Any reductions to the RSRB budgets, or dramatic changes in flight manifest, would require an assessment of the impact to the Ares' budget and schedule.

Ares recognizes that such dependencies on the Shuttle Program constitute risks that must be managed judiciously. The Ares Deputy Manager serves as the transition manager and is responsible for mitigating such risks through integrated communication and coordination at the Project and Program levels.

In terms of vehicle integration, logistics, and operations, the Ares depends on Ground Operations, led by KSC, and Mission Operations, led by JSC, for the Constellation Program, to modify processing and launching facilities, while developing new ground and flight operations procedures in parallel with Shuttle operations. Operations concept inputs are factored into the vehicle designs. Resident managers act as communication points, connecting the Ares with appropriate counterparts at other Centers and with industry partners.

The Constellation Program's Orion Project located at JSC is providing the payload (crew and/or cargo) for the Ares I. Coordinating the required internal and external interfaces, as specified in ICDs, is a major dependency for the Ares. Integration points at the Program level facilitate clear definition of interfaces between the launch vehicle and payload and the launch vehicle and launch site systems.

Ares uses Technical Task Agreements (TTAs), Task Description Sheets (TDSs), and Memorandums of Agreement (MOAs) to accomplish specific work throughout NASA and with Government partners.

The Ares has an MOA with the Space Operations Mission Directorate (SOMD) and the SSP that includes the following provisions to reduce the risk of transitioning hardware assets and provide efficient integration points:

- Ares Elements coordinate activities with respective SSP propulsion managers to maximize efficiency and resource utilization.
- Budget and schedule assumptions, including charge codes, etc., are coordinated and implemented with respective Project elements.
- The Ares and the SSP propulsion elements coordinate budget plans prior to submittal to ESMD.
- Each Ares Element is represented on Engineering Review Boards, Safety Review Panels, and Project-level Boards.
- The SSP is represented on the Ares PCB and the Ares is represented on the Shuttle Propulsion Element Council.
- Project elements and Shuttle Program propulsion elements are collocated to the maximum extent possible.

Technical Task Agreements are being established between Ares and other NASA Centers to leverage expertise across the Agency. Collaborative Work Commitments (CWCs) have been established with MSFC for Project Management; SE&I; S&MA; FS development with prime contractor; US design, development, integration, and testing; USE development; core stage engine development with prime contractor; and flight demonstrations. These agreements will be updated periodically as planning changes and the Project progresses.

1.5 CUSTOMER AND STAKEHOLDER DEFINITION

Ares is dedicated to enabling the Nation’s space transportation need for assured access to LEO and for eventual trips to the Moon and Mars. It is a cornerstone of NASA’s human space flight activities and an integral part of the Global Exploration Strategy. As such, Ares’ primary customers and stakeholders are the ESMD, SOMD, Constellation Program, the Office of Management and Budget (OMB), the Office of Science and Technology Policy (OSTP), and Congress.

To ensure that Ares is customer-focused, it works closely with the Constellation Program to collaboratively define Program interfaces, roles, and responsibilities associated with developing and operating an Ares I system and integrating it with the Orion and ISS systems. These relationships, where customer advocacy is on the critical path of system implementation, ensure that primary customers and the key stakeholders are well served.

Advocacy, which is a strategic communication goal, includes informed strategic research and analysis as well as a customer satisfaction system to measure effectiveness of advocacy.

Ares collects feedback and measures satisfaction to anticipate customer and stakeholder needs based on external and internal trend and event analysis. With this knowledge, the Project actively integrates its customers’ and stakeholders’ needs into its various Project-level implementation plans.

The Project also acknowledges a number of stakeholders that are not direct consumers of its products and services, including the human space flight community at large, the aerospace technology community, and the American public. These stakeholders are served by the Project's outreach and communication strategies.

1.6 TECHNICAL SUMMARY

The Ares I will provide the capability to carry the Orion to LEO. The Ares V will provide the capability to carry the Altair to LEO, where it will rendezvous with the Orion before beginning the trip to the Moon. This section provides top-level technical details for each Ares hardware element. The technical approach described herein is subject to change as the vehicle design matures.

Ares I and Ares V propulsion and structures hardware commonality is reflected in the Ares technical organization, which includes the FS Element (Ares I and Ares V), US Element (Ares I and Ares V EDS), and USE Element (Ares I and Ares V). The VI Element provides overarching systems engineering and assimilation for the breadth of technical engineering activities, while the FITO Element is responsible for planning and executing flight testing for both launch vehicle systems.

The hardware implementation strategy includes building on legacy systems to leverage knowledge bases and existing resources—infrastructure and workforce—and involves multiple NASA Centers providing support in their respective areas of expertise through TTAs. The Constellation Program guides the acquisition process, including in-house versus contracted efforts. (See Section 3.4, Acquisition Plan.) Government oversight into contracted work is provided, and resident managers are embedded to provide effective, efficient communication channels.

1.6.1 Vehicle Integration Element

In its overarching systems engineering capacity, the VI Element coordinates technical activities across participating NASA Centers to foster integrated execution of essential functions. It employs an extensive network of panels and working groups as forums for product teams (and/or integration groups) in the broad range of technical disciplines and for vehicle flight processing and launching functions. It regularly provides formal and informal communication opportunities and presents reports at Project-level reviews. The VI Element is responsible for planning and managing flight testing in support of the Ares Projects. The VI Manager conducts and chairs the VICB, which reviews and approves engineering trade studies and recommendations, and serves on the Ares PCB.

The Project's flight testing philosophy is to fly increasingly flight-like vehicle configurations leading to full-up verification flights that will be followed by the initial operational flights. The developmental tests will provide engineering data and give confidence in the engineering designs. The qualification flights will be used as final verification of the design and manufacturing of the vehicles.

1.6.1.1 Risk Mitigation

Utilization of the civil service workforce to lead the SE&I for Ares is an unparalleled effort for the current generation of MSFC engineers. In order to mitigate the risk that poses for a project of this scale, the Project must assure training of personnel where there are skill deficiencies, hire support contractors with experience to cover skill gaps, utilize expertise and experience at other NASA Centers to cover gaps, and utilize outside experts (e.g., former NASA personnel) to help bridge the experience gap.

1.6.1.2 Facilities

Vehicle Integration will utilize wind tunnel test facilities at MSFC, Langley Research Center (LaRC), Arnold Air Force Base, Ames Research Center (ARC), and Boeing St. Louis.

1.6.2 Flight and Integrated Test Office

The Flight and Integrated Test Office, based at MSFC, is responsible for developing, approving, integrating, managing, and evaluating the standards for Flight Test Vehicles (FTVs), starting with the Ares I-X developmental test flight in 2009. FITO will conduct a series of demonstration (ascent), verification (orbital), and mission flight tests to supplement ground testing and simulations with real-world data, factoring the results of each test into the next one.

FITO is divided into two principal operational areas: flight test integration and system test and verification testing. The flight test team will conduct a progressive series of flight tests that will supplement the system test and verification team’s ground tests, which will include vibration, avionics, and propulsion system testing. The system test and verification testing team, by conducting extensive ground testing of complete systems, will work to reduce vehicle risk prior to flight through activities such as ground vibration testing.

The initial Constellation mission manifest shown in Table 1-1 provides a frame of reference for the early test flights. Two ascent (suborbital) and one orbital flight of the Ares I/Orion system will be fully automated (no crew on board). Astronauts will be onboard the second of three orbital flight-test missions. Ares I-X will be the first of the ascent tests. While this schedule is still flexible and dependent on resource allocations, it is used as a basis for authorizing work and phasing tasks to a detailed, logic-linked integrated master schedule. It also gives ground operations and mission managers target dates for transitioning from the Shuttle manifest to Ares/Orion operations. These dates may need to be adjusted due to hardware modifications that will need to be made to Launch Complex 39B following the Hubble Space Telescope repair mission in Fall 2008.

Like the Apollo program, the Constellation Program will adapt its flight manifest to take into account technical challenges and lessons learned on each flight before moving on to the next level of challenge and complexity. While space exploration will never be routine, repeated testing of hardware and procedures will eventually allow NASA personnel to take on known challenges with reasonable confidence and prepare to face the unknown based on solid testing experience.

Along with component and flight testing, FITO will help develop logistical and ground operations during the test program with the intention of reducing future costs and improving the efficiency of regular Ares flight operations. FITO will also conduct ground-based simulations and tests of propulsion systems, as well as structural, environmental, and vibration tests. Upon successful completion of the full test manifest, FITO will certify that Ares I is ready for crewed operations.

Table 1-1. Preliminary Constellation Program mission objectives.

Mission Objectives
Ares I-X Ascent flight control algorithm demonstration In-flight stage separation demonstration Assembly and recovery of a CLV-like configuration Integrated vehicle roll torque characterization Demonstration of first stage separation, entry, and parachute dynamics
Ares I-Y 1st 5-segment booster flight test 1st Ares avionics prototype demonstration 1st upper stage prototype test 1st high-altitude abort test 1st launch from redesigned KSC launch complex
Orion 1 1st flight of production upper stage 1st in-flight start of J-2X engine 1st flight of Crew Module (CM) and Service Module (SM) 1st flight of Integrated Avionics Systems 1st CEV entry, landing, and recovery (nominal) 1st use of operational Mission Control Center (MCC) and Launch Control Center (LCC)
Orion 2 1st crewed test flight Initial Operational Capability 1st CEV docking with ISS Prox ops sensor characterization (multiple ports) Deliver and Install Androgynous Peripheral Attachment System (APAS) and Low Impact Docking System (LIDS) Adapter May return partial ISS crew
Orion 3 Prox ops sensor characterization (multiple ports) Deliver and Install APAS/LIDS Adapter May return partial ISS crew
Orion 4 Full Operational Capability (FOC) First ISS Crew Rotation

1.6.2.1 Risk Mitigation

By definition, flight testing deals with risks and unknowns, as the development team attempts to fly hardware that has never been flown before. While Ares understands that minor, major, or even catastrophic failures can occur during the process of testing new launch vehicles, the FITO team is committed to reducing those risks as much as possible through a series of incremental tests prior to full-up testing. Additionally, as in the Apollo program, the flight test program will not progress to the next, more complex series of objectives until it has successfully completed the first precursor objectives.

1.6.2.2 Facilities

Due to the wide-ranging nature of its activities, FITO will be involved in operations throughout the country. Headquartered at MSFC, FITO will also interface closely with the Ground and Mission Operations teams at KSC to develop vehicle processing, launch, and recovery operations; and at GRC and MAF to help develop manufacturing and logistics processes.

A major dependency is when the Space Shuttle Program will hand over needed assets to the Flight Test Program. This includes specific flight hardware as negotiated between the First Stage Element Office and the Space Shuttle Program Office (SSPO). Also included is use of Shuttle processing facilities (e.g., Rotation Processing Surge Facility, Assembly and Refurbishment Facility, Hangar AF) as well as shared infrastructure at KSC (e.g., Mobile Launcher, Launch Pad, Vehicle Assembly Building). It is recognized that such dependencies constitute risks that must be managed judiciously. The FITO Manager must work with the Constellation Program Office and the First Stage Element Office to mitigate such risks through integrated communication and coordination at multiple levels. In addition to transitioning existing Shuttle hardware, FITO is refurbishing the Dynamic Test Stand (TS 4550) at Marshall Space Flight Center to support ground vibration testing (GVT).

1.6.3 First Stage Element

The FS is a five-segment design, which will boost the Ares I upper stage, and later, paired boosters will serve as an element of the Ares V first stage. The five-segment first stage is derived from existing four-stage Shuttle RSRB hardware. Like the current Shuttle RSRBs, the first stage will burn PBAN propellant. The first stage is designed with new forward structures for housing avionics, parachutes, and for mating to the upper stage.

The Ares I first stage boundary starts at the launch pad interface, including the separation system from the launch pad, and ends at the separation plane between the forward frustum and the interstage barrel section. The first stage expanded view is shown in Figure 1-20.

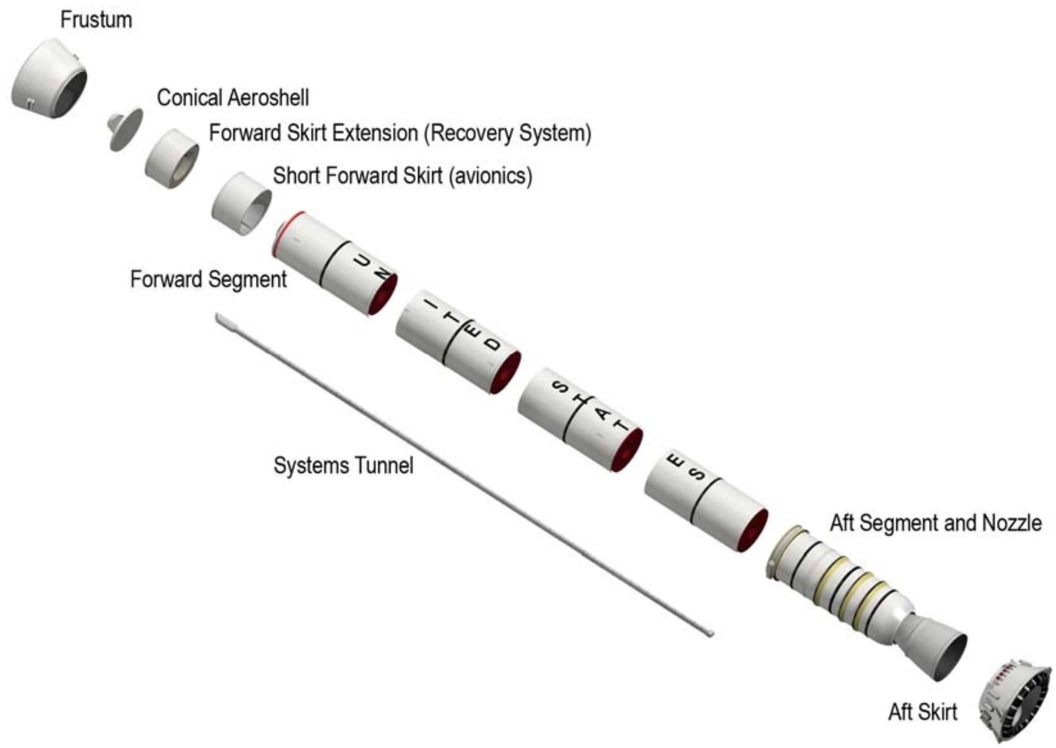


Figure 1-20. First stage hardware expanded view.

1.6.3.1 Risk Mitigation Strategy

The Shuttle SRB was selected to maximize legacy knowledge as a prime risk reduction strategy. The motor performance characteristics of the Shuttle RSRB are well understood, and anchored models have been established for the growth to a five-segment booster. In addition, the successful test of Engineering Test Motor 3 (ETM–3) on October 23, 2003, demonstrated the ability to extend the existing Shuttle RSRB to five segments, as well as established that PBAN propellant burn rate can easily be tailored to the Ares' mission parameters. The test further demonstrated the transferability of existing RSRB ignition systems to a five-segment motor. As a necessary part of conducting the test, Test Stand T-97 (located at the Alliant Techsystems, Inc. (ATK) Launch Systems facility in Utah), has already been modified to accommodate a five-segment RSRB.

1.6.3.2 Facility Requirements

All development and operations of the FS Element will utilize existing SSP and contractor facilities infrastructure. Sufficient capacity exists to support both Space Shuttle and FS manifest requirements with no appreciable need for increased support capabilities. This approach provides for a cost-effective transition from current Space Shuttle to FS DDT&E and production needs.

1.6.4 Upper Stage Element

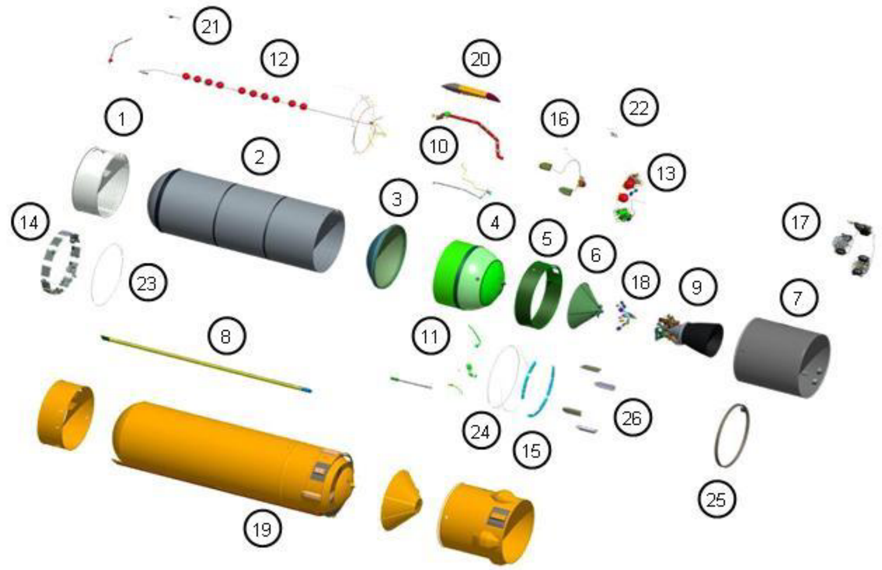
The US Element is a clean-sheet design that is being designed and developed in-house, with Element management at MSFC. The implementation plan for the Government-led US DDT&E is to have periodic independent reviews to assess the Element's progress. The first review was conducted during the Upper Stage SRR time frame. (See Section 3.8, Reviews.)

NASA will lead the DDT&E for the Ares I US through the NDT. This includes the upper stage systems integration, ILS and operations, software systems, propellant tanks, GSE, avionics hardware, structural elements, MPS, RCS, TVC system, and component development programs. The NDT is responsible for development of the upper stage systems requirements, development of the Ares I external and internal IRDs, development of the CEI specifications, and the definition of the Ares I avionics and software architectures.

As of DAC–2B, the Ares I upper stage will be a self-supporting cylindrical structure, approximately 25.5 m long and 5.5 m in diameter. It will be powered by a single J-2X main engine and consists of the following primary products:

- Primary Structures.
    - LOX Tank.
    - LH_2 Tank.
    - Common Bulkhead.
    - Thrust Structure (aft skirt and thrust cone).
    - Instrument Unit.
    - Interstage.
- Secondary Structures: System Tunnel.
- Avionics and Software.
- Main Propulsion System.
- First Stage RoCS and Upper Stage ReCS.
- Thrust Vector Control.
- Separation System.
- Purge and Vent System.

Figure 1-21 provides an overall conceptual arrangement of the critical US subsystems listed above. The systems tunnel, which carries fluid and electrical power functions to other elements, is included as a secondary structure. Avionics and software consists of the component subsystems command and data handling (C&DH), flight software, sensors and instrumentation, video, communications, vehicle management, power systems, electrical integration, and electrical GSE.



1. Instrument Unit (IU)
2. Liquid Hydrogen (LH2) Tank
3. Common Bulkhead
4. Liquid Oxygen (LO2) Tank
5. Aft Skirt
6. Thrust Cone
7. Interstage
8. System Tunnel
9. Upper Stage Engine
10. LH2 System
11. LO2 System
12. Pressurization & Pneumatic System (cryogenic)
13. Pressurization & Pneumatic System (ambient)
14. IU Avionics
15. Aft Skirt Avionics
16. Upper Stage Reaction Control System (ReCS)
17. First Stage Roll Control System (RoCS)
18. Thrust Vector Control
19. Thermal Protection System
20. LH2 Feedline Fairing
21. IU Umbilical Panel
22. Aft Skirt Umbilical Panels
23. IU Purge & Hazardous Gas Detection System
24. Aft Skirt Purge & Hazardous Gas Detection System
25. Interstage Purge System
26. Ullage Settling Motors

Figure 1-21. Upper stage hardware expanded view.

The MPS includes all propellant fill, feed, pressurization, purge, and actuation subsystems required to supply propellants to the engine. The first stage RoCS is a distributed, pressure-regulated, monopropellant hydrazine system that will provide 1-DOF active roll control for the first stage active mission phase. The first stage RoCS is mounted on the interstage and contains two RoCS modules located 180 degrees apart. Each module contains twelve 625-pounds-force (lbf) thrusters.

The upper stage ReCS will provide three degrees of freedom (3-DOF) (pitch, yaw, and roll) active control during the active mission phase for the upper stage. The system, a distributed blow-down monopropellant hydrazine system, will contain two ReCS thruster modules located 180 degrees apart on the upper stage outer diameter. Each module will contain six 100-lbf thrusters.

Separation and MPS propellant settling is accomplished using the booster deceleration motors (located on the aft skirt of the first stage) and the ullage settling motors respectively. The TVC system includes the actuators and control systems required to provide gimbaling capability to the USE. The separation system includes the components required for the use and initiation of the stage and payload separation systems. The purge and vent system includes all the components of the multiple purge systems used on the US and ventilation systems for venting and removal of gases.

The US LSI strategy is based on a disciplined, unified, and iterative approach to the technical and management activities necessary to integrate supportability considerations into system and equipment design. The end result of the LSI effort is to minimize the support required and costs associated (logistic footprint) with fielding the Ares I. The logistics depot for the upper stage will be located at MAF.

1.6.4.1 Risk Mitigation Strategy

A clean-sheet upper stage design inherently carries more risk than using a modified design, and there are several key drivers for this increased risk. New systems, especially those that require human rating, require extensive DDT&E prior to flight certification. Additionally, the existence of qualified hardware and vendors to produce human-rated hardware is limited. Most current flight hardware being produced supports non-human-rated, expendable launch systems. While designs for human-rated components and subsystems exist, they primarily represent designs for reusable Shuttle systems and are not necessarily applicable for a clean-sheet expendable system. Many of the original hardware vendors utilized during the early development of the Space Shuttle have been displaced or retired, the designs and fabrication rights have been bought and sold, and the design drawings are not, in all cases, current. Reconstitution of the vendor base for the production of a new human-rated system is required.

However, a clean-sheet approach has many advantages. It can be designed for increased supportability (to help meet the goal of reducing the logistics footprint) and increased reliability, as would be necessary to meet the human-rating requirements imposed by NPR 8705.2, NASA Human Rating Requirements for Space Systems. The extensibility of the Ares I upper stage to the EDS is a prime risk mitigation strategy in the area of structures and interfaces. State-of-the-art materials, hardware, design, fabrication processes, test techniques, and integrated logistics planning are incorporated, facilitating a supportable, reliable, and operable system.

1.6.4.2 Facility Requirements

Since the US is a Government-led clean-sheet design and the initial prototype vehicles and test hardware will be manufactured at NASA facilities, facility requirements are of special importance. To meet the aggressive schedule, the early infusion of resources is required for facility modifications. It is also planned that most US testing will be done at Government-provided facilities. Major facility modifications will be minimized to focus resources on the development and flight hardware.

The manufacturing, integration, assembly, and checkout of the Main Propulsion Test Article (MPTA), the GVT test article, flight-like simulators, and initial prototype flight stages is baselined to be performed at several NASA Centers, including MSFC, MAF, and GRC. Some facility modifications are required at all participating Centers in order to support the integrated assembly and test of these vehicles. This will include establishment of production capabilities at MAF, refurbishment of building 4670 (Advanced Engine Test Facility at MSFC), and reactivation of SSC's B-2 Test Facility. Both 4670 and B-2 are currently in mothballed status. During the operational phase of the US Element, launch vehicle manufacturing, integration, assembly, and checkout will be performed at MAF. Propulsion development and acceptance testing is baselined at MSFC, SSC, and GRC. NASA's White Sands Test Facility (WSTF) will be utilized to conduct subsystem-level hot-fire verification testing of the RCS and TVC subsystems.

1.6.5 Upper Stage Engine Element

The USE is a 294,000 lbf vacuum thrust LOX/LH_2 engine called the J-2X, being developed to power the Ares I upper stage and the Ares V EDS. The prime contractor is PWR. A development goal is to meet the requirements for both vehicle applications with one engine DDT&E cycle in 2006–2012.

The J-2X engine is a gas generator cycle selected to enable component testing and leverage PWR flight-proven LOX/LH_2 gas generator cycle J-2 and RS-68 engine capabilities. The J-2X is required to deliver 294,000 lbf vacuum thrust and deliver specific impulse (Isp) of 448 seconds (sec). To meet these performance requirements the J-2X design includes turbomachinery derived from the heritage J-2S developed for Saturn and utilized for the X-33 aerospike XRS-2200 engine. The J-2X also includes a higher chamber pressure than heritage J-2 and a larger nozzle area ratio which includes a regeneratively cooled nozzle and a radiatively cooled nozzle extension. Human rating considerations dictate fault tolerance and redundancy of some critical subsystems such as control hardware and software. Engine throttling is achieved by changing the propellant mixture ratio from 5.5 to 4.5. Engine operating life requirements cover cumulative starts and hot fire time to account for engine acceptance testing, stage green run testing, altitude start, and in-space restart.

The USE development plans include testing of engine components, including subscale injector, igniter, powerpack assembly (turbopumps, gas generator, and associated ducting and structural mounts), full-scale gas generator, full-scale thrust chamber assembly (injector, chamber, and regeneratively cooled nozzle), valves, and control software with hardware in the loop. Engine system development testing includes seven engines, including one engine for MPTA and two engines for the Orion 1 and Orion 2 test flights. This is a minimal engine system development test program with success dependent on extensive component testing, leverage from heritage LOX/LH_2 gas generator cycle engines, and rigorous design and development to minimize test-fail-fix cycles. Engine mass simulators will be provided for Ares I-X and Ares I-Y test flights. Engine system certification testing includes two engines to be tested before USE Design Certification Review (DCR) to certify the engine design for human flight. A certified design engine will be delivered for the first human flight, Orion 2. Engine system testing for development and certification is planned at the SSC A-1 test stand for sea level testing, and the GRC Plum Brook Station (PBS) B-2 test stand for thermal/vacuum hot-fire testing of altitude start and in-space restart. A second sea level test stand is also being planned to enable an aggressive test rate and redundant test capability needed during engine development to mitigate schedule risk.

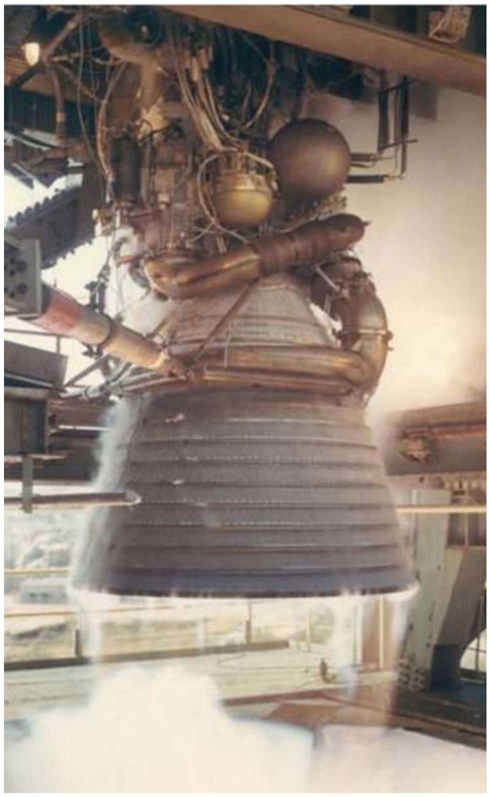


Figure 1-22. The J-2X engine is a new design to meet Ares I and Ares V requirements in one engine.

1.6.5.1 Risk Mitigation Strategy

Upper stage engine development is identified as a top Constellation risk, and as such the development funding and schedule are aimed at supporting Ares I orbital flight tests (OFT) 1/2/3 in 2012 (vs. 2013/2014 for Ares I baseline as shown in Figure 1-23), which challenges rapid progression of Ares milestones through 2008 and mitigates engine schedule risk. The aggressive USE development plan includes baseline of key driving requirements followed by conceptual design definition as requirements mature, design leveraged from J-2/J-2S and RS-68 heritage LOX/LH_2 gas generator cycles, rigorous design and development processes and tools proven on

RS-68 and other engines, extensive component testing, and engine system testing in multiple test stands to enable an aggressive test rate.

1.6.5.2 Facility Requirements

Component testing will be performed at MSFC Test Stand 116, Powerpack Assembly testing at SSC A-1, and engine system testing at SSC A-1, GRC PBS B-2, and another engine system test facility. Modifications are necessary at SSC A-1 and PBS B-2. Engine system assembly and acceptance testing will be done at SSC.

1.6.6 Ares V Integration

This section gives top-level technical information about the Ares V being developed by the Ares Projects. The Ares V is comprised of a newly designed core stage using six upgraded RS-68 engines as the main propulsion system augumented by two 5.5-segment RSRBs (see Section 1.6.3, First Stage Element) and a new upper stage, the EDS. The Ares V is designed to deliver 187.7 mT (413,800 lb) to LEO or 71.1 mT (156,700 lb) to trans-lunar injection in conjunction with the Ares I.

Following ATP, the Ares Project will develop a new core stage and upgrade the commercially available RS-68 to meet the needs of the Ares V missions. The core stage is 10 m in diameter and approximately 71 m long. In order to minimize cost, design trades and assessments will be performed to determine the most effective design for the core stage.

The Ares V mission requires that the current RS-68 engine be upgraded to be more reliable, efficient, and powerful. The new RS-68 will have higher efficiency, more thrust, and greater reliability while maintaining low manufacturing and operating costs. The performance upgrades that are needed for the Ares V mission may benefit other members of the space launch community and any synergistic opportunities that may arise will be pursued to the fullest.

External interfaces will be similar to the current RS-68 except for changes needed due to vehicle driven requirements. Performance (Isp and thrust) will increase from the current RS-68. Table 1-2 lists current RS-68 engine characteristics.

Table 1-2. Current RS-68 engine characteristics.

Thrust, vac (K lbf) – 102%	758
Chamber pressure (psia)	1,486
Engine mixture ratio	5.97:1
Isp, vacuum (sec)	407.7
Expansion Ratio	21.5:1
Engine Dry Weight (lb)	14,800

The production goal is to maintain a low per-engine cost while producing engines at a rate of 10 to 15 engines per year. The engine development cycle is anticipated to be 4 years from ATP through first engine delivery, including a certification test. System constraints include limited test facilities, with two active engine development efforts (J-2X upper stage engine and RS-68 Ares V core stage engine).

1.6.6.1 Risk Mitigation Strategy

Building on a foundation of legacy knowledge from past and current propulsion and vehicle programs, such as the RS-68 program, the Ares Projects will provide a high degree of risk mitigation for the Ares V development. Current work is focused on modifications to the RS-68. Helium spin start hardware acquisition and testing is planned for 2008 at Stennis Space Center. Additional design and test work is under consideration to lower design risk, including design and fabrication of a development gas generator and helium spin start duct.

1.6.6.2 Facility Requirements

The Ares Projects is evaluating current assembly operations and facilities. Recommendations for process improvements were identified. It is anticipated that existing contractor assembly facilities will be adequate to support development activities and production rates; however, the launch manifest will drive the required number of development, certification, and flight stages to be produced as well as subsequent facility requirements.

1.7 MISHAP PREPAREDNESS AND CONTINGENCY PLANNING

The Ares Projects policy for contingency planning, mishap preparedness, mishap and close call reporting, investigation, and recordkeeping is to implement this activity in accordance with NPR 7120.5D, NASA Space Flight Program and Project Management Requirements, and NPR 8621.1B, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping.

The Ares Projects shall support MSFC S&MA in the development of the Ares Appendix to the ESMD Mishap Preparedness and Contingency Action Plan (<**TBD-002**>), providing concurrence on the final document for implementation. In the event of a mishap or close call at the Center, Ares will activate the Center Mishap Preparedness and Contingency Plan. For mishaps or close calls that occur off-site, Ares will activate ESMD MRCAP-XX.XX (<**TBD-003**>), the ESMD Mishap Response and Contingency Action Plan. Ares will work with MSFC S&MA if jurisdiction requires the implementation of the MSFC Center Mishap Preparedness and Contingency Plan. Ares will provide funding and support for investigations within the project jurisdiction or involving Ares hardware and facilities and will assist the investigating authority as requested.

When tasked by the Appointing Official, Ares will develop the Corrective Action Plan (CAP), implement the CAP, support the MSFC S&MA personnel as they verify that the CAP has been completed, and generate the lessons learned.

2.0 PROJECT BASELINE

2.1 REQUIREMENTS BASELINE

Requirements management is critical to mission success. The Project defines and integrates the overall requirements and technical documentation schema for Ares. In addition, it evaluates requirements for compatibility and validation, and ensures that existing requirements can be verified. The programmatic documentation that defines the flow and levies the processes used in the Ares is shown in Appendix B.

The Ares Manager is responsible for the allocation, definition, management, verification, and configuration control of Ares I and Ares V requirements as Chair of the Ares PCB. Requirements are validated according to established processes as stated in the Program requirements document, which also defines Project requirements and below for the Ares I and Ares V systems and maintains traceability of those requirements, ensuring all validation and verification processes are performed according to SP-2007-6105, NASA System Engineering Handbook, and CxP 72018, the Ares SEMP. The Project works in concert with the Chief Engineer to define the overall validation strategy for Ares.

The Ares requirements documentation is developed at an appropriate level of elaboration to form a logical requirements hierarchy. This documentation supports the Project philosophy, links Project-governing documentation to the appropriate guidance (e.g., NPDs), and assures maximum empowerment is provided to the engineering and business management teams.

The Project keeps required programmatic activities that belong in contract SOWs separate from technical requirements that the Ares I and Ares V systems must satisfy. Ares ensures that requirements and requirements philosophy are defined, analyzed, controlled, and maintained, then properly communicated to participating organizations.

The attributes of Constellation Program-level requirements are directly traceable to the mission needs. They are clear and concise and within the scope, budget, and schedule defined in the Project Formulation Authorization. More specifically, these requirements shall define the following:

- What the system must do (functional requirements).
- How well the system must do it (performance requirements).
- Within what constraints the system must operate.

CxP 72032, Ares I Operational Concept Document, provides a broad conceptual view of the launch vehicle systems. It also defines the organizational and system interfaces required during Ares I and Ares V operations. The operations concept is defined in terms of operational needs without resolving detailed technical design issues. It provides input to functional analyses that will be used to derive system-level requirements and to define system interfaces and boundaries. The operations concept is used to identify key operations trade studies.

CxP 72034, the Ares I SRD, and CxP 72004, Ares V SRD, define the top-level solutions to Program requirements. Project-level specifications address technical solutions in terms of functional performance, constraints, and physical characteristics. The Ares I documentation was reviewed during the Ares I SRR. The Ares V documentation will be reviewed during its SRR. The Element Requirements Document (ERD) and CEI specifications define the next-level solutions to the Ares requirements.

2.1.1 Human Rating

The human rating requirements and approach are documented in NPR 8705.2, Human Rating Requirements for Space Systems, and is used for developing human-rating requirements for the Ares. Requirements are derived from CxP 70000, the Constellation Architecture Requirements Document (CARD), which in turn flows down requirements to the SRDs and IRDs for all vehicles.

The design of the Ares I and Ares V systems addresses aspects of human rating beginning in the formulation phase. The Project ensures that issues, problems, and decisions regarding the specification and achievements of human rating are elevated to appropriate management levels through formal review, with an emphasis on safety and risk management.

2.1.2 Traceability

The desired attributes of a “good” requirement are that it is defined at the appropriate level and can be verified and validated. The Cradle database is used to capture the links between sources and destinations of requirements.

Ares assures that compliance and verification processes have clear traceability with all functional and performance design requirements. Requirements traceability has a number of benefits, including:

- Avoids requirements “creep” by eliminating untraceable requirements.
- Ensures requirements are accurately defined to lower level subsystems and components.
- Supports management of a disciplined requirements flow-down effort by monitoring relevant requirements attributes throughout the requirements decomposition process.
- Validates and verifies all requirements.

2.2 WBS BASELINE

An overview of the Ares Projects WBS baseline is shown in Table 2-1. The complete WBS dictionary can be found in Appendix K of CxP 72018 Rev C, Ares Systems Engineering Management Plan.

Table 2-1. Ares Projects Work Breakdown Structure.

5.0	**Ares Projects Office**
5.1	**Project Management**
5.1.1	Project Management and Administration
5.1.2	Business Management
5.1.3	Contractor Relationships
5.1.4	Technical Reviews
5.1.5	Information Technology Management
5.1.6	Advanced Planning & Special Studies
5.2	**Vehicle Integration**
5.2.1	Systems Management
5.2.2	Systems Requirements and Design Integration
5.2.3	(N/A)
5.2.4	Integrated Design and Analysis
5.2.5	Operations and Supportability
5.2.6	Avionics Integration and Vehicle Systems Test
5.2.7	Crew Safety and Reliability
5.2.8	Vehicle Development & Flight Evaluation
5.3	**S&MA**
5.4	Science & Technology
5.5	Payloads
5.6	Aircraft/Spacecraft
5.7	Mission Operations System
5.8	Crew Launch Vehicle
5.8.1	First Stage
5.8.2	Upper Stage
5.8.3	(N/A)
5.8.4	Upper Stage Engine
5.9	Ground Systems
5.10	**Flight & Integration Testing Operations**

2.3 SCHEDULE BASELINE

The Ares IMS was developed and is currently maintained in Microsoft Project. Upon successful completion of the Primavera pilot test program, the Ares I schedule will be migrated into Primavera. See Figure 2-1 for top-level Ares I milestones and Figure 2-2 for top-level Ares V milestones.

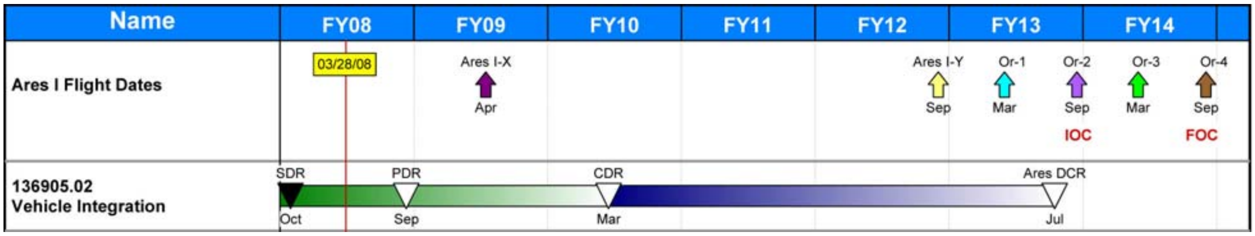


Figure 2-1. Ares schedule milestones (by fiscal year).

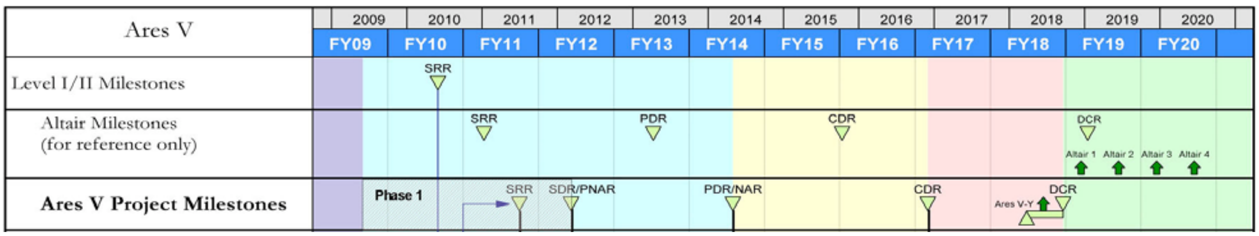


Figure 2-2. Ares V tentative schedule milestones (by fiscal year).

The Ares Schedule Management System provides the Project with a maintainable IMS that:

- Supports the ability to accurately track and assess the Ares Elements' schedule progress relative to the established baseline.
- Provides insight and integration of Element activities relative to major Project reviews and decision points.
- Ensures integrated coordination between all aspects of the Project activities and milestones that are critical to Program and mission success.
- Achieves both horizontal and vertical integration within the IMS. Horizontal integration exists between Projects and Elements. Vertical integration exists between Project and Element milestones/tasks and the Orion milestones and decision points.
- Includes schedule probabilistic risk assessment (PRA), using Monte Carlo simulations as a basis (see APO-1002, Ares Project Risk Assessment Guidelines).

In addition, key Project-level schedule milestones are baselined and approved through the Ares PCB. Change request approval is required for changes to baselined Project-level milestones and Program-controlled activities. Ares I Element schedules are integrated within the Ares IMS and will be integrated with the monthly cost and technical performance data for informed decisions.

Ares I Element schedule submissions include the following:

- Deliverables in support of Project activities/reviews and decision points.

- Project-specific contract awards/periods of performance and deliverables.
- Summary schedule with sufficient detail to convey scope and content with intermediate milestones to track and assess progress (includes Project- and Element-level details).
- Critical path identification.
- Logic linkage identification between Project-specific tasks and Program milestones.

To baseline the initial Project IMS, schedulers within a specific Ares Element work with technical points of contact (POCs) to finalize Project tasks and the associated schedule logic. The Element schedules are integrated by importing them into a single schedule known as a master project. Logical relationships are then established between the Element schedules and to the project-level major milestones. The Element schedules are saved individually but maintain their electronic integration through the logic established in the master project environment. Once predecessor and successor tasks and logical connections are identified, Project technical POCs verify their entries in the IMS. Then, with Project support/coordination, overall key milestones are identified and subsequently baselined through the Ares PCB.

The IMS health checks and schedule risk analyses are performed against the latest version, and Project-level analysis charts can be generated. A weekly Project schedule integration meeting—with Project schedulers, technical POCs, and Element Managers—is held to address any issues and concerns after analysis charts are completed. Items that are addressed include identification and resolution of tasks needing to be statused, review of critical paths, event accomplishments, upcoming events, and schedule issues (by WBS). Any changes, updates, or corrections to these items are made to generate a set of schedules that are then made available to the entire Project via a controlled access file server.

2.4 RESOURCE BASELINE

2.4.1 Budget

The Ares budget process follows Agency guidance. The PPBE process begins each year in February. The Mission Directorates issue guidance for the upcoming budget horizon. Center management issues strategic guidance in the same timeframe. Budgets are developed via various processes that are somewhat unique to each Center. These are submitted via Center input and Project input in the May timeframe. The summer is spent working scenarios and gaining clarification on any issues. The Agency submits the budget to OMB in September. Also, as a part of the budget process, task agreements and work packages that present detailed plans for the upcoming fiscal year are established, negotiated, and a final agreement reached. This activity takes place each summer with plans in place at the beginning of each fiscal year. The task agreements are presented to the PCB for approval along with the corresponding budget by Element by Center. Any changes to the guidelines will be subject to change requests approved by the PCB. As phasing plans are established, monthly plan versus actual reporting will be required at each level of the Program (i.e., Levels III, II, and I). Earned value management is used to measure cost and schedule. This is discussed in further detail in Section 3.1.3, Earned Value Management.

2.4.2 Human Capital

The Ares I personnel estimates will be attached in a separate appendix (<**TBD-004**>). These estimates are established as part of the PPBE process described above. The calculations are based on full-time equivalents (FTEs) for civil service personnel and work-year equivalents (WYEs) for support contractor personnel. The workforce for the project will be planned in the Workforce Integrated Management System (WIMS), an Agency tool used to plan workforce at each Center. As with the budget, detailed plans by execution year are in place. This involves civil service planning by name and support contractors by WYE. The budget horizon is planned by competencies by organization.

2.5 PERFORMANCE BASELINE

The Ares' mission success entails delivery of Ares I and Ares V systems (made up of segments, elements, and subsystems) that technically satisfy NASA's Program-level requirements as captured in the Ares I SRD and Ares V SRD, as shown in Figure 2-3, and results in safe, operable, and efficient assets for the Agency.

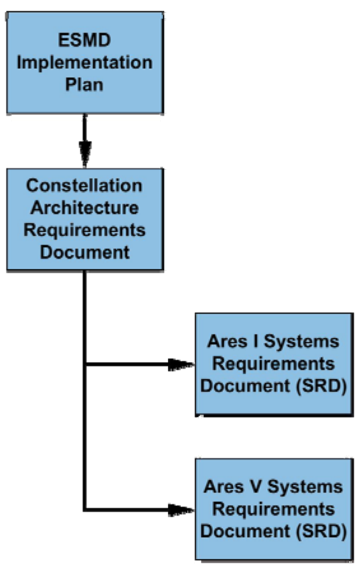


Figure 2-3. SRD flow-down.

The Ares Key Performance Parameters (KPPs) that are measured to gauge mission success are maintained by the Ares Manager and outlined in Section 1.2.1, Technical Performance Measures. Adherence to these parameters will be reviewed at Key Decision Points (KDPs) throughout the Projects' life cycle to determine readiness for the next phase of the life cycle. At these KDPs, the Project will receive ATP from the Program or Project Decision Authority, as appropriate.

3.0 SUBPLANS

3.1 TECHNICAL, SCHEDULE, AND CONTROL PLAN

The Ares Projects Plan establishes baselines in terms of schedule, budget, and technical performance. Element managers may adjust task funding within their authority, provided that Element-controlled Project milestones are met and task scope remains unchanged. If projected schedule and cost performance exceeds the Non-Advocate Review (NAR) baseline by 10 percent, the Ares Manager shall report the variance to the Constellation Program Manager and the information shall be presented to the Governing Program Management Council (GPMC).

3.1.1 Review Boards

The Ares employs a series of review boards for control of the baseline configurations and changes to them. The Ares VICB is responsible for integration across all Ares I and Ares V technical areas; it reviews and approves technical work provided and dispositions baseline configurations and changes to them to the next control level. Since most engineering support resides within the MSFC Engineering Directorate, it has chartered the CERB to perform engineering accountability and technical authority and function as a decision-gate before products proceed to the next level. The Ares PCB is the ultimate decision-making body for Ares I and Ares V baseline configurations and changes to them. Section 3.11 provides more details about process flow.

3.1.2 Budget and Performance Integration Tools

For budget and performance integration, the Ares uses tools established as an enhancement to the Integrated Enterprise Management Program (IEMP). In addition to the reporting capabilities available with Business Warehouse (BW) and Software Applications Provider (SAP), the Ares uses the Guideline Tracer, Resources Planning System (RPS), and the Accounting Resources System to house plans, actual costs, workforce, guidelines, and so forth, for any reporting requirements identified by the Constellation Program and NASA HQ. The Guideline Tracer manages guidelines and changes. RPS is a budget formulation tool that houses phasing plans and supports Project internal and external integration functions. Monthly variance analysis and reporting capabilities are integrated into this system. The ARS is a Web-based system that integrates plans from RPS and actual costs from the BW for funding and workforce. Standardized and ad-hoc reporting capabilities are a part of this system. Control systems are also in place. A PCB has been established (refer to Section 3.11) for the Ares I whereby any budget, schedule, and WBS changes will be requested by a change package and approved by the PCB and further documented within the planning and control systems identified previously.

3.1.3 Earned Value Management

Earned value management (EVM) parameters such as SPI and CPI will be assessed on a monthly basis. The goal for these indicators is 1.0. Variances will be required for +/– 0.1. Estimates at completion (EACs) will be assessed quarterly and will require variance explanations for +/– 5 percent. If the EAC exceeds the contract budget base (CBB) by greater than 10 percent, the contractor will be required to submit for approval a plan for corrective action.

3.2 SAFETY AND MISSION ASSURANCE

3.2.1 System Safety

Within the Ares, the objective of System Safety Engineering is to ensure the safest possible Ares I vehicle design, given programmatic and technical limitations, through a comprehensive approach to the identification and mitigation of hazards and the associated controls and mitigation activities linked to the design. System Safety activities are distributed among Vehicle Integration, First Stage, Upper Stage, and the J-2X engine elements. System Safety Engineers work as an integral member of IPTs and other teams supporting various activities to influence the Ares I vehicle design. Planned tasks provide for the early identification, analysis, reduction, and/or elimination of hazards that might cause:

- Loss of life, or injury or illness of people.
- Damage to or loss of equipment or property, including software.
- Unexpected or collateral damage as a result of tests.
- Failure of mission.
- Loss of system availability.
- Damage to the environment.

Risks associated with hazards are reduced through a robust hazard identification process, clear communication to engineering disciplines as well as interfacing organizations, and employing effective hazard mitigations as early as possible in the design. Examples of analysis techniques employed to identify hazards include fault tree analysis, event tree analysis, common cause analysis, energy analysis, and others as applicable to the system being evaluated. At the VI level, System Safety is responsible for integrating the safety products provided by each of the Elements into an overall Ares I product, performing a hazard assessment of interfaces, and an assurance function including the elevation of any concerns. The results of all hazard analyses shall be documented in accordance with CxP 70038, Constellation Program Hazard Analysis Methodology. Additionally, System Safety serves as a member of the CSRT to ensure that safety issues are properly considered when optimizing key characteristics to achieve system requirements. Refer to CxP 72020, Ares Project System SR&QA Plan, for details of the Ares safety engineering effort.

3.2.2 Reliability & Maintainability

Within the Ares, Reliability and Maintainability (R&M) Engineering responsibilities are distributed among the Vehicle Integration, First Stage, Upper Stage, and Upper Stage Engine elements. Reliability and maintainability engineers are assigned to each of these Elements to work as an integral member of the team and are responsible for various analysis activities that serve to define the R&M requirements and influence the Ares I design to meet CxP R&M requirements (i.e., loss of crew, loss of mission, launch availability, and mean time to repair). Examples of these analyses include ascent risk modeling and assessment, FMEA/CIL, and maintainability analysis. At the VI level, R&M is responsible for integrating the R&M products provided by each of the Elements into an overall Ares I product, as well as assessment of element-to-element interface issues. Additionally, VI R&M serves as a member of the CSRT to ensure that reliability and maintainability issues are properly considered when optimizing key characteristics to achieve system requirements. Refer to CxP 72020 for details of the Ares R&M engineering effort.

3.2.3 Quality Engineering and Quality Assurance

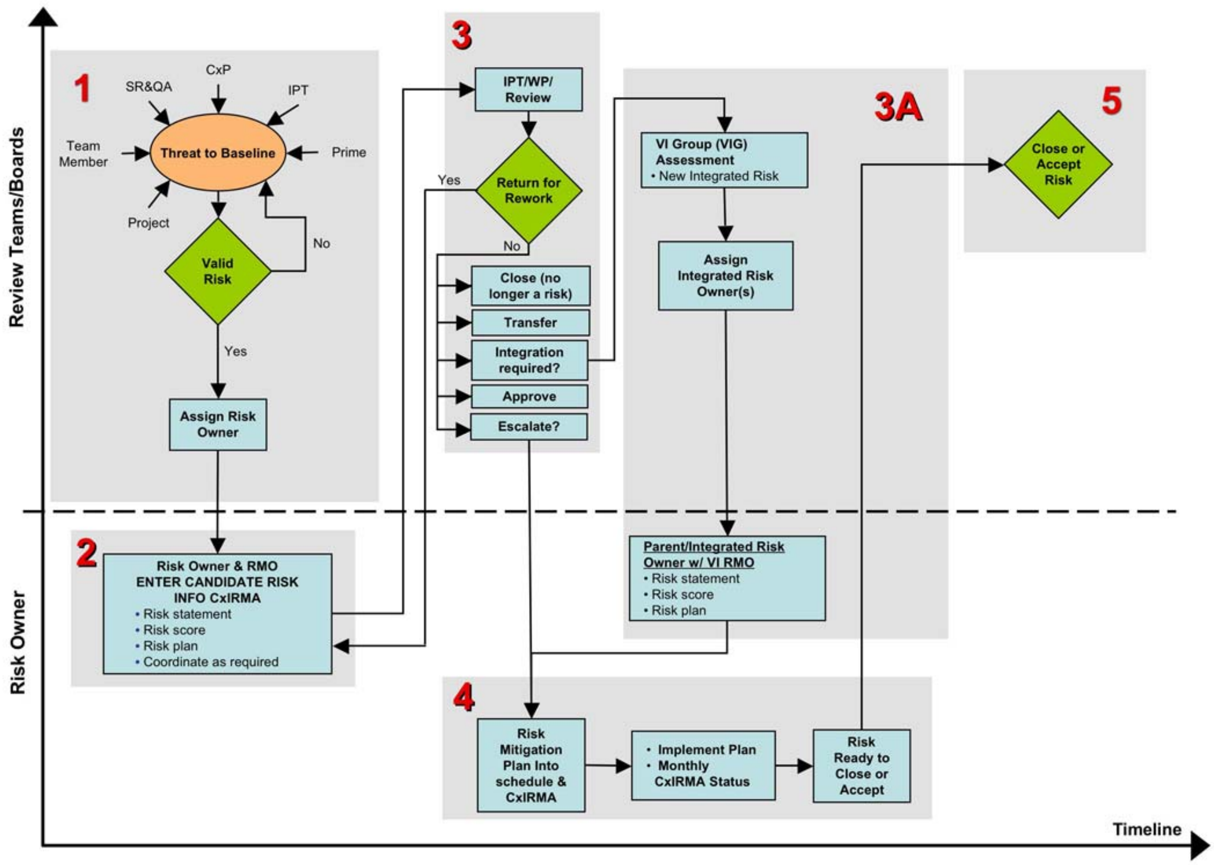
Serving as an integral part of the Ares Projects Office, Quality Engineering and Quality Assurance are assigned to the First Stage, Upper Stage and Upper Stage Engine (J-2X) Elements as well as Vehicle Integration. Responsibilities include identifying the activities needed for the quality management system and their application throughout the Ares elements life cycle (e.g., surveillance, drawing review, and test monitoring). To ensure that these functions are performed effectively and meet the Constellation Program Quality requirements, Quality will determine the criteria and methods as well as the sequence and interaction needed; monitor, measure, and analyze the activities; ensure the availability of resources and information necessary to support the operation and monitoring of these activities; and implement any corrective actions needed to achieve the planned results and obtain continuous improvement. Additionally, as a part of VI, Quality will cooperate and coordinate with other S&MA disciplines and technical organizations (SE&I; Reliability, Maintainability, Supportability (RMS); Safety; etc.) in the development and performance of activities such as verification and validation, auditing, resolution of nonconformances, and other activities to ensure the development of quality hardware, software, and GSE throughout the life cycle of the Ares vehicles. Personnel training and certification will be performed in accordance with CxP 70059, Constellation Program Integrated Safety, Reliability and Quality Assurance (SR&QA) Requirements document. Refer to CxP 70059 and CxP 72020 for detailed Quality activities. In the event there is a conflict between CxP 70059 and CxP 72020, the document precedence is CxP 70059.

3.3 RISK MANAGEMENT

The Ares uses continuous risk management (CRM) to provide a proactive process to identify, track, and mitigate threats to Program and Project success. CRM is an organized, systematic decision-making process that efficiently identifies, analyzes, plans (for the handling of risks), tracks, controls, communicates, and documents risk to increase the likelihood of achieving Project and Program goals.

CRM supports the Ares leadership philosophy by establishing a process whereby the Project can capture knowledge to enhance decision-making capabilities. CRM requires total team involvement, encouraging and promoting effective communication and teamwork, and assuring

Project management that risks are continually identified, tracked, and mitigated. The general process employed is shown in Figure 3-1. The Ares has tailored this process to meet its specific needs.



RMO – Risk Management Office; VIG – Vehicle Integration Group; WP – Work Package

Figure 3-1. CRM process flow.

The procedures and processes supporting Ares risk management are detailed further in CxP 72019, Ares Projects Office Risk Management Plan, and are implemented to create a risk management process that increases the likelihood of Project success without becoming a constraint. The process supports the Project's success criteria, addresses the primary threats to the Project, and is efficiently and effectively deployed throughout the Project. Ares uses the CxIRMA tool as the cornerstone for Project risk tracking.

The Ares Projects Office Risk Management Plan objectives are to ensure that:

- The decision-making processes are organized and methodical, are used to identify and assess risks, and effectively eliminate or mitigate them.

- The CRM process is proactive in nature and structured to provide early insight through appropriate collection and use of data, implementation of proven analytical techniques, and through management review and verification.
- The integrated effect of various risk categories (safety, mission success, technical, cost, and schedule) is properly analyzed and evaluated.
- The risks associated with heritage Shuttle hardware that have been identified and documented will be given emphasis for Ares I management attention and action early in the project's design life cycles.

3.4 ACQUISITION PLAN

In its role to execute NASA's acquisition strategy, the Ares complies with standard procurement practices, which are ensured by collaboration with the MSFC Office of Procurement. With ESMD guidance, the Office of Procurement defines Ares acquisition processes, documentation, management requirements, and key strategic decisions. The Ares Manager is responsible for coordinating with the Constellation Program Office and NASA HQ to ensure the Ares acquisitions are completed on schedule and within budget and other Agency guidelines. Table 3-1 gives an overview of the systems used to manage acquisition.

Table 3-1. Ares acquisition management systems.

➢ Acquisition Strategy Planning
• Market Survey Competitive Determination
• RFP Development
• SEB Selection
• Contract Negotiations
➢ Risk-Based Acquisition Management (RBAM)
• Technology Transition Management
➢ Contract Administration
• Administrative and quality assurance surveillance requirements
• COTR
• NASA Resident Management Office
• Other agencies
➢ Long-range Planning for Future Requirements
• Follow-on production contracts
• Operations efficiencies
• Availability of resources
• Commercialization opportunities

Acquisition Strategy Meetings (ASMs) are conducted for each of the major elements or sub-elements that are separately procured. The resulting acquisition strategy is captured in the ASM presentation and minutes. Since the Ares is Government-led, the acquisition strategy is adjusted accordingly. The Ares contractual arrangements are shown in Table 3-2.

Table 3-2. Ares planned contractual arrangements.

Category	Type	Agencies	Purpose
External	Contract	First Stage Contractor	Provide the Ares with a first stage of the new launch vehicle as defined by the agreed-to contract.
External	Contract	Upper Stage – Structures Contractor	Provide the Ares with an upper stage of the new launch vehicle as defined by the agreed-to contract. Acquisition may be in phases or increments for specific subelements of the overall stage.
External	Contract	Upper Stage – Avionics Contractor	Provide the Ares with upper stage avionics for the new launch vehicle as defined by the agreed-to contract.
External	Contract	Upper Stage Engine Contractor	Provide the Ares with an upper stage engine for the new launch vehicle as defined by the agreed-to contract.
External	Contracts and other Contractual Actions	Other support as required	Provide the Ares with other contractual support necessary for successful accomplishment of mission.

The Ares and supporting Legal and Procurement personnel will carefully consider the Government's intellectual property requirements when entering into Ares I-related contracts. When feasible, sufficient data and intellectual property will be obtained in the DDT&E phase to enable NASA to conduct competitive procurements for later production of new (not derived from legacy hardware) elements or major systems on the Ares I, and to achieve commercialization goals. Project personnel will support these objectives by carefully reviewing contractor-submitted data for improper restrictive markings.

3.5 TECHNOLOGY DEVELOPMENT PLAN

The Ares I and Ares V systems are being developed to minimize the required amount of technology development to accomplish their missions. The approach to Ares I development is to make maximum use of existing critical Space Shuttle hardware with minimal modifications. To support new technology needs, the ESMD technology effort is focused only on those technologies required to enable these systems. Technology Development Plans based on the requirement specified in Section 4.5.2 in NPR 7120.5D will be developed. The Ares I plan (CxP 72209, Ares I Technology Development Plan) has been baselined. The plan provides a framework for reporting the assessments at major project reviews. Also, the plan describes the methodology and tools used to conduct the technology assessment.

New technologies will be pursued to improve safety, reliability, and operations cost within the limitations of Program and Project costs, schedules, and environmental and other regulations. Where those limitations prevent early incorporation of new technologies in the initial Ares I design, action plans will be made a part of project planning for their subsequent incorporation into the baseline Ares I configuration.

As a rule, NASA expects to engage prime contractors in the development of major systems such as launch vehicles, upper stages, crew vehicles, and habitats. NASA typically manages the interfaces between major systems. In addition to these NASA prime contractor arrangements, NASA intends to pursue commercial partnerships where there is an appropriate ratio of risk to reward. NASA will partner with other Government agencies to leverage shared technologies and capabilities.

Technology advances derived from the Ares may have potential for commercialization. The methods that will be used to identify opportunities for commercialization throughout the Project's life cycle include comparison of off-the-shelf capabilities with Project needs and consideration of the potential applicability of Project-developed capabilities in the commercial market.

3.6 SYSTEMS ENGINEERING MANAGEMENT PLAN

The VIO provides guidance for Ares I and Ares V engineering activities. The Ares SEMP provides further information about the overall technical management and integration DDT&E activities within the performance goals, cost requirements, and schedule levied on the Ares by the Constellation Program.

The SEMP establishes the technical content of the engineering work early in the Project's formulation phase. It provides specifics of the technical effort and describes what processes are used in relation to the tasks that must be accomplished. The SEMP defines the engineering and Project-level boards, panels, and working groups, and their relationships to one another.

Verification will be done on the design specifications and on the physical solution to assure compliance with requirements. The principal methods of verification will include a combination of analysis, test, demonstration, and inspection. For example, a development test flight using a simulated payload with the correct Orion outer mold line and mass will be conducted prior to crewed flights as a part of the system verification process (See Section 2.1). CxP 72035, the Ares Master Verification Plan, gives details on this process.

Validation is the process of determining that a proposed system solves the problem for which it is intended. Verification is the process of determining that system design specifications satisfy the requirements and that a built system satisfies its specifications. For purposes of minimizing Project costs and schedule risks, it is highly desirable and practical, prior to the start of design work, to assure the Project's requirements will produce a design that totally satisfies the Mission Needs Statement and Program-level requirements. To this end, the requirements validation process focuses on the quality and feasibility of the requirements defined for the system and lower-level items. CxP 72024, the Ares Project Systems Analysis Plan (SAP), provides more detail on this process.

3.7 SOFTWARE MANAGEMENT PLAN

Ares software development and acquisition is performed in compliance with the directives of NPR 7150.2, Software Engineering Requirements, and NASA Standard 8739.8, Software Assurance Standard. More detailed information can be found in CxP 72051, Ares Software Management Plan, and the Ares SEMP.

3.8 REVIEWS

Formal reviews are scheduled throughout the course of the Ares as a resource to add value to Ares I and Ares V products and to share knowledge by collaborating with outside experts who provide independent confirmation of the Project's approach and recommended options. As tools for communication, formal Project reviews offer an opportunity to organize, assess, and share critical data and information between providers, customers, and stakeholders. These control gates provide a snapshot of the Project's health and progress. An IBR is conducted after the baselining process to ensure that those responsible for schedule, budget, and technical performance measures are fully informed about reporting processes and expectations.

In addition to the major reviews prescribed by SP-2007-6105, the NASA Systems Engineering Handbook, which are described below, the Ares facilitates independent reviews that are conducted by impartial panels composed of management, technical, and budget experts outside of the Project's advocacy circle. For example, a Pre-Non-Advocate Review (PNAR) is planned at the end of Phase A and a Non-Advocate Review (NAR) is planned at the end of the Project's formulation phase/beginning of Phase B to provide Agency management with an independent assessment (IA) of the Project's readiness to proceed into the implementation phase. Review criteria include assessment of the Project's preliminary design, plans for implementation, and associated documentation. Other such independent reviews will be conducted throughout the Project's life cycle.

The Ares Projects will accommodate IAs to be performed by non-advocate groups. Independent assessments will be performed at all phases of the Project's requirements, design, and readiness reviews to assure adequate S&MA requirements are planned and implemented. The IAs will be conducted to assess the Project's DDT&E, manufacture, assembly, test, integration, ground operations, and flight operations relative to S&MA requirements. The IAs will assess the Project's processes including Quality Management, System Safety, and Reliability processes. The Project's schedule will accommodate planned IAs for the S&MA organization to perform Programmatic Audits and Reviews to determine the Project's compliance to S&MA Programmatic requirements. The IAs will also be performed to determine the Project's implementation of CRM processes to assure compliance with NPR 7120.5D, NASA Space Flight Program and Project Management Requirements, and NPR 8000.4, Risk Management Procedural Requirements. CRM assessments will determine Risk Management capability maturity levels being performed by Ares Projects teams.

Top-level Ares reviews and Element reviews are shown in Table 3-3.

Table 3-3. Ares reviews.

Ares Reviews	Baseline Date
System Requirements Review (SRR)	September 2006
System Definition Review (SDR)	September 2007
Non-Advocate Review (NAR)	February 2008
Preliminary Design Review (PDR)	September 2008
Critical Design Review (CDR)	March 2010
Design Certification Review (DCR)	July 2013
Flight Readiness Review (FRR)	**<TBD-005>**

In accordance with CxP 70070-ANX09, Earned Value Management Systems (EVMS) Description, and NPR 7120.5D, which requires the program manager to apply the 7 Principles or 32 Guidelines (depending on the contract's dollar value) found in the American National Standards Institute/Electronic Industries Alliance (ANSI/EIA)-748-A standard, Industry Guidelines for Earned Value Management Systems, the Element Managers will conduct IBRs on contracts with EVM requirements, within 6 months of ATP.

An IBR is a formal review led by the Government Program Manager and technical support staff, conducted jointly with the contractor. The purpose of an IBR is to verify the technical content of the Performance Measurement Baseline (PMB), assess the accuracy of the related resources (budgets) and schedules, and identify potential risks. The IBRs provide a mutual understanding of risks inherent in contractors' performance plans and underlying management control systems. Properly executed IBRs are an essential element of the Project's risk management approach.

3.8.1 System Requirements Review

The SRR activities continued the formal process of assuring that the Project requirements were properly defined, verifiable, and implemented; were traceable; and that the hardware and software were being designed and built to the authorized baseline configuration requirements. An SRR was conducted to ensure the system- and element-level design and interface requirements were defined prior to proceeding into the Ares' design phase. Specifically, the SRR confirmed that the requirements and their allocations contained in the system specifications were sufficient to meet Project objectives. Successful completion of the SRR established the Ares requirements via formal PCB baselining of the applicable requirements documents.

Ares developed a number of documents leading to the SRR. Some of these documents are referenced in this Project Plan; others are also included in the Documents listing (Appendix B). CxP 70006-ANX2.1, the System Requirements Review Process Plan: Crew Launch Vehicle SRR, provided a documentation road map, with clear markers progressing to the first major milestone in the Ares' history. Prior to SRR, the Ares office had:

- Identified all internal and external interfaces within the Ares I system and responsible offices.
- Developed and documented the SRR Plan and schedule.
- Performed a functional decomposition and allocated functions at the stage and interface levels.
- Identified and decomposed all documentation required for SRR.
- Developed templates for all required documents using the Cradle information technology tool.

Successfully conducting the SRR process in September 2006 led to a formal decision to proceed to the design phase, which led to SDR. Entrance and success criteria were identified in NPR 7123.1A, NASA Systems Engineering Processes and Requirements.

3.8.2 System Definition Review

The SDR, in September 2007, demonstrated that the requirements allocation process was complete, and that the vehicle design concept and architecture were in compliance with those requirements. The review also demonstrated that the system and its operation were well enough understood to proceed towards PDR. Entrance and success criteria were identified in NPR 7123.1A.

3.8.3 Preliminary Design Review

A successful PDR in September 2008 produced baselined design specifications, the identification and acquisition of long-lead items, manufacturing plans, and firm life cycle cost estimates, a methodical process that effectively brings the design to 10 percent completion. The PDR provided the basis for determining whether the baseline design is acceptable and if the process leading to CDR may proceed. To support PDR goals, a hazard analysis was submitted that identified potential hazard causes and the design and operational controls that address those causes. Successful completion of the elements' PDRs culminated with the baselining of the Elements' requirements specifications. Entrance and success criteria are identified in NPR 7123.1A.

3.8.4 Critical Design Review

The CDR discloses the complete system design in full detail, ascertains that technical problems and design anomalies have been resolved, and ensures that the design maturity justifies the decision to initiate fabrication and manufacturing, integration, and verification of mission hardware and software. Entrance and success criteria are identified in NPR 7123.1A.

3.8.5 Design Certification Review

The DCR is the control gate that ensures the launch vehicle system can accomplish its mission goals. To support DCR goals, a Hazard Analysis will be submitted that documents the closure actions completed (hazard controls and potential hazard causes and the design and operational controls and related verification actions). This review ensures the requirements have been properly verified, or that actions are in place to verify requirements in a manner to support launch operations. Entrance and success criteria are identified in NPR 7123.1A.

3.8.6 Flight Readiness Review

After the system has been configured for launch, the FRR process examines tests, demonstrations, analyses, and audits that determine the system's readiness for a safe and successful launch and for subsequent flight operations. The Project Manager and Chief Engineer certify that the system is ready for safe flight. Entrance and success criteria are identified in NPR 7123.1A.

3.8.7 Termination Review Criteria

The Ares will be subject to a Termination Review if its schedule projections show that it cannot meet the approved Ares I IOC date or if its cost is projected to exceed the approved run-out (including reserves) by more than 25 percent. The PMC shall make a recommendation to the GPMC as to whether a Termination Review should be conducted. The Headquarters GPMC would make this recommendation to the NASA Administrator.

3.9 LOGISTICS AND OPERATIONS

The current Ares I and Ares V concepts involve extensive use of existing hardware, facilities, GSE and systems, and operations processes. CxP 72032, the Ares I Operational Concept Document, details overall Ares I and supporting system characteristics and concepts for vehicle integration, logistics, and operations. It also provides the basic operational concepts needed for the development of design requirements for the vehicle and supporting infrastructure. The Ares V Operational Concept Document (<**TBD-006**>) will provide similar detail on the Ares V system. The Ares I flight profile is depicted in Figure 1-8, and the Ares V flight profile can be seen in Figure 3-2.

CxP 70064, the Constellation Program Supportability Plan, provides a basis for ILS for all Constellation System projects. APO-1034, the Ares I ILS Plan, uses CxP 70064 for guidance. The ILS Plan gives details about the integration of maintainability, supportability, and reliability considerations into element and component design as early as possible in the life cycle. These tenets will be implemented through the development of supportability requirements that are based on launch availability objectives and the design; the acquisition or development of the required support infrastructure; and the implementation of provisioning support during the operational phases at minimum cost, all with the implementation focused at minimizing both direct and indirect costs.

During the early phases, Logistics Support Analysis (LSA) is performed to influence system design to ensure that logistics supportability requirements are satisfied. As the design matures and the project transitions into operations, the identification of logistics support resources is emphasized. This logistics analysis is captured in CxP 72077, Ares I Logistics Support Analysis Report.

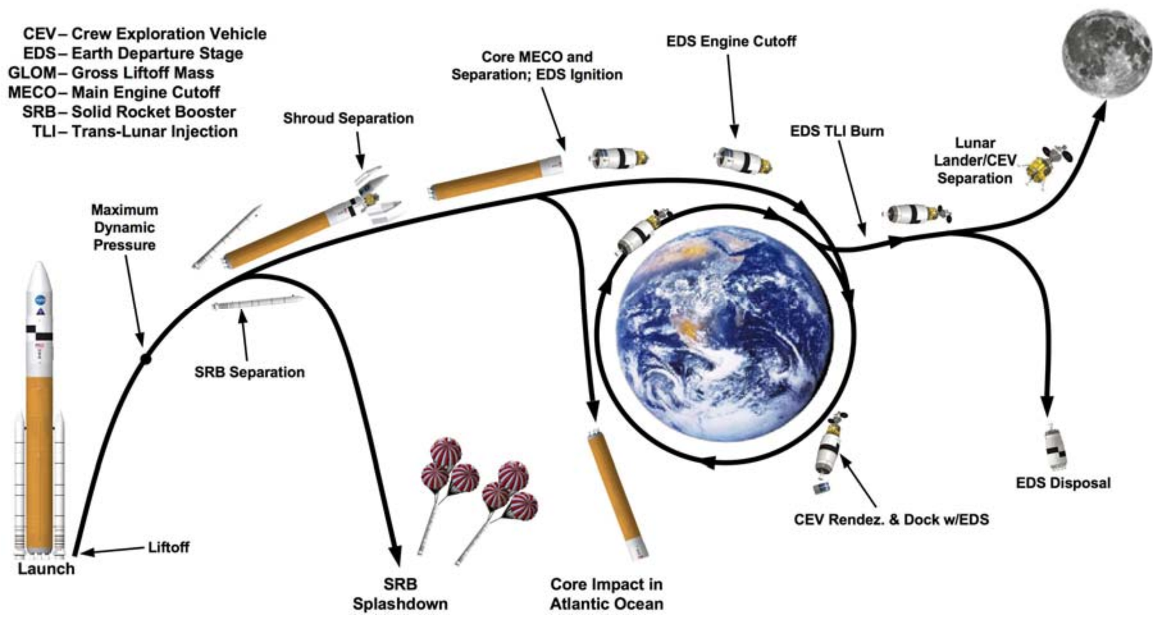


Figure 3-2. Notional Ares V flight profile.

Assembly, test, and checkout activities at the launch site that duplicate those operations to be nominally accomplished at the manufacturing facilities increase cost and impact processing schedules. To aid in minimizing the logistics footprint (a key tenet of the ILS approach), the Project will implement a “ship-and-shoot” approach. This approach is implemented at the Element level, not the vehicle level, since the overall launch systems being developed are too massive and complex to be completed prior to delivery to KSC for launch processing. To this end, the elements will not be delivered to the launch site with open manufacturing facility or factory work required prior to assembly and integration. This excludes activities that are nominally conducted at the launch site. The Project will enforce the philosophy that all elements should be delivered to the launch site ready to begin planned vehicle assembly and integration activities.

CxP 72224, Ares I Ground Operations Data Book, CxP 72071, Ares I Integrated Mission Timeline, and CxP 72243, Ares I Flight Operations Data Handbook, give details of specific processes and procedures for launch vehicle ground processing, operations, and vehicle integration and flight operations activities.

Upon arrival at the appropriate KSC receiving area, each flight hardware element, with its transporter, is delivered to the assigned processing or storage facility where the element is removed from its shipping container and placed on processing stands. Flight hardware elements are prepared for the assembly and integration phase and are connected to the required ground systems for power, control, monitoring, data, and fluids servicing from the assigned control and monitor areas. Throughout the element integration, a portion of the testing and verification is managed locally using ground support equipment; a portion is managed from facility control rooms; and a portion is managed from the Launch Control Center (LCC). After each element is assembled and tested at the appropriate facility, it is transported to the vehicle integration facility for final assembly and checkout and integration with the Orion and/or payload before the integrated launch vehicle moves to the launch pad.

Launch operations begin with initiation of the launch countdown after successful completion of all prelaunch activities. The Launch Control Team manages and executes the countdown with support of the Ares Element offices, prime contractors, S&MA, the Mission Control Center (MCC), and the MSFC Engineering Support Team.

Nominal terminal countdown results in launching the vehicle at L–0, when first stage ignition occurs and the integrated Ares I/Orion (or Ares I/payload or Ares V/payload) lifts off of the launch pad. The Ares I ascent guidance and control systems provide automated trajectory control during first and upper stage powered flight. The MCC and Ares Engineering Support Team monitor Ares I systems and tracking data to assess ascent performance and to maintain awareness of abort mode options. Upon Orion/payload deployment and insertion into LEO, the MCC transitions from ascent flight operations to on-orbit mission operations activities.

3.10 ENVIRONMENTAL MANAGEMENT

3.10.1 Purpose and Scope

In accordance with NPR 7120.5D, CxP 70070-ANX06, the CxP Program Management Plan: Environmental Management Plan, and Marshall Procedural Requirement (MPR) 8500.1F, MSFC Environmental Management Program, and in compliance with NPR 8580.1, Implementing the National Environmental Policy Act (NEPA) and Executive Order 12114, "Environmental effects abroad of major Federal actions," the Ares is responsible for developing a plan for Environmental Management.

The purpose of the Environmental Management Plan is to provide an Ares Project-specific framework for conforming to current NASA policy and applicable Federal, state, and local laws, regulations and Executive Orders regarding environmental compliance. In addition, this plan identifies how Ares will minimize program risk associated with proposed or pending regulation changes relating to Safety, Health, and Environmental (SHE) issues such as material usage and manufacturing processes as well as the potential consequence of such regulatory changes on the supplier base.

NPR 7120.5D identifies specific topics that should be addressed by this plan. This plan is complimentary to MPR 8500.1F, which specifies the procedures and responsibilities for environmental compliance at MSFC.

This plan identifies specific activities the Ares Projects will be required to accomplish to be compliant with NEPA requirements, and approaches to reducing risk associated with environmental laws and related regulatory changes. It also identifies the responsibilities of the Ares Elements in meeting these requirements.

3.10.2 Key Documents

Documents of relevance to environmental management are identified in the Applicable and Reference Document lists in Appendix B of the Ares Projects Plan. Specific documents are called out as required to establish specific sources of environmental guidance.

3.10.3 National Environmental Policy Act (NEPA) Requirements

This section briefly describes the objectives of NEPA and the assessment and documentation requirements necessary to assure compliance.

3.10.3.1 NEPA Process

The basic objectives of the NEPA process are to protect and enhance the quality of the human environment through:

a. Integrating environmental considerations into the planning of agency actions at the earliest practical stage.

b. Ensuring that risks to the environment, as well as technical and economic considerations, are weighed during decision making before actions are taken.

c. Ensuring that the decision maker and the public are aware of the environmental consequences of proposed agency actions and that informed decisions are made.

CxP 70070-ANX06 describes the approach Constellation and its Projects are following to achieve these objectives.

3.10.3.1.1 Programmatic Environmental Impact Statement

A Programmatic Environmental Impact Statement (PEIS) was completed by Constellation with the Record of Decision signed by the AA/ESMD in February 2008. It was accomplished with the support of the Projects and encompasses both the Ares I and Ares V launch vehicles.

3.10.3.1.2 Other Environmental Actions

During the course of development and operations for the Ares Projects, the understanding of facility needs, manufacturing processes, test requirements, and operations will continue to mature. The Ares Projects are responsible for informing the MSFC Environmental Engineering & Occupational Health (EEOH) Office of potential changes to their planning so EEOH may assess the potential environmental consequence. Several options short of conducting another Environmental Impact Statement are available depending on the nature and extent of the changes. The EEOH will follow MPR 8500.1 guidance and maintain an administrative record to document the decision-making process and, based on assessment of the planned actions, accomplish one or more of the following:

- **Environmental Assessment (EA)** – Used to determine whether a Federal action would significantly affect the environment. The finding of the EA determines whether an EIS is required. If the EA indicates that no significant impact is likely, then the Agency can release a finding of no significant impact (FONSI) and carry on with the proposed action. Otherwise, the Agency must then conduct a full-scale EIS if the proposed action remains the same. Environmental Assessments resulting from Constellation Program activity will be tiered from the Constellation PEIS. Any EAs involving significant activities at a single Center will be rendered and signed by the Center Director after review and concurrence by the Program Environmental Manager. The AA/ESMD will be the designated decision maker for any tiered EAs involving significant activities at multiple Centers.

- **Categorical Exclusion (CatEx)** – Actions which do not individually or cumulatively have a significant effect on the human environment based on an assessment using established procedures and for which, therefore, neither an environmental assessment nor an environmental impact statement is required.

Tiering is the process of ordering interrelated environmental reviews for the various stages of Program development and implementation by preparing a broad NEPA analysis (PEIS) for the Program followed by one or more subsequent NEPA analyses (CatEx, EA, and/or EIS) for individual actions included within the scope of the Program. Tiering is allowed only from an EIS. The subsequent NEPA analyses or “tiers” incorporate, by reference, the general discussions from the previous statements and concentrate solely on the issues specific to the statement subsequently prepared. Each subsequent tiered EIS or EA should follow the guidance in CxP 70070-ANX06. The Constellation Program Environmental Manager shall be notified of any potentially tiered EAs or EISs as soon as possible.

Segmentation must be avoided and Projects will not produce any NEPA documentation independent of the Program EIS without justification under NEPA and approval from the Constellation Program Environmental Manager.

3.10.3.1.3 Administrative Record

The administrative record documents the decision-making process and forms the basis for defense against any challenges that may arise regarding the NEPA process and Agency compliance. The Constellation Program will maintain the Constellation PEIS administrative record in support of each NEPA decision point. The Constellation Program Environmental Manager is the individual responsible for this administrative record. The Ares Projects will maintain Project-related administrative records and will designate an individual responsible for their maintenance. All Ares Projects administrative record materials will be stored and catalogued in Windchill so that the Constellation Program can make an informed decision as to which materials need to become part of the Constellation PEIS administrative record.

3.10.3.2 Environmental Actions by non-NASA Federal Agencies

The Ares Projects Office will ensure that the Constellation Program is informed of any Project activities which necessitate another Federal Agency to initiate NEPA documents. Any NEPA documentation initiated on behalf of the Ares Projects and Constellation Program by another Federal Agency will be coordinated with the Constellation Level II and HQ/ESMD prior to the public review process. The Ares Projects Office will ensure that NASA is recognized as a Cooperating Agency in such NEPA documents.

3.10.3.3 Historic Preservation

Before existing facilities can be modified for use by Ares, NASA must first determine if they are historically important. All proposed project actions involving modification, demolition, or disposal of properties listed or determined eligible for listing on the National Register of Historic Places (NRHP) will be submitted for review and comment to the State Historic Preservation Officer (SHPO) according to National Historic Preservation Act (NHPA) consultation procedures. The Advisory Council on Historic Preservation may participate when there are substantial impacts to important historic properties or when a proposal presents policy or procedural questions. Each consultation may result in a MOA between NASA and the SHPO that outlines measures NASA will take to avoid, minimize, or mitigate the adverse effects on those properties. The Project will have budgetary responsibility for implementing historic preservation measures identified in the MOAs.

As part of the Shuttle transition and retirement process, real property assets used by the Space Shuttle Program are being evaluated for historic significance. The evaluation will identify those NASA-controlled facilities of local, state, and/or national significance in the historic context of the U.S. Space Shuttle Program, circa 1969 to 2010. Such facilities may include, but are not necessarily limited to, those used for research, development, design, testing, fabrication, and operations. If an evaluation recommends that the property meets the criteria for historical significance under the NHPA, MSFC will submit the evaluation to the appropriate SHPO for comment and concurrence. The Ares Projects will participate in the Space Shuttle Program historic preservation survey and identify those facilities that will be needed including facilities at MAF.

The MSFC EEOH Office and Facilities Management Office worked together to produce the "Cultural Resources Management Plan for Marshall Space Flight Center 2007–2011," which serves as a guide for assuring compliance with NHPA.

3.10.4 Environmental Assurance and Regulatory Changes

Experience on past programs, and in particular the Space Shuttle, has illustrated that changes to environmental laws and regulations as well as related safety and health standards impact material choices and processes and have clearly affected technical performance. Constellation is expected to implement a risk mitigation program against this dynamic external program constraint similar to what the Space Shuttle did in NSTS 37345, the Shuttle Environmental Assurance (SEA) Initiative.

Over the life of Constellation, domestic and international environmental, safety, and health related policies, laws, and regulations as well as Agency policies and requirements under which the Constellation Program systems were originally designed are very likely to change. These future changes can lead to numerous program constraints including imposing restrictions on materials used in hardware fabrication, controls on processes for manufacturing or material application, and limitations on facility activities and operations. These regulatory changes will impact the supplier base as well as their willingness to provide materials due to economic factors and potential litigation concerns and consequently may create obsolescence problems. Collectively, these issues may adversely affect Constellation and Ares cost, schedule, and mission risks, and pose supportability challenges unless a proactive effort is made to plan for approaching changes, and through regulatory monitoring anticipate potential changes.

3.10.4.1 Constellation Program Environmental Assurance Plan

The Constellation Program has identified a need for, and is carrying a risk to develop, an integrated approach for communication and assessment of regulatory-driven risks; program-wide collaboration on risk management and mitigation; and conservation of program resources by minimizing duplication of effort and using existing Agency-wide initiatives. This process will not specifically address mission safety issues, but can enhance mission safety through risk reduction strategies.

When funding is secured for the Constellation Environmental Assurance (CEA) Initiative, a Constellation environmental assurance plan will be developed and an organizational structure established with the roles and responsibilities of the projects identified. Ares Element representation is expected to be required and regular meetings to communicate risks and identify and share data will probably be held.

3.10.4.2 Regulatory Risk – Principal Center for Regulatory Risk Analysis and Communication (RRAC)

Marshall Space Flight Center has been tasked by NASA Headquarters to operate as the Principal Center for NASA's review of emerging environmental regulations, analysis of the regulations for potential impact, and communication of the potential impacts to the NASA community. The lead for this activity is MSFC's EEOH Office and they periodically provide data to the Ares Projects via regulatory update meetings. In addition, RRAC provides a biweekly regulatory summary to Ares, MSFC Engineering Directorate, and the space systems community at large describing Federal and state regulatory change actions as well as other significant relevant developments and news.

3.10.5 Project and Element Responsibilities

3.10.5.1 General

The MSFC EEOH Office will work with the Ares Vehicle Integration Office and will serve as the Ares Projects Office POC for coordination of the Ares I and Ares V environmental analysis inputs to the Constellation Program Level II PEIS or future Level II NEPA documentation.

3.10.5.1.1 Ares Projects Office

The Ares Projects Office has delegated to the Vehicle Integration Office responsibility for sustaining environmental related activities identified in this plan.

3.10.5.1.2 MSFC EEOH

The MSFC EEOH in coordination with the Vehicle Integration Office and the Constellation Program Environmental Manager will continue to prepare appropriate documentation tiered from the Constellation PEIS as required for Ares Projects activities. The processes specified in MPR 8500.1F will be followed. When preparation of such documentation requires public comment and input, these efforts will be coordinated with Education and Public Outreach activities.

The MSFC EEOH Office supported by the Vehicle Integration Office will provide status information on Project-driven NEPA activities to the Constellation Program on a regular basis.

The MSFC EEOH Office and the Vehicle Integration Office will ensure that the Ares Projects Office and Constellation Program are informed of any Project or Element activities that may necessitate another Federal Agency initiating NEPA documents.

The MSFC EEOH Office will also interface with the design team through regular face-to-face meetings to ensure that environmental requirements are considered early on and to ensure applicable environmental permits and approvals are obtained to support the mission schedules.

The MSFC EEOH Office will provide quarterly updates to the Ares Projects Office and Elements on Principal Center for RRAC activities and areas of potential Project impacts.

The MSFC EEOH office will support Level II Constellation environmental assurance activities as required to reduce risk from materials, process, and obsolescence issues.

3.10.5.1.3 Ares Projects Elements

Each Ares Projects Element will identify a lead for interfacing with the Vehicle Integration Office and EEOH as single interface for Element facility use plans, material usage and manufacturing processes, and testing and operations plans. Through this lead the Elements will:

a. Provide and maintain a current list of NASA facilities the Element plans to use during development and operations including the intended use, period of use, any modifications that may be needed, and the source of funding for any modifications or construction.

b. Support bi-monthly status meetings with EEOH to review facility plans, material and process plans, and test and operations plans to ensure sustained environmental compliance. These meetings are critical to ensuring the proper NEPA compliance review is completed in a timely manner and proper permits and approvals are in place for any planned operations.

c. Identify to the Vehicle Integration Office and MSFC EEOH any Element activities at non-NASA Federal Agency facilities or ranges that may require that Agency to initiate NEPA documentation.

d. Support quarterly updates to the Ares Projects Office on Principal Center for RRAC activities and areas of potential impacts.

e. Support Level II Constellation environmental assurance activities as required to reduce risk from materials, process, and obsolescence issues.

3.11 INFORMATION AND CONFIGURATION MANAGEMENT PLAN

The Change Control Management System provides a process to review, approve, implement, and track changes to baselined Project items, both configuration items (CIs) and non-configuration items. This process, shown in Figure 3-3, results in the definition of the respective control boards' baselines.

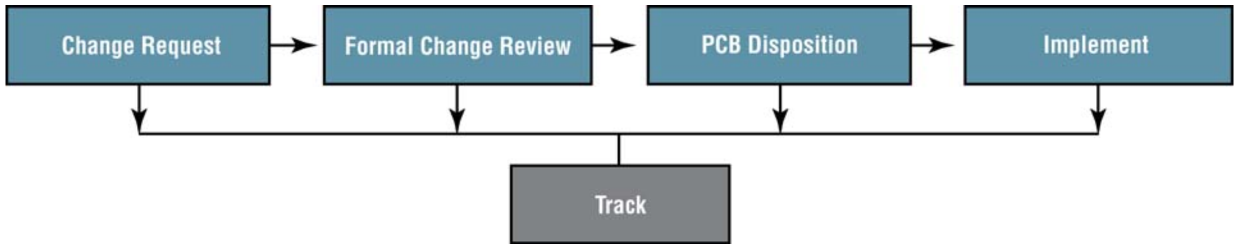


Figure 3-3. Ares change control process.

Change control is applied by a hierarchy of Program/Project/Element Control Boards (CBs), as shown in Figure 3-4. The VICB and ERBs are integrally involved in the process. The VICB may be delegated change control authority of selected Ares PCB baseline requirements. The VICB and the CERB are responsible for the evaluation and technical disposition recommendation and identification of technical impacts of system-level (multi-element) change proposals, requests, deviations, and waivers. The CERB serves as the independent engineering forum. The Element ERBs are responsible for the evaluation and technical disposition recommendation and identification of technical impacts of their respective element change proposals, requests, deviations, and waivers.

The Constellation CB (CxCB) allocates: (a) specific functional and physical requirements to the Ares PCB, and (b) specific element functional and physical requirements to the Ares Elements' CBs.

Each CB must assure that it only dispositions changes to its baseline. Changes determined to be beyond the scope of its baseline must be forwarded to the appropriate higher level CB, with a recommended disposition and associated technical and programmatic impact definition.

The Ares PCB is chaired by the Ares Project Manager, and its membership includes the Project Chief Engineer, Element Managers, PP&C Office Manager, Project Integration Office Manager, VI Manager, and senior representatives from S&MA, the MSFC Engineering Directorate, Astronaut Office, Mission Operations Project, and Ground Operations Project. *Ex officio* members include representatives from Advanced Planning and Procurement, as well as a senior advisor and the Space Shuttle Deputy Manager for Propulsion. Other members may be added as determined to be appropriate by the PCB Chair. Each Element CB is chaired by its respective Element Manager, and its membership includes the Business Office Manager, the Element Chief Engineer, the Element SE&I representative, and S&MA and Procurement representatives. Other members may be added as determined appropriate by the Element CB Chair.

The CBs' functions are to control configuration, and to baseline and control changes to other cost and schedule baselines. Documentation that identifies hardware and/or software performance, design, and verification is defined as configuration documentation and is controlled in accordance with CxP 72015, the Configuration Management (CM) Plan for Ares Projects, and CxP 72017, the Data Management (DM) Plan for Ares Projects. Other documents are defined as non-configuration documentation and are also controlled in accordance with the Ares DM Plan. The configuration baseline documentation and all authorized changes will be recorded in the Ares I configuration accounting database. Each Element shall define its respective baseline. The data deliverables are defined in the applicable contractual DRD, in-house Task Agreements, and CxP 72293, the Ares I Level III Data Requirement List (DRL).

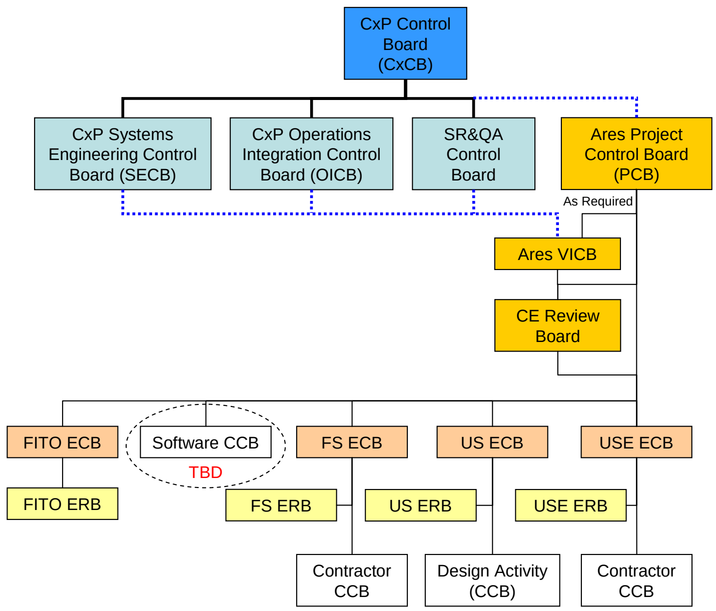
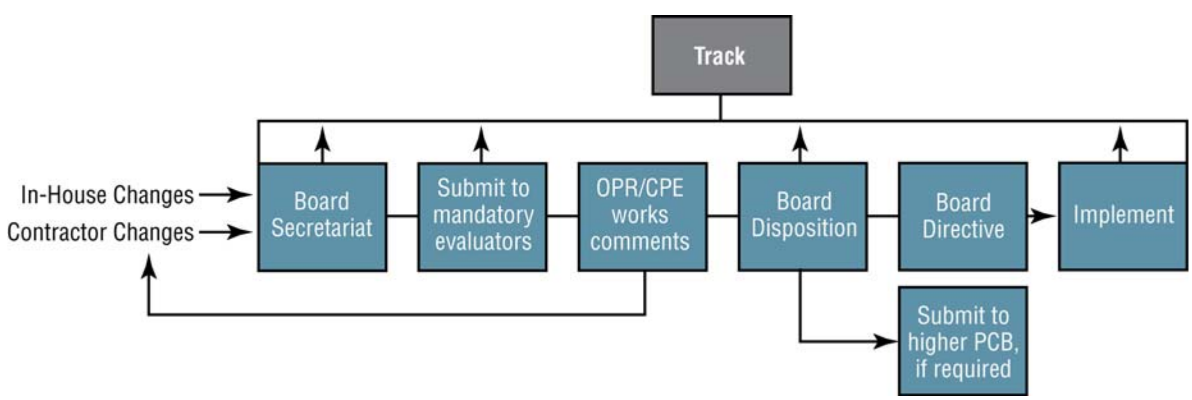


Figure 3-4. Ares controls and compliance.

Change control for Ares CIs and Computer Software Configuration Items (CSCIs) will be established for each Ares contractor using the contract Changes Clause(s). Engineering Change Proposals are used to approve and implement contractor technical requirements changes.

Key processes to be used in Ares Change Control Management include CM, DM, and the CB structure and hierarchy. Figure 3-5 provides a process summary for the Project-level CB.



CPE – Change Package Engineer; OPR – Office of Primary Responsibility

Figure 3-5. PCB process summary.

The inputs for this system are the change packages and documents that require CB disposition and control. The resulting PCB products are the Board disposition, directives, CB minutes, and the current and correct configuration accounting database.

The Windchill tool and process will be used to generate and process baseline changes, deviations, and waivers from receipt through evaluation, control board disposition, and issuance and implementation of control board direction, and will define the approved baseline for each control board.

3.12 SECURITY

The Ares shall comply with the latest version of NPR 1600.1, NASA Security Program Procedural Requirements. Security compliance shall require the Project to establish and maintain a security program to protect people, property, and information, implementing procedures that adhere to security standards and specifications, and will be applied Project-wide, including all Project personnel and facilities. This section provides further information for specific Ares Projects processes required for the security compliance.

3.12.1 Information Technology Management and Security

The Ares Projects Office manages the established IT infrastructure to:

- Support and improve efficient Project communications and collaboration.
- Enable informed integrated Project decisions.
- Minimize redundancy, manual reentry, and long-term operating costs.

Ares embraces IT as essential to achieving its mission and goals. In the spirit directed by the President's Management Agenda—to expand electronic Government—IT and the IT infrastructure, IM, and Management Information Systems (MIS) permeate all aspects of the Project's operations and enable informed, integrated decisions.

Ares' active approach to IT involves tactical and strategic planning and establishing a strategic IT infrastructure to provide a framework for future use. This minimizes redundancy, manual reentry, and long-term operating costs, and transcends Ares organizational boundaries to include NASA HQ, Centers, MSFC IT and business processes and systems (i.e., IEMP), strategic initiatives, and operational plans (i.e., Entrust Public Key Infrastructure (PKI)).

Ares information includes a variety of secure data types, such as Proprietary, Financial, and Export Control, which are all identified as NASA SBU. Ares adheres to all requirements and processes as defined in NPR 2810.1, Security of Information Technology, CxP 70170, Constellation Program Information Technology (IT) Functional Security Requirements, and the NASA Information Technology Requirements (NITR). This includes planning for and oversight of appropriate IT security in protecting Project information under contracts. Ares adheres to all requirements and processes as defined in Marshall Policy Directive (MPD) 2190.1, MSFC Export Control Program. This includes planning for and submitting information by the required timeframes to obtain export review, approval, and protection. The Ares Export Control Plan (Section 3.13) defines the Project's unique export control processes and procedures. All Project documentation is clearly marked according to its availability limitations as described in Marshall Work Instruction (MWI) 7120.4E, Documentation Preparation, Programs/Projects. No products or information are exported without obtaining prior written export approval. The Information Management System representatives work closely with the Ares Computer Security Officer to help ensure adherence to IT security and export control requirements. See Section 3.13 for more information.

Information technology tools for business applications, shown in Table 3-4, are coordinated with the ESMD CIO, the MSFC CFO, and the MSFC Office of the CIO as service providers.

Table 3-4. Ares business information tools.

Tool	Purpose	Service Provider	Certified for SBU data?
ICE/Primavera	EVM	ESMD	<**TBR-001**>
ICE/Primavera IMP/IMS	Integrated master planning (IMP) and integrated master scheduling (IMS)	ESMD	<**TBR-002**>
ICE/wInsight	EVM	CFO	<**TBR-003**>
Entrust PKI	Encrypting sensitive information and digital signatures	NASA	Yes
ICE/Windchill	Collaborative environment for cross-functional program/project management, review and approval processes, configuration management, etc.	ESMD	Yes
ICE/ConCERT	Review item discrepancy (RID) database	ESMD	No
ICE/Confluence	Wiki tool	ESMD	No
ICE/Cradle	Requirements management database, IMS	ESMD	Yes
ICE/CxIRMA	Risk management	CxP	<**TBR-004**>
ICE/Pro/Engineer	Mechanical computer-aided design (MCAD) data manager	ESMD	<**TBR-005**>
ICE/ECAD Tool	Electrical computer-aided design (ECAD) data manager	ESMD	<**TBR-006**>
ICE/Integration Broker	Integration of applications	ESMD	<**TBR-007**>
Webex	Virtual meeting/online application collaboration	ODIN[1]	No
ED03 RID Tool	Used for RID review and disposition during PDR	ED03	No

[1] ODIN – Outsourcing Desktop Initiative for NASA

The Integrated Collaborative Environment (ICE) application comprises the primary set of IT tools used for the Ares. The ESMD CIO's Manager of Operations approves every request for an ICE account, including verification of citizenship. All ICE applications are set up and run in an environment that is compliant with the ESMD ICE Security Plan (<**TBD-007**>). The ICE system is a collection of "single sign-on" applications, i.e., one username and password combination will afford access to all ICE applications. The ICE applications, though developed by many different vendors, include an "integration broker," which will minimize (and in some cases eliminate) the need to transfer data manually among applications.

The ESMD CIO's Manager of Operations provides a support team that administers an ICE Help Desk. This team also maintains username and password support and conducts all formal training for ICE application users. The Ares Integration Manager has a staff that will provide day-to-day assistance to Ares ICE users. This includes setting up and maintaining document folder structure and maintaining the proper data access for Ares ICE users, as well as maintaining security in accordance with the ICE IT Security Plan (<**TBD-008**>).

3.12.2 Project Protection

In accordance with NPR 1600.1, NASA Security Program Procedural Requirements, the project shall conduct an Information and Technology Classification and/or Sensitivity Level Determination to identify sensitive information and technologies associated with the Project. Upon identification of sensitive information or technologies, the Project team, to include external partners and other relationships, will work closely to ensure the overall protection of NASA Critical Program Information and/or Mission Essential Infrastructure (MEI) designated assets, where appropriate. External partners shall be key participants in the overall Program Protection Planning process as is appropriate for their mission and scope of effort. The Project shall address the following processes as a minimum:

1. Identify Critical Program Information based on criteria defined by NASA.
2. Conduct a security vulnerability analysis of the system elements.
3. Develop security countermeasures.
4. Implement carefully selected security countermeasures to reach an acceptable level of risk.
5. Develop a Project Protection Plan (PPP) that outlines program protection strategies, policies, and procedures and distribute for implementation throughout the project.

3.12.2.1 Physical Security

CxP <**TBD-009**>, The Ares Project Protection Plan (PPP), defines the Project security strategies, requirements, processes and responsibilities when conducting all Project activities. The Project and Project personnel—who may include civil servants, contractors, and university partners—regardless of location, shall comply with MPR 1600.1D, MSFC Security Procedural Requirements, as well as any current security direction from MSFC and NASA Headquarters. Project facilities or assets that are formally categorized as MEI, i.e., mission essential facilities, hardware, or equipment, shall meet the minimum requirements for protecting NASA MEI assets in accordance with MPR 1600.1.

3.12.2.2 Security Personnel

Ares Security personnel provide security advice and assistance to the Project Manager and to project personnel. Project security personnel will serve as the focal point for all programmatic security matters and will be responsible for the coordination of day-to-day security issues.

3.12.2.3 Access Control and Information Protection

The Project shall be diligent in protecting sensitive information and equipment through such means as using electronic key card access/locks to restrict access to project areas, locking sensitive information into cabinets or desks when unattended, ensuring the use of password protection and security controls on portable electronic devices, locking laptops into a docking station, locking Universal Serial Bus (USB) drives, external hard drives, personal digital assistants (PDAs), desktops, or laptops into a secure cabinet or desk, and using discretion when discussing project information. Personnel shall also safeguard data and electronic media while on travel.

Access to restricted areas will be approved through Ares Security personnel in coordination with the Project Manager or designee. Internal rooms that are protected by locks and keys will comply with MPR 1600.1, Chapter 9. To obtain keys for desks and cabinets, personnel should contact their Ares administrative officer.

To protect against unauthorized access to Project computers and information, password-protected screensavers must be used for desktop or laptop computers, which activate after a maximum of 10 minutes of inactivity.

Proper identification badges will be prominently displayed while working in Project areas. Badges will not be displayed outside of Project areas when off property and shall be protected from loss or damage. Project personnel have the responsibility to challenge any person who is not wearing an approved identification badge to determine their identity and need to be in the area. Immediately report lost NASA identification to NASA Protective Services.

3.12.2.4 Visit Procedures

Visitors to all Ares areas will be sponsored by Project personnel and registered upon their arrival at Project areas. Project visitors to MSFC shall be registered through the Visitor Management System (VMS) posted under the Protective Services link on Inside Marshall (http://co.msfc.nasa.gov/ad50/visitor_manage.html) prior to the visit. Visits to MSFC will be conducted in accordance with MSFC visitor control procedures outlined in MPR 1600.1, Chapter 4, with the assistance of Ares Security personnel. Foreign National (FN) visitors require special processing and must be approved through the MSFC International Visit Coordinator (IVC) a minimum of 30 days prior to the visit, in accordance with MPR 1371.1D, Procedural Requirements for Processing Foreign Visitor Requests. The NASA Foreign National Management System (NFNMS), which can be accessed through the Protective Services home page, will be used to complete requests (https://ivan.esportals.com/login.cfm). Approved foreign visitors will be escorted while present on the MSFC in accordance with the Foreign Visitor Escort Program. Project personnel must plan well in advance for any FN visit.

3.12.2.5 Security Education

The Ares Security personnel develop and conduct appropriate security training for the Project personnel, describing the security risks and responsibilities involved with protecting Project information and associated sensitive work areas. Project personnel with access to sensitive or classified Project information receive an initial security briefing and annual security refresher training. Attendance is monitored to ensure all personnel shall receive the training.

3.13 EXPORT CONTROL PLAN

This section describes the approach and procedures to be used by the Ares Projects in conducting their export control activities. This plan complies with the requirements provided in MPD 2190.1C, MSFC Export Control Program.

3.13.1 Introduction

3.13.1.1 Purpose

The purpose of this Export Control Plan is to define the policies and procedures to be implemented by the Project to comply with International Traffic in Arms Regulations (ITAR), the Export Administration Regulations (EAR), and other export requirements by providing effective control of both data and hardware exports by Project personnel. This Plan meets the requirements of MPD 2190.1 and NPR 7120.5D, NASA Space Flight Program and Project Management Requirements.

3.13.1.2 Applicability

This Export Control Plan applies to all in-house activities and products produced or received and funded through the Ares Projects. The products are considered to be required to accomplish Project objectives, which may involve the transmittal of hardware, software, or technical information to destinations outside the United States, or to “Foreign Persons” within the United States. Hardware and software shipments, foreign visitor/workers control, and technical publications, as well as exports via U.S. Postal Service, fax, e-mail, hand carry, personal contacts, etc., will follow the requirements of the applicable MSFC requirements and procedures (see MWI 6000.1F, Procurement Traffic Management and Freight Traffic Actions; MPR 1371.1, Procedures and Guidelines for Processing Foreign Visitor Requests; and MPR 2220.1Q, Scientific and Technical Publications).

3.13.2 Definitions

Data: Spoken, written, or otherwise recorded information.

Center Export Administrator (CEA): The individual appointed by the MSFC Center Director who shall:

- Serve as the Center resident authority on all matters related to export control and international technology transfer, and the principal Center point of contact with the Headquarters Export Administrator (HEA).
- Maintain a reference library of relevant policies, regulations, international agreements, etc.

Center Export Representative (CER): The individual appointed by each of the Center's major organizations to serve as the primary point of contact, and to assist, monitor, and ensure the appropriate implementation of NASA and/or MSFC policies and procedures for export control.

Export: The shipment, transfer, or transmission of anything (i.e., hardware, software, technology or technical data, intellectual property, or technical assistance) to a "Foreign Country," "Foreign Person," "Foreign Entity," or "Foreign Destination" by any means, anywhere, anytime, or the knowledge that what you are transferring is to a "U.S. Person" representing a "Foreign Person." An export also occurs when information is placed on a publicly accessible Web site.

Exporter: The person responsible for the transfer of an export item.

Foreign Person: In relation to export control, a "Foreign Person" is any person who is not a U.S. citizen, permanent resident alien, or "Protected Individual" of the United States.

Transfer: Any method of conveying information, software, or hardware related to the Ares.

3.13.3 Export Control Approach

Export of Project technical data and hardware may be required with foreign entities and its associated countries in order to meet the objectives of the Ares. Such exports are subject to U.S. export control laws (ITAR and EAR). These laws, however, recognize that some exports do not require a license because they are not subject to the Department of Defense United States Munitions List (USML), the Missile Technology Control Regime (MTCR), or the Department of Commerce Control List (CCL), because they are in the public domain, or because of either specific exceptions to the CCL or specific exemptions to the USML. For this purpose, the classification No License Required (NLR) has been established within the export control regulations. Since most of the anticipated Ares exports will involve only planning, interface definition, payload integration, safety, and general engineering topics, such exports could fall under the classification NLR, simplifying Project procedures.

Under special, currently unforeseen, circumstances, information on topics that could conceivably be related to the applicable USML, MTCR, or CCL items (i.e., Spacecraft Systems and Missile Technology) may need to be exported. Should such an occasion arise, the exporter will review the proposed export with their organizational CER and the Project Manager, if necessary, to determine whether a recommendation for an export license needs to be submitted to the CEA.

3.13.3.1 Roles and Responsibilities.

The Ares Manager shall:

- Develop and maintain the Ares Export Control Plan.
- Coordinate with the Ares CER and the CEA in all issues involving Ares export control.
- Assure that all Project personnel and CERs are familiar with and properly implement the requirements of this plan, and arrange training where necessary.

The Ares Element Managers shall appoint a primary and alternate CER from their organization and notify the Ares CER and the CEA of the appointee. The Element CER appointees must complete MSFC export control training.

The Ares CERs shall:

- Complete annual export control training before serving, as required in NPR 2190.1, NASA Export Control Program.
- Provide guidance to and coordinate with the CEA office regarding interpretation of the overall export control policies and guidelines to the Ares.
- Provide guidance to and coordinate with the CEA to support the Project technical personnel on export sensitivity issues or questions.
- Periodically review this Export Control Plan and submit a Change Request to the Ares Projects Plan to alter those procedures based on changes in the export control regulations.
- Assist in the preparation and submittal of NASA Form 4312, Export Clearance Information Sheet (ECIS), and coordinate with the CEA the appropriate export classification as required for material to be exported.
- Coordinate with the CEA on issues requiring a determination of export license(s) on a proposed export action.
- Assist in the preparation and submittal of MSFC Form 1676, NASA Scientific and Technical Document Availability Authorization. Review, approve, and coordinate with the CEA the appropriate export classification as required for the documentation to be exported.
- Maintain a log and a copy (PDF is acceptable for the electronic file) of all CER-approved documents, containing the author name(s), publication title, event/publication presented/published, and the marking applied (data is sensitive or publicly available), in the Windchill folder(s) established by the Ares.

- Maintain personal records of all data products approved, along with a copy of the approval form, in a locked cabinet or desk, or stored on a password-protected electronic device.

- Maintain an electronic record of concurrence for a Foreign National or Foreign Representative (FR) visit following review by the MSFC IVC and acceptance into the NFNMS, detailed further below.

The Ares Data Manager shall:

- Assure that the Ares data management plan provides guidance for data management activities to be implemented in accordance with the requirements of the Export Control Plan.

- Ensure that data management processes include adequate references to this Export Control Plan's requirements for marking and review by the appropriate official (e.g., organization CER for export-controlled data) so that any sensitive, proprietary, or export-controlled data is appropriately identified and marked.

The Ares Projects Web Page Designers shall design the Ares Web pages to comply with all NASA/MSFC export control requirements and NPR 2810.1, Security of Information Technology.

The Ares Contracting Officer shall ensure that export regulation compliance is addressed in Ares contracts and that contractor personnel who are exporting products funded by the Ares shall also comply with MPD 2190.1 and NPR 7120.5D.

All Ares Exporters shall:

- Become familiar with the requirements of the Ares Export Control Plan and maintain continuous cognizance of and sensitivity to export control.

- Participate in the training given by the MSFC Export Control Program Office.

- Provide the initial screening for the determination of requirement for export and the exportability with respect to Project export guidelines.

- Implement Ares export actions in strict accordance with Project export control requirements.

- Work with their respective CERs, initiating the necessary forms and applications where required, and obtain an export classification for the material intended for export, which may include completing the MSFC ECIS (MSFC Form 4312). Note: Plan for a 6-week approval process. The length of the approval time is based on the nature and complexity of the project or item being exported.

- Refer unclear or questionable issues within the required export activity to the organizational CER, the Chief Engineer, or the Ares Manager for resolution.
- Understand the issues involved with export control that include: lead times for submitting abstracts, papers, presentations, reports, or any other external technical product, and understand that the submittal of materials for review may require 1 month or longer prior to their deadline, depending on the complexity of the product or item being exported.
- Secure approval for all exports from the Ares Projects Office prior to release.

3.13.3.2 Export Control Guidelines

Constant awareness shall be exercised by all Project personnel to prevent inadvertent transmittal of sensitive information.

3.13.3.3 Export Control Procedures

Export-related activities that the Ares personnel will encounter most frequently are described in more detail below.

3.13.3.3.1 Science and Technical Information (NASA Form 1676)

The MSFC policy relating to Scientific and Technical Information (STI) requires export control review and approval for release of the information as defined in MPR 2220.1Q, Scientific and Technical Publications. This information includes, but is not limited to, abstracts, papers, presentations, and journal articles. The process flow and steps to complete NASA Form (NF) 1676 are in accordance with MPR 2220.1, paragraph 5, and a logic flow diagram is located in Figure 3-6.

Figure 3-6. Export control logic flow diagram.

- Download NF 1676 from the NASA electronic forms Web site http://server-mpo.arc.nasa.gov/Services/NEFS/User/ForSea.taf?function=search&_UserReference=38C62A8205ABE6ED48E0F609&sort=type.

- **Block 1:** The product author must initiate the latest version of NF 1676 and complete the information requested in block 1a. In block 1b, the author indicates the type of STI and the conference name, location, and date, if applicable.

- **Block 2:** The author marks the national security classification. If the STI is classified, it must be submitted to the Center Security Officer for approval.

- **Block 3:** The author marks the availability of the information—publicly available or not—in box 3a. If the product is not to be made publicly available, block 3b, c, and/or d will be designated with assistance from the CER.

- **Block 6:** The author signs block 6 prior to submission for review and approval. Submit the completed NF 1676, along with the product, to the author's supervisor for review before requesting the next level signature. The author makes edits as required by the supervisor.

- **Block 7:** The author obtains signature required by the COTR, mid-level supervisor, Element Manager, or technical monitor (for contractor products), noting their concurrence with the product and the availability category (block 3).

- **Block 8:** The author submits the product (abstract, paper, presentation, technical publication, etc.) to the CER in the appropriate technical area, along with the NF 1676 that has been completed and signed through block 7. A list of CERs may be found under the "MSFC Services" button on the Inside MSFC Web site, located in the blue bar near the top of the page, http://co.msfc.nasa.gov/export_control/index.html.

- The CER shall perform the review and reach agreement with the author between the content of the product and the STI designation. The author may be required to clarify or rework the product to reach resolution. Duplicate signatures are not permitted on NF 1676. For example, Project Managers or the COTRs cannot sign in block 7 and as the CER in block 8.

- **Block 9:** The author submits the product and NF 1676 to the Ares approving official (JP01) or their approved designee for review and signature. Currently, electronic signatures have not been approved at MSFC. Therefore, only handwritten signatures will be accepted. Names should also be printed in the signature block for clarity.

- **Block 10:** Once the Ares Projects Office signature is obtained, the author submits the STI product and NF 1676 to the MSFC Document Availability Authorization Representative (DAAR) in the Chief Information Office for Center approval. (The DAAR contact information may be found under the export control link.) The author should request that the DAAR return the original STI and NF 1676 to the author after the process is complete. The DAAR will send an electronic copy of the STI and NF 1676 to the NASA Center for AeroSpace Information (CASI) to be included in the NASA STI database (http://www.sti.nasa.gov).

Additional information regarding the NF 1676 process may be found on page 4 of NF 1676, as well as in Section 5 of MPR 2220.1.

Note: When the product is SBU, it must be encrypted before transmitting by e-mail. All SBU shall be protected with a yellow NASA SBU cover form (NF 1686), with the SBU designation assigned (ITAR, EAR, Proprietary, NASA Sensitive, etc.) indicated on the form. All SBU materials shall be handled in accordance with NPR 1600.1, NASA Security Program Procedural Requirements, and under controlled access at all times. The SBU covers may be obtained through a Project CER or, if numerous copies are required, ordered through the MSFC Printing and Reproduction Services group. For more specific details, refer to the SBU paragraph covered in this section.

3.13.3.3.2 Foreign Proceedings

The Ares activities will include foreign audiences and conferences. Presentations on these occasions may be cleared using NF 1676. However, transferring any additional materials for publication in foreign proceedings or transferring additional copies of materials also requires approval using the latest version of MSFC Form 4312 (https://repository.msfc.nasa.gov/forms/forms.html). Further assistance may be obtained through the CEA located in the Center Export Control Office in the MSFC Protective Services Department, if necessary. The CEA may be located through the Inside MSFC Web site, under Protective Services.

3.13.3.3.3 Foreign Visitors

The Ares activities may occasionally involve visits from a Foreign National (FN) or a Foreign Representative (FR) (representing foreign interests). The Ares point of contact or sponsor requesting the visit shall be responsible for determining the need for the visit, obtaining the personal history information from the FN or FR, and ensuring that the Foreign Visit request is completed. Allow at least 1 week to obtain the required information to complete the visit request. Incomplete information will prevent the request from being submitted (see below). In accordance with MPR 1371.1, requests must be submitted 20 working days prior to a visit of less than 30 days. For visits greater than 30 days, requests must be submitted 2 months prior to assignment.

The CER shall determine if the visitor is on the denied persons list (http://www.bis.doc.gov/dpl/default.shtm) in accordance with the latest version of NPR 1371.2A, NASA Procedural Requirements for Processing Requests for Access to NASA Installations or Facilities by Foreign Nationals or U.S. Citizens Who Are Representatives of Foreign Entities, Appendix A, or through the Export Control Web page, the “Related Links” button. If the person is not on the list, the CER will evaluate if the visit is relevant to NASA’s mission and of benefit to NASA. Additionally, the CER will evaluate if the visit involves transferring technology and what restrictions should be levied on the visit.

The NFNMS electronic system to complete Foreign Visitor requests resides at: https://ivan.esportals.com/login.cfm, which can be accessed through the Protective Services Office home page by clicking on the Foreign National link. A NFNMS "Request for Visit User Guide" is available through the Protective Services Web site (https://srs.msfc.nasa.gov/catalog/iwcs/docs/RFVGuide2.doc). This guide steps the Sponsor through the Foreign Visitor Web site process, which includes the Sponsor validating their credentials each time a new visit is requested. The Ares shall have certified Foreign National Escorts, in compliance with MPR 1371.1, to ensure that Foreign Visitors comply with the restrictions for their visit.

3.13.3.3.4 Sensitive But Unclassified Information

All Ares personnel shall comply with NPR 1600.1, NASA Security Program Procedural Requirements, for handling official information and material. In particular, SBU controlled information is discussed in paragraph 5.24 of NPR 1600.1. Information in any format may be labeled SBU (digital, hard-copy, magnetic tape, etc.), with common examples of SBU information being export controlled under the ITAR or the EAR, proprietary information, source selection and proposal information, Small Business Innovative Research (SBIR) data, privacy act information, national space policy not yet publicly released, and drawings and specifications of specific mission essential infrastructure. Refer to NPR 1600.1 for more information.

The document originators or the Ares representatives are responsible for properly marking the Project information, as well as for removing the markings whenever the necessity no longer exists. NASA Checklist Form 1733 (http://server-mpo.arc.nasa.gov/Services/NEFS/Home.html) may be completed to determine possible SBU designation. Information protected by statute or regulation, and marked as such, need not be additionally marked SBU. Assistance in determining appropriate document marking may be obtained through an Ares CER or the Ares Security personnel.

The Project information should be prominently marked at the top and bottom of the front cover, first page, title page, back cover, and each individual page with the statement "SENSITIVE BUT UNCLASSIFIED (SBU)." NASA Form 1686 should be used as the cover page and the appropriate boxes checked (NASA Sensitive, Proprietary, ITAR, etc.). Additional marking on the document pages may be applied to further describe the restrictions, as noted in NPR 1600.1, paragraph 5.24.3. All SBU information shall be stored in a locked cabinet or desk when not actually in use. The number of hard copies will be limited to the minimum necessary and e-mail transmission will be encrypted. When the information is no longer needed it shall be destroyed by approved MSFC methods, such as shredding, burning, or removal from IT systems. Further details about data safeguards are described in MPR 1600.1. Personnel shall be subject to administrative sanctions if they improperly disclose SBU information.

3.13.3.3.5 Data Export

Ares objectives will be used to determine the need for an export, with the initial determination to be made by the exporter. The fundamental responsibility for this determination rests with the data originator and respective Element Manager. The Element CER can provide assistance with the decision, along with other technical disciplines, as necessary. If a mandatory export falls outside the authority provided by this plan and the blanket ECIS, then the exporter shall complete an ECIS (MSFC Form 4312), forward it to the organizational CER for an export classification, and determine whether an export license is required. All Ares export records will be maintained on the Windchill database.

3.13.3.3.6 Shipping of Project Hardware

All hardware shipments shall follow the requirements outlined in MWI 6000.1. All such shipments will require the completion of an ECIS, which is to be approved by the Ares Office and Project CER, and other normal paperwork associated with overseas shipments (MSFC Form 57 and Form 57-1). An export license may or may not be required for such shipments. This is to be determined by the CEA, in coordination with the Ares CER. For further information, see APO-1034, Ares I Integrated Logistics Support Plan.

3.13.3.4 Export Control Licenses

A license, if required, will be sought pursuant to MPD 2190.1C.

3.13.3.5 Export Control Documentation and Records

The Ares shall retain copies of all logs, export control forms, ECISs, shipping paperwork, and related documentation on the Windchill database. Export control documentation shall be considered to be part of the Project's records and is to be retained per NPR 1441.1, NASA Records Retention Schedule, and export control regulations, whichever is longer.

Under the requirements set forth in MPR 1440.2, MSFC Records Management Program, the CEA shall retain the records as set forth below in Table 3-5.

Table 3-5. Record retention and disposition guidelines.

Record	Repository	Period of Time	Final Disposition
Record of Annual CEA, CER, Management, and General Training	Maintained by Export Control, Protective Services	Retain 5 years from completion date of the activity	Destroy
Export Clearance Information Sheet (ECIS) MSFC Form 4312	Maintained by Export Control, Protective Services	Retain 5 years from completion date of the activity	Destroy
Annual Export Control Program Audit Report	Maintained by Export Control, Protective Services	Retain 5 years from completion date of the activity	Destroy

3.14 COMMUNICATIONS PLAN

The Ares Projects recognizes that clear communication is imperative to mission success. It also is aware that its national leadership role in aerospace development offers unique opportunities to support NASA's educational and public outreach initiatives. In this regard, the Ares partners with the MSFC OSAC, as well as with the ESMD Strategic Communications Office, to plan and perform the following activities, as outlined in CxP 72299, Ares Communication Plan:

- Convey knowledge about the Ares and NASA activities to internal and external audiences, as appropriate.
- Manage the Ares' image through effective communications with stakeholders, customers, and employees.
- Inform and educate the general public regarding the relevance of the Ares to the Global Exploration Strategy, as well as the overall value of NASA's missions.
- Assess stakeholder needs and measure satisfaction.
- Develop relationships with executive leadership and legislative representatives such as state and local government officials.
- In keeping with the strategic direction of OSAC, develop, deliver, and evaluate communication products and tools that ensure consistent messaging and are targeted to specific internal and external audiences, i.e., stakeholders.

3.14.1 Systems Approach to Communications

The Ares' systems approach to communication aligns efforts with the Agency's goals and helps drive communication transformation throughout the entire organization through:

- Phased, strategic planning and ultimate tasking.
- Efficient, integrated HQ, ESMD, Constellation Program, and Ares activities, achieved through leveraging the many communications functions within the organization.
- Clear, targeted, coordinated, and consistent messages.

Strategic research and analysis of stakeholders and the external environment serve as the foundation for the communications system. Specific sub-plans will enable the following outputs:

- Executive communication support.
- Internal communication support.
- Media/public relations support.
- Marketing communications support.

- Technical communications support.
- Audience research.
- Strategic research and analysis of stakeholders and the external environment.
- Web site support.
- Interface with legislative and community stakeholders.
- Special event, exhibit, and conference planning.
- Communication tools.

Ares representatives participate in a variety of forums and staff informational exhibits, providing feedback gained through these experiences. Key processes and products include strategic definition and analysis of industry, educational, and professional conferences; development of informational materials and exhibits; and presentation of targeted technical briefings and papers after clearance by the Ares and MSFC Export Control officials, following guidelines such as NPR 2190.1, NASA Export Control Program, and MPD 2190.1, MSFC Export Control Policy (See Section 3.13).

3.14.2 Internal Stakeholders: Customers and Employees

Internal audiences include those who have a specific interest in this work, including the Constellation Program, and other internal NASA customers, as well as employees.

Formal and informal reviews and status meetings, with associated documentation (minutes, action items, etc.) and briefing materials, are the primary means for conveying information and receiving feedback from customers.

Internal communication channels frequently provide employees with the latest information about topics ranging from safety guidelines to personnel instructions. The Ares electronic document tree gives employees easy access to plans and processes using the Ares Projects Plan as a basis for navigating this paperless system. Communication vehicles provide feedback loops to gauge the effectiveness of messages and tools.

3.14.3 Education and Public Outreach

The Ares Projects addresses diverse external audiences with a variety of tools. Opportunities range from Congressional briefings, to press conferences, to professional meetings and school events. The effectiveness of key messages and delivery methods are analyzed and adjusted based on feedback.

Effective advocacy gains support through developing an understanding of customer and stakeholder expectations and consistently delivering what is important to them. Ares representatives regularly communicate with elected officials, delivering targeted messages that support NASA's agenda. Within this framework, the MSFC Protocol Office provides support for visiting dignitaries, including developing effective, efficient itineraries and escorting officials to maximize their time spent at MSFC.

The Ares inspires the next generation of explorers through its educational activities such as participating in events at NASA Explorer Schools and the Student Launch Initiative. It reports on plans and progress to the public through its outreach initiatives via forums such as the Marshall Speakers' Bureau and exhibits program. Ares representatives work with the MSFC Media Relations Office to develop press releases and participate in interviews with local, state, and national media outlets. Informational materials such as white papers and fact sheets are developed to convey key messages to targeted audiences. External Web sites hosted through the NASA portal provide a ready reference for Ares content and status.

3.15 KNOWLEDGE MANAGEMENT PLAN

In pursuit of the Ares Projects Office becoming a more effective learning organization and for organizational development purposes, Ares risk management includes the integration of knowledge and risk management into the Ares life cycle. Designing a complex architecture of hardware, software, ground and space-based assets to return to the Moon and then on to Mars will require an effective strategy to generate, capture, and distribute knowledge. The ESMD risk and knowledge management communities have embarked on an effort to integrate risk and knowledge management over the life cycle of the Constellation Program using a set of interrelated strategies. Risk Management Officers, who already use lessons learned as a source of information for risk identification, are in a unique position within the organization to effectively perform and facilitate some of these functions.

Ares Knowledge Management comprises a range of practices used to identify, create/capture, validate, and distribute knowledge for reuse, awareness, and training. Knowledge Management has a focus on some specific knowledge assets and the development and cultivation of the channels through which knowledge flows. Knowledge may be accessed or captured at three stages: before, during, and after knowledge-related activities. Key interrelated components and strategies to implement Ares Knowledge Management are:

- Ares Lessons Lived.
- Knowledge Based Risks.
- Lessons Learned.
- Pause and Learn Events.
- Web-Based Collaboration (e.g., Wikis and Communities of Practice).
- Knowledge-Sharing Forums.

4.0 WAIVERS/DEVIATIONS LOG

The Ares Projects submits requests for deviations and waivers to the Constellation Program for review and approval. Some Centers use deviations prior to the implementation phase and waivers during the implementation phase. This process documents agreements intentionally releasing the Project from meeting a requirement. Deviations and waivers to baselined requirements will be processed in accordance with CxP 72015, the Ares CM Plan. For information on Waivers/Deviations requirements, see CxP 72018, Ares Systems Engineering Management Plan.

The Ares will make deliberate and considered attempts to minimize the use of the waiver process. However, those deviations and waivers that are being inherited from the Space Shuttle hardware and systems will be worked aggressively in order to take appropriate design action that eliminates or mitigates their continued usage in the new project. Waivers and deviations, along with their rationales and dates implemented, can be seen in Table 4-1.

Table 4-1. Deviations log.

Waiver/Deviation	Rationale	Date

APPENDIX A
ACRONYMS

1-DOF	One Degree of Freedom
3-DOF	Three Degrees of Freedom
A&S	Avionics and Software
AA	Associate Administrator
AFSIG	Ascent Flight Systems Integration Group
AIT	Analysis and Integration Team
Al-Li	Aluminum-Lithium
ANSI	American National Standards Institute
ANX	Annex
AoA	Analysis of Alternatives
APA	Allowance for Program Adjustment
APAS	Androgynous Peripheral Attachment System
APO	Ares Projects Office
ARC	Ames Research Center
ASM	Acquisition Strategy Meeting
ATK	Alliant Techsystems, Inc.
ATP	Authority To Proceed
B	Billion
BDM	Booster Deceleration Motor
BW	Business Warehouse
C&DH	Command and Data Handling
CADRe	Cost Analysis Data Requirement
CaLV	Cargo Launch Vehicle
CAP	Corrective Action Plan
CARD	Constellation Architecture Requirements Document
CASI	Center for AeroSpace Information
CatEx	Categorical Exclusion
CB	Control Board
CBB	Contract Budget Base
CCB	Configuration Control Board
CCL	Commerce Control List
CDR	Critical Design Review
CE	Chief Engineer

CEA	Center Export Administrator
CEA	Constellation Environmental Assurance
CEI	Contract End Item
CER	Center Export Representative
CERB	Chief Engineer Review Board
CEV	Crew Exploration Vehicle
CFO	Chief Financial Officer
CI	Configuration Item
CIL	Critical Items List
CIO	Chief Information Officer
CLV	Crew Launch Vehicle
CM	Configuration Management
CoF	Construction of Facilities
CoFR	Certificate of Flight Readiness
COTR	Contracting Officer’s Technical Representative
CPE	Change Package Engineer
CPI	Cost Performance Index
CPR	Contract Performance Report
CR	Change Request
CRM	Continuous Risk Management
CSCI	Computer Software Configuration Item
CSO	Chief Safety Officer
CSR	Crew Safety and Reliability
CSRT	Crew Safety and Reliability Team
CWC	Collaborative Work Commitment
CxAMP	Constellation Assets Management Panel
CxCB	Constellation Control Board
CxETIG	Constellation Environmental Test Integration Group
CxIRMA	Constellation Integrated Risk Management Application
CxP	Constellation Program
CxPTIG	Constellation Propulsion Test Integration Group
DAAR	Document Availability Authorization Representative
DAC	Design Analysis Cycle
DCR	Design Certification Review
DDMS	Design and Data Management System
DDT&E	Design, Development, Test, and Evaluation

DM	Data Management
DRD	Data Requirements Description
DRL	Data Requirements List
DRM	Design Reference Mission
EA	Environmental Assessment
EAC	Estimate at Completion
EAR	Export Administration Regulations
ECAD	Electrical Computer-Aided Design
ECAN	Exploration Communications and Navigation
ECB	Element Control Board
ECIS	Export Clearance Information Sheet
ED	Engineering Directorate
EDS	Earth Departure Stage
EEOH	Environmental Engineering and Occupational Health
EIA	Electronic Industries Alliance
EIS	Environmental Impact Statement
EMC	Engineering Management Council
ENGO	Exploration Needs, Goals, and Objectives
EOI	Earth Orbit Insertion
ERB	Engineering Review Board
ERD	Element Requirements Document
ESA	Executive Support Assistant
ESAS	Exploration Systems Architecture Study
ESM	Encapsulated Service Module
ESMD	Exploration Systems Mission Directorate
ETM	Engineering Test Motor
EVA	Extravehicular Activity
EVM	Earned Value Management
EVMS	Earned Value Management System
FAD	Functional Analysis Document
FAR	Federal Acquisition Regulation
FFBD	Functional Flow Block Diagram
FITO	Flight and Integrated Test Office
FMEA	Failure Modes and Effects Analysis
FN	Foreign National
FOC	Full Operational Capability

FOM	Figure of Merit
FONSI	Finding of No Significant Impact
FR	Foreign Representative
FRR	Flight Readiness Review
FS	First Stage
FSB	Forward Segment Booster
ft	Feet
FTE	Full-Time Equivalent
FTV	Flight Test Vehicle
FTWG	Flight Test Working Group
FY	Fiscal Year
GFI	Government Furnished Items
GLOM	Gross Liftoff Mass
GN&C	Guidance, Navigation, and Control
GPMC	Governing Program Management Council
GRC	Glenn Research Center
GSE	Ground Support Equipment
GVT	Ground Vibration Test
HEA	Headquarters Export Administrator
HQ	Headquarters
HTPB	Hydroxyl Terminated Polybutadiene
IA	Independent Assessment
IBR	Integrated Baseline Review
ICD	Interface Control Document
ICE	Integrated Collaborative Environment
IEMP	Integrated Enterprise Management Program
IFTS	Integrated Flight Test Strategy
ILS	Integrated Logistics Support
IM	Information Management
IMP	Integrated Master Planning
IMS	Integrated Master Schedule
IMSB	Integrated Management Systems Board
IOC	Initial Operational Capability
IPAO	Independent Program Assessment Office
IPRT	Independent Project Review Team
IPT	Integrated Product Team

IRD	Interface Requirements Document
IRT	Independent Review Team
Isp	Specific Impulse
ISS	International Space Station
IT	Information Technology
ITA	Independent Technical Authority
ITAR	International Traffic in Arms Regulations
IU	Instrument Unit
IUA	Instrument Unit Avionics
IUAC	Instrument Unit Avionics Contractor
IVC	International Visitor Coordinator
IVDDD	Integrated Vehicle Design Definition Document
IVGVT	Integrated Vehicle Ground Vibration Test
JSC	Johnson Space Center
K	Thousand
KDP	Key Decision Point
KPP	Key Performance Parameter
KSC	Kennedy Space Center
LaRC	Langley Research Center
LAS	Launch Abort System
lb	Pounds
lbf	Pounds Force
lbm	Pounds Mass
LCC	Launch Control Center
LCC	Life Cycle Cost
LEO	Low Earth Orbit
LH_2	Liquid Hydrogen
LIDS	Low Impact Docking System
LO_2	Liquid Oxygen
LOI	Lunar Orbit Insertion
LOX	Liquid Oxygen
LRU	Line Replaceable Unit
LSA	Logistics Support Analysis
LSAM	Lunar Surface Access Module
LSI	Logistics Support Infrastructure
m	Meter

M&A	Manufacturing and Assembly
MAF	Michoud Assembly Facility
MCAD	Mechanical Computer-Aided Design
MCC	Mission Control Center
MDAA	Mission Directorate Associate Administrator
MECO	Main Engine Cutoff
MEI	Mission Essential Infrastructure
MIS	Management Information Systems
MMO	Mission Management Office
MOA	Memorandum of Agreement
MOD	Mission Operations Directorate
MPD	Marshall Policy Directive
MPR	Marshall Procedural Requirement
MPS	Main Propulsion System
MPTA	Main Propulsion Test Article
MRCAP	Mishap Response and Contingency Action Plan
MSA	Management Support Assistant
MSFC	Marshall Space Flight Center
MSOD	Mission Support Office Directorate
mT	Metric Ton
MTCR	Missile Technology Control Regime
MWI	Marshall Work Instruction
NAR	Non-Advocate Review
NASA	National Aeronautics and Space Administration
NDT	NASA Design Team
NEPA	National Environmental Policy Act
NESC	NASA Engineering and Safety Center
NF	NASA Form
NFNMS	NASA Foreign National Management System
NHPA	National Historic Preservation Act
NITR	NASA Information Technology Requirements
NLR	No License Required
NM&I	NASA Management and Insight
nmi	Nautical Mile
NPD	NASA Policy Directive
NPR	NASA Procedure and Regulation

NRHP	National Register of Historic Places
NSPD	National Security Presidential Directive
OCE	Office of Chief Engineer
ODIN	Outsourcing Desktop Initiative for NASA
OFT	Orbital Flight Test
OICB	Operations and Integration Control Board
OMB	Office of Management and Budget
OPR	Office of Primary Responsibility
OSAC	Office of Strategic Analysis and Communication
OSMA	Office of Safety and Mission Assurance
OSTP	Office of Science and Technology Policy
PBAN	Polybutadiene Acrylonitrile
PBS	Plum Brook Station
PCB	Project Control Board
PCBD	Project Control Board Directive
PDA	Personal Digital Assistant
PDF	Portable Document Format
PDR	Preliminary Design Review
PEIS	Programmatic Environmental Impact Statement
Ph.D.	Doctor of Philosophy
PHS&T	Packaging, Handling, Storage, and Transportation
PIR	Program Implementation Review
PKI	Public Key Infrastructure
PL	Product Lead
PMB	Performance Measurement Baseline
PMC	Program Management Council
PNAR	Pre-Non-Advocate Review
POC	Point of Contact
PP&C	Program Planning and Control
PPBE	Programming, Planning, Budgeting, and Execution
PPP	Project Protection Plan
PRA	Probabilistic Risk Assessment
psia	Pounds Per Square Inch Absolute
PWR	Pratt & Whitney Rocketdyne
R&M	Reliability and Maintainability
RBAM	Risk-Based Acquisition Management

RCS	Reaction Control System
ReCS	Reaction Control System
RFP	Request For Proposal
RID	Review Item Discrepancy
RMO	Risk Management Office
RMS	Reliability, Maintainability, and Supportability
RoCS	Roll Control System
RPS	Resources Planning System
RR	Requirements Review
RRAC	Regulatory Risk Analysis and Communication
RSRB	Reusable Solid Rocket Booster
RSRM	Reusable Solid Rocket Motor
RSRMV	Five-segment Reusable Solid Rocket Motor
S&MA	Safety and Mission Assurance
S&T	Structures and Thermal
SAP	Software Applications Provider
SAP	Systems Analysis Plan
SBIR	Small Business Innovative Research
SBU	Sensitive But Unclassified
SDR	System Definition Review
SE&I	Systems Engineering and Integration
SEA	Shuttle Environmental Assurance
SEB	Source Evaluation Board
sec	Second(s)
SECB	Systems Engineering Control Board
SEMP	Systems Engineering Management Plan
SERP	Safety and Engineering Review Panel
SHE	Safety, Health, and Environment
SHPO	State Historic Preservation Office
SIL	Systems Integration Laboratory
SM	Service Module
SMA	Safety and Mission Assurance
SME	Subject Matter Expert
SOMD	Space Operations Mission Directorate
SOW	Statement of Work
SPI	Schedule Performance Index

SR&QA	Safety, Reliability, and Quality Assurance
SRB	Solid Rocket Booster
SRB	Standing Review Board
SRD	System Requirements Document
SRIIG	Systems Requirements and Interfaces Integration Group
SRR	System Requirements Review
SSC	Stennis Space Center
SSM	Subsystem Manager
SSME	Space Shuttle Main Engine
SSP	Space Shuttle Program
SSPO	Space Shuttle Program Office
STE	Special Test Equipment
STI	Scientific and Technical Information
SyTIG	Systems Test Integration Group
TA	Technical Authority
TBD	To Be Determined
TBR	To Be Resolved
TDS	Task Description Sheet
TEI	Trans-Earth Injection
TIG	Test Integration Group
TIM	Technical Interchange Meeting
TLI	Trans-Lunar Injection
TPA	Turbine Pump Assembly
TPM	Technical Performance Measure
TPP	Technology Prioritization Planning
TPS	Thermal Protection System
TS	Test Stand
TTA	Technical Task Agreement
TVC	Thrust Vector Control
U.S.	United States
US	Upper Stage
USB	Universal Serial Bus
USE	Upper Stage Engine
USEP	U.S. Space Exploration Policy
USM	Ullage Settling Motor
USML	United States Munitions List

USO	Upper Stage Office
USPC	Upper Stage Production Contractor
VAC	Variance at Completion
VI	Vehicle Integration
VICB	Vehicle Integration Control Board
VIG	Vehicle Integration Group
VIO	Vehicle Integration Office
VMS	Visitor Management System
WBS	Work Breakdown Structure
WG	Working Group
WIMS	Workforce Integrated Management System
WP	Work Package
WSTF	White Sands Test Facility
WYE	Work-Year Equivalent

APPENDIX B
APPLICABLE AND REFERENCED DOCUMENTS

B1.0 APPLICABLE DOCUMENTS

	FY 2006 Appropriations Act for NASA
	NASA Authorization Act of 2005
	U.S. Space Transportation Policy (January 2005)
ANSI/EIA-748-A	Industry Guidelines for Earned Value Management System
CxP 70003-ANX04	Constellation Program Plan: Standing Review Board Coordination Plan for Life Cycle Reviews
CxP 70006-ANX2.1	Systems Requirements Review Process Plan: Crew Launch Vehicle System Requirements Review
CxP 70038	Constellation Program Hazard Analysis Methodology
CxP 70059	Constellation Program Integrated Safety, Reliability, and Quality Assurance Requirements
CxP 70070-ANX06	Constellation Program Program Management Plan: Environmental Management Plan
CxP 70070-ANX09	Constellation Program Program Management Plan: Earned Value Management System Description
CxP 72015	Configuration Management Plan for Ares Project
CxP 72017	Data Management Plan for Ares Project
CxP 72018	Ares Systems Engineering Management Plan
CxP 72035	Ares Master Verification Plan
CxP 72209	Ares I Technology Development Plan
ESMD MRCAP-<**TBD-010**>	ESMD Mishap Response and Contingency Action Plan
ESMD <**TBD-011**>	ESMD Mishap Preparedness and Contingency Action Plan

Executive Order 12114	Environmental Effects Abroad of Major Federal Actions (January 4, 1979)
IMSB-Plan-7123.1	MSFC Technical Excellence and Technical Authority Implementation Plan
MPD 2190.1C	MSFC Export Control Program
MPR 1371.1D	Procedural Requirements for Processing Foreign Visitor Requests
MPR 1440.2	MSFC Records Management Program
MPR 1600.1D	MSFC Security Procedural Requirements
MPR 2220.1Q	Scientific and Technical Publications
MPR 8500.1F	MSFC Environmental Management Program
MWI 6000.1F	Procurement Traffic Management and Freight Traffic Actions
NASA Std 8739.8	Software Assurance Standard
MPD 8500.1B	NASA Environmental Management
NPR 1371.2A	NASA Procedural Requirements for Processing Requests for Access to NASA Installations or Facilities by Foreign Nationals or U.S. Citizens Who are Representatives of Foreign Entities
NPR 1441.1	NASA Records Retention Schedules
NPR 1600.1	NASA Security Program Procedural Requirements
NPR 2190.1	NASA Export Control Program
NPR 2810.1	Security of Information Technology
NPR 7120.5D	NASA Space Flight Program and Project Management Requirements
NPR 7150.2	Software Engineering Requirements
NPR 8000.4	Risk Management Procedural Requirements
NPR 8553.1	NASA Environmental Management System (EMS)
NPR 8580.1	Implementing the National Environmental Policy Act and Executive

	Order 12114
NPR 8621.1B	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping
NPR 8705.2	NASA Human Rating Requirements for Space Systems
NSPD-31	U.S. Space Exploration Policy (January 14, 2004)
SP-2007-6105	NASA Systems Engineering Handbook
<**TBD-012**>	Constellation Environmental Assurance Management Plan

B2.0 REFERENCED DOCUMENTS

APO-1002	Ares Project Risk Assessment Guidelines
APO-1034	Ares I Integrated Logistics Support (ILS) Plan
CxP 70000	Constellation Architecture Requirements Document (CARD)
CxP 70003	Constellation Program Plan
CxP 70007	Constellation Design Reference Missions and Operational Concepts
CxP 70064	Constellation Program Supportability Plan
CxP 72004	Ares V System Requirements Document
CxP 72019	Ares Projects Office Risk Management Plan
CxP 72020	Ares Projects System Safety, Reliability, and Quality Assurance Plan
CxP 72024	Ares Project Systems Analysis Plan
CxP 72027	Ares Projects Knowledge Management Plan
CxP 72032	Ares I Operational Concept Document
CxP 72034	Ares I System Requirements Document
CxP 72051	Ares Software Management Plan
CxP 72070	Ares I Integrated Vehicle Design Definition Document

CxP 72071	Ares I Integrated Mission Timeline
CxP 72077	Ares I Logistics Support Analysis Report
CxP 72114	Ares Project Document Tree
CxP 72224	Ares I Ground Operations Data Book
CxP 72243	Ares I Flight Operations Data Handbook
CxP 72293	Ares I Level III Data Requirements List (DRL)
CxP 72299	Ares Communication Plan
<**TBD-013**>	Ares Project Protection Plan
<**TBD-014**>	Ares Software Assurance Plan
ESMD ENGO-01.08	Exploration Needs, Goals and Objectives (ENGO) Document
MPD 8500.1D	MSFC Environmental Management Policy
MPR 8500.1F	MSFC Environmental Management Program
MPR 8715.1F	Marshall Safety, Health, and Environmental (SHE) Program
MWI 7120.4E	Documentation Preparation, Programs/Projects
MWI 7120.6D	Program/Project Continuous Risk Management
NASA-TM-2005-214062	Exploration Systems Architecture Study (ESAS) Final Report
NPD 1000.0A	Governance and Strategic Management Handbook
NPD 9501.3	Earned Value Management
NPR 7123.1A	NASA Systems Engineering Processes and Requirements
NSTS 37345	Shuttle Environmental Assurance (SEA) Initiative
RD06-142	J-2X Project Management Plan
RD06-154	J-2X Engine Development Plan
USO-CLV-25000	Upper Stage Office (USO) Management Plan

B3.0 ARES DOCUMENT TREE

A top-level overview of the Constellation and Ares document tree is shown in Figure B-1. The documentation and relationships between those documents is provided in CxP 72114, Ares Project Document Tree Rev C, where Figures 4 and 5 give detailed document trees for both programmatic and technical documentation, respectively.

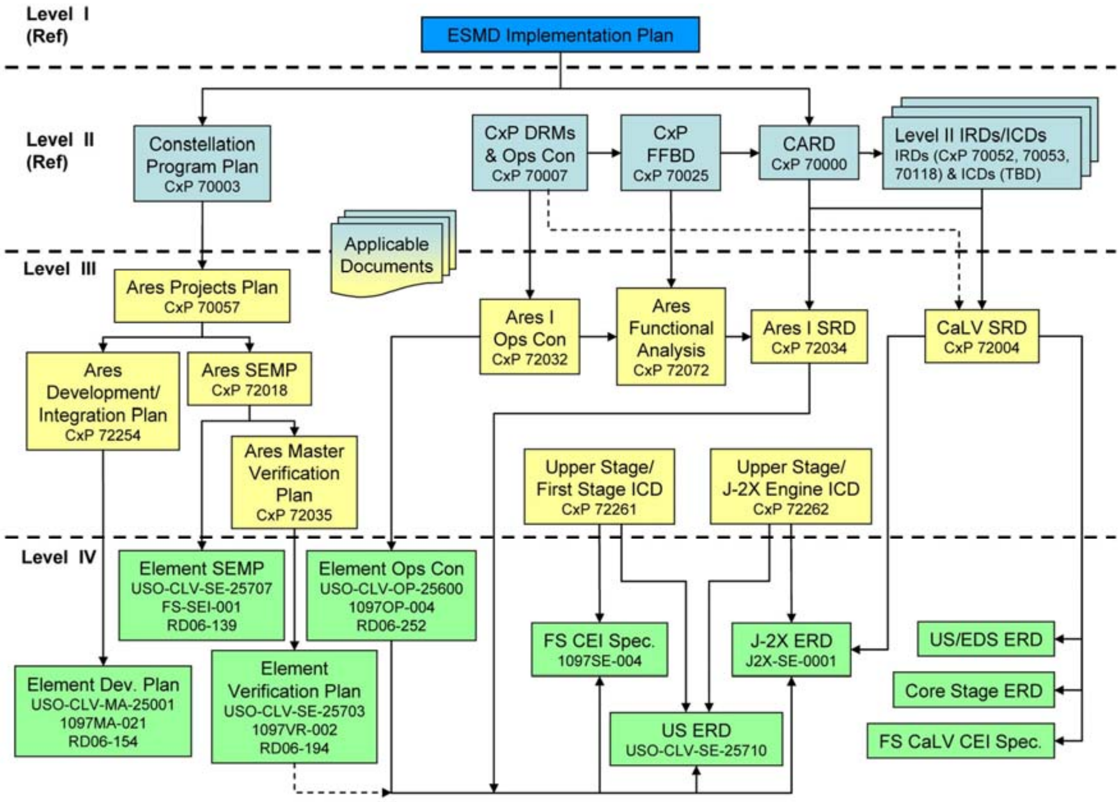


Figure B-1. Conceptual hierarchy of Ares documents.

APPENDIX C
GLOSSARY

Acquisition. The acquiring, by contract, of supplies or services (including construction) through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, or evaluated. Acquisition begins at the point when Agency needs are established and includes the description of requirements to satisfy Agency needs, solicitation, and selection of sources, award of contracts, contract financing, performance, administration, technical, and management functions directly related to the process of fulfilling Agency needs by contract.

Activity. Any of the program and project management components that are executed in order to complete the four-part management process.

Advocacy Chain. Any person that has a vested interest in the outcome of a particular program or project.

Approval. The process used to initially decide on a program/project's readiness to proceed from formulation into implementation and subsequently used to approve changes to the program/project baseline.

Assessment. The classification of a program or project with respect to its accomplishments and performance in meeting requirements.

Assure. Making certain that specified activities performed by others are performed in accordance with specified requirements.

Audit. An examination of records or financial accounts to check their accuracy.

Baseline. The technical performance and content, technology application, schedule milestones, and budget (including contingency and allowance for program adjustment (APA)), which are documented in the approved Program and Project Plans.

Commercialization. Identify opportunities for establishing partnerships with the private sector, academia, and other government organizations to conduct dual-use research, develop mutually beneficial technologies, and transfer results into NASA for mission use and the private sector for commercial application.

Configuration Management. A management discipline applied over the product's life cycle to provide visibility and to control performance and functional and physical characteristics.

Contingency. Reserves, including funding, schedule, performance, manpower, and services, allocated to and managed by the Program/Project Manager for the resolution of problems normally encountered to mitigate risks while ensuring compliance to the specified program/project scope.

Continuous Risk Management (CRM). The process that identifies risk; analyzes their impact and prioritizes them; develops and carries out plans for risk mitigation or acceptance; tracks risk and the implementation of plans; supports informed, timely, and effective decisions to control risks and mitigation plans; and assures that risk information is communicated and documented.

Contract. A mutually binding legal relationship obligating the seller to furnish the supplies or services (including construction) and the buyer to pay for them. It includes all types of commitments that obligate the Government to an expenditure of appropriated funds and that, except as otherwise authorized, are in writing. In addition to bilateral instruments, contracts include, but are not limited to, awards and notices of awards; job orders or task letters initiated under basic ordering agreements; letter contracts; orders, such as purchase orders, under which the contract becomes effective by written acceptance or performance; and bilateral contract modifications. Contracts do not include grants and cooperative agreements.

Cost Analysis Data Requirement (CADRe). A formal document to understand the cost and cost risk of space flight projects. The CADRe consists of a Part A “Narrative,” a Part B “Technical Data” in tabular form, and a Part C “Project Life Cycle Cost Estimate.”

Customer. Any individual, organization, or other entity to which a program or project provides a product(s) and/or service(s).

Data Requirement Description (DRD). A document inserted into an RFP and contract requiring data (e.g., EVM Contract Performance Report (CPR); CADRe; Integrated Master Schedule (IMS); Risk Management Plans and Reports; etc.). A DRD can describe tailoring to a standard (e.g., EVM CPR Data Item Description (DI-MGMT-81466) or be a stand-alone data requirement if there is no underlying standard (e.g., CADRe).

Deviation. A documented agreement intentionally releasing a program or project from meeting a requirement. (Some Centers use deviations prior to Implementation, and waivers during Implementation.)

Earned Value Management (EVM). A tool for measuring and assessing project performance through the integration of technical scope with schedule and cost objectives during the execution of the project. EVM provides quantification of technical progress, enabling management to gain insight to project status and project completion costs and schedules. Two essential characteristics of successful EVM are EVM system data integrity and carefully targeted monthly EVM data analyses (i.e., risky WBS elements).

Ensure. Performing specified activities in accordance with requirements for that activity.

Environmental Impact. The direct, indirect, or cumulative beneficial or adverse effect of an action on the environment.

Environmental Management. The activity of ensuring that program and project actions and decisions which potentially impact or damage the environment are assessed/evaluated during the formulation/planning phase, reevaluated throughout implementation, and performed according to all NASA policy and Federal, state, and local environmental laws and regulations.

Evaluation. The process used to provide independent assessments of the continuing ability of the program/project to meet its technical and programmatic commitments. Evaluation also provides value-added assistance to the program/project managers.

Formulation. The process used to define the program/project concept and plan to meet customer requirements.

Full Operational Capability (FOC). The full attainment of the capabilities to employ an item of equipment, or system of approved specific characteristics, operated and supported by a trained workforce.

Governing Program Management Council (GPMC). The highest level PMC that has the responsibility to regularly review a program or project.

Implementation. The process used to deliver the products and capabilities specified in the approved Program/Project Plan.

Independent Assessment (IA). The general term referring to an evaluation of a program or project conducted by experts outside the advocacy chain. The evaluation results in an assessment of the program's or project's readiness (technical, schedule, cost, risk) to proceed to the next phase in the life cycle that is reported to a GPMC.

Independent Program Assessment Office (IPAO). The NASA organization responsible for scheduling, organizing, and conducting the independent reviews (Concept Decision Review, Preliminary Non-Advocate Review, Non-Advocate Review, and Production Review) for programs and projects reporting to the Agency PMC.

Independent Review Team (IRT). The general term used to refer to an independent group of individuals outside the advocacy chain of a program or project that is charged with conducting an independent program or project review. The IRT can refer to an IPAO, SMO or third party team.

Independent Technical Authority (ITA). Technical Authority is the authority, responsibility, and accountability to establish, approve, and maintain technical requirements, processes, and policy. The execution of technical authority in support of mission-related programs and projects without organizational or financial control by such program and/or projects.

Information Technology (IT). Hardware and software operated by a Federal Agency or by a contractor of a Federal Agency or other organization that processes information on behalf of the Federal Government to accomplish a Federal function, regardless of the technology involved, whether by computers, telecommunications systems, automatic data processing equipment, or other.

Infrastructure Requirements. The real property/facilities, aircraft, personal property or equipment, and information technology resources, that are required to support programs and projects. Utilization of the capability afforded by the infrastructure includes full life cycle cost, including operations, sustainment, disposal, environmental impacts, and other liabilities it presents.

In-House Project. One that is conducted onsite or in the immediate vicinity of a NASA Center in which most major technical, business, and management tasks are performed primarily by the Center's civil service workforce.

Initial Operating Capability (IOC). The first attainment of the capability to employ an item of equipment, or a system of approved specific characteristics, operated and supported by a trained workforce.

Initiative. A "project-like" activity that is managed by the Mission Support offices.

Integrated Baseline Review (IBR). An IBR is a formal project-level review that includes total project (contracted as well as in-house NASA) efforts. It is conducted jointly with personnel responsible for the efforts. Specifically, an IBR verifies that the technical content of the performance measurement baseline is consistent with the contract scope, work breakdown structure, and actual budget and schedule; ensures that effort personnel have identified all risks and are aware of their responsibilities for their management; ensures that there is a logical sequence of effort planned consistent with the contract schedule; ensures the disciplined implementation of all project Earned Value Management Systems (EVMS); establishes a forum through which the Program/Project Manager and the technical staff gain a sense of ownership of the cost/schedule management process; and establishes the baseline for the life of the contract.

Integrated Master Schedule (IMS). An IMS includes a baseline master schedule and derivative schedules which provide the framework for time phasing and coordinating all project efforts into a master plan to ensure that objectives are accomplished within program or project commitments. The IMS baseline also serves as the basis for development of the Performance Measurement Baseline (PMB) utilized in earned value management (EVM).

Integration. A process for examining synergy, redundancies, and the effectiveness of resource utilization. Primarily done during Implementation Plan development, but also includes development of the annual budget, audits, and assessments.

Investigation. A research activity that is directed by a Principle Investigator (PI) according to an approved research design.

Iterative Processes. A systems engineering concept in which any or all of the systems engineering processes may need to be performed repetitively during a system's life cycle. For example, requirements definition may occur at a high level during formulation, and again at progressively lower levels in implementation. Even though it occurs at different phases in the system life cycle, the same process is applied.

Key Performance Parameters (KPPs). Those capabilities or characteristics (typically engineering-based or related to safety or operational performance) considered most essential for successful mission accomplishment. Failure to meet a KPP threshold can be cause for the project, system, or advanced technology development to be reevaluated or terminated. Failure to meet a KPP threshold can be cause for the system-of-systems concept to be reassessed or the contributions of the individual systems to be reassessed. A project's KPPs are identified and quantified in the Project Baseline.

Lesson Learned. The significant knowledge or understanding gained through past or current programs and projects that is documented and collected to benefit current and future programs and projects.

Life Cycle Cost (LCC). The total of the direct, indirect, recurring, nonrecurring, and other related expenses incurred, or estimated to be incurred, in the design, development, verification, production, operation, maintenance, support, and disposal of a project. Life cycle cost (LCC) of a project or system can also be defined as the total cost of ownership over the project's or system's life cycle from formulation through implementation. It includes all design, development, deployment, operation and maintenance, and disposal costs.

Logistics. The management, engineering activities, and analysis associated with design requirements definition, material procurement and distribution, maintenance, supply replacement, transportation, and disposal which are identified by flight and ground systems supportability objectives.

Margin. The allowances carried in budget, projected schedules, and technical performance parameters (e.g., weight, power, or memory) to account for uncertainties and risks. Margin allocations are baselined in the formulation process, based on assessments of risks, and are typically consumed as the program/project proceeds through the life cycle.

Metric. A measurement taken over a period of time that communicates vital information about a process or activity. A metric should drive appropriate action.

Mission. A major activity required to accomplish an Agency goal or to effectively pursue a scientific, technological, or engineering opportunity directly related to an Agency goal. Mission needs are independent of any particular system or technological solution.

Mission Assurance (Activities). The activities that are necessary to (1) check whether a product or service being developed meets specified mission technical requirements, and (2) to provide confidence in the program or project's ability to achieve mission success.

Mission Success (Activities). Those activities performed in line and under the control of the program or project that are necessary to provide assurance that the program or project will achieve its objectives. The mission success activities will typically include risk assessments, system safety engineering, reliability analysis, quality assurance, electronic and mechanical parts control, software validation, failure reporting/resolution, and other activities that are normally part of a program or project work structure.

Mission Success Criteria. Standards against which the program or project will be deemed a success. Mission success criteria may be both qualitative and quantitative, and may cover mission cost, schedule, and performance results as well as actual mission outcomes.

Non-Advocate Review (NAR). The analysis of a proposed program or project by a (non-advocate) team composed of management, technical, and budget experts (personnel) from outside the advocacy chain of the proposed program or project. It provides Agency management with an independent assessment of the readiness of the program/project to proceed into implementation.

NAR Baseline. Final quantitative values of each key performance parameter, funding, and schedule established at the NAR approval of a project.

Occupational Health. The promotion and maintenance of physical and mental health in the work environment.

Performance-Based Contracting. Structuring all aspects of an acquisition around the purpose of the work to be performed as opposed to either the manner by which the work is to be performed or broad and imprecise statements of work.

Performance Measurement Baseline (PMB). The time-phased budget plan against which contract execution is measured. It is formed by the budgets assigned to scheduled control accounts and the applicable indirect budgets. For future effort, not planned to the control account level, it also includes budgets assigned to higher level contractor work breakdown structure elements and undistributed budgets. It equals the total allocated budget less management reserves.

Portfolio. A collection of investments in strategies, such as R&D investigations, managed to further a common goal or goals.

Principal Investigator (PI). Leader of relatively small basic or applied research activity which is part of a larger portfolio of research investments. In some cases, principal investigators from industry and academia act as project managers for development efforts with NASA personnel providing oversight.

Probabilistic Risk Assessment (PRA). A comprehensive, structured, and logical analysis method aimed at identifying and assessing risks in complex technological systems for the purpose of cost-effectively improving their safety and performance in the face of uncertainties. PRA assesses risk metrics and associated uncertainties relating to likelihood and severity of events adverse to safety or mission.

Program. A strategic investment by a Mission Directorate (or Mission Support Office) that has defined goals, objectives, architecture, funding level, and a management structure that supports one or more projects.

Program Management Council (PMC). One of the hierarchy of forums, composed of senior management, that assesses program or project planning and implementation, and provides oversight and direction as appropriate. These are established at the Agency, Mission Directorate, Center, and lower levels.

Program Plan. The document that establishes the baseline for implementation, signed by the Mission Directorate Associate Administrator (MDAA) (or Mission Support Office Directorate (MSOD)), Center Director, and Program Manager.

Program (Project) Team. All participants in program (project) formulation and implementation. This includes all direct reports and others that support meeting program (project) responsibilities.

Project. A specific investment identified in a Program Plan having defined goals, objectives, requirements, life cycle cost, a beginning, and an end.

Project Plan. The document that establishes the baseline for implementation, signed by the cognizant Program Manager, Center Director, and Project Manager.

Quality Assurance. A planned and systematic set of actions necessary to provide confidence that the products or services conform to documented requirements.

Requirements Review (RR). An assessment, during the formulation process, of the completeness, consistency, and achievability of the project objectives and requirements, including those specified in the Functional Analysis Document (FAD). The RR covers, as applicable, mission, project, science, operational, flight system and ground system requirements, including cost and schedule. The RR is conducted prior to the initiation of preliminary design.

Reserves. The APA and contingency resources.

Resources Management. A function that is composed of planning and monitoring implementation of cost, workforce, and facility requirements; correlating these requirements to technical and schedule performance; and comparing these parameters to baselines established for the program and projects. This function establishes, monitors, and updates budget development and execution and contractor financial reporting.

Risk. The combination of the probability that a program or project will experience an undesired event (some examples include a cost overrun, schedule slippage, safety mishap, health problem, malicious activities, environmental impact, failure to achieve a needed scientific or technological breakthrough or mission success criteria) and the consequences, impact, or severity of the undesired event, were it to occur. Both the probability and consequences may have associated uncertainties.

Risk Assessment. An evaluation of a risk item that determines (1) what can go wrong, (2) how likely it is to occur, and (3) what the consequences are.

Risk Management. An organized, systematic decision-making process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risk to increase the likelihood of achieving program/project goals.

Safety. Freedom from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.

Schedule Management. The establishment, monitoring, and maintenance of the baseline master schedule and derivative detailed schedules. It is composed of the establishment and operation of the system and includes (1) definition of format, content, symbology, and control processes, and (2) selection of key progress milestones and indices for measuring program and project performance and indicating problems.

Security. Protection of people, property, and information assets owned by NASA that covers physical assets, personnel, IT, communications, and operations.

Stakeholder. An individual or organization having an interest (or stake) in the outcome or deliverable of a program or project.

Success Criteria. That portion of the top-level requirements that define what will be achieved to successfully satisfy the Strategic Plan objectives addressed by the program, project, or technology demonstration.

Surveillance (Project Evaluation Context). An ongoing assessment after the NAR approval conducted by the designated IA organization that examines project performance against the NAR Baseline. Adverse trends are reported to the GPMC.

Surveillance (Acquisition Context). The continual monitoring and verification of status of an entity and analysis of records to ensure that specified requirements are being met. Surveillance can be performed in an insight, oversight, or a combined mode, using a risk-based decision process.

System. The combination of elements that function together to produce the capability required to meet a need. The elements include all hardware, software, equipment, facilities, personnel, processes, and procedures needed for this purpose.

Systems Engineering. A disciplined approach for the definition, implementation, integration, and operation of a system (product or service). The emphasis is on achieving stakeholder functional, physical, and operational performance requirements in the intended use environments over its planned life within cost and schedule constraints. Systems engineering includes the engineering processes and technical management processes that consider the interface relationships across all elements of the system, other systems, or as a part of a larger system.

Termination Review. An analysis by the GPMC or by an independent assessment board, i.e., IPAO or SMO, for the purpose of securing a recommendation as to whether to continue or terminate a program or project. Exceeding the parameters or levels specified in controlling documents will result in GPMC consideration of a termination review.

Trade Study. A technique for comparing alternatives for the purpose of deciding which of them is preferred. Trade studies (also known as trade-off analyses) support decisions throughout the systems engineering process, including (but not limited to) functional allocation choices, performance requirements definition, physical architecture and design choices, technology selection, and risk management. Trade studies may be formal, as in the case of an Analysis of Alternatives (AoA), or informal using engineering judgment or "back-of-the-envelope" analyses, but in either case, the selection of the preferred alternative is based on specific quantitative criteria.

Validation. Proof that the product accomplishes the intended purpose. May be determined by a combination of test, analysis, and demonstration.

Verification. Proof of compliance with specifications. May be determined by a combination of test, analysis, demonstration, and inspection.

Waiver. A documented agreement intentionally releasing a program or project from meeting a requirement. (Some Centers use deviations prior to Implementation, and waivers during Implementation.)

Work Breakdown Structure (WBS). A product-oriented hierarchical division of the hardware, software, services, and data required to produce the program/project's end product(s), structured according to the way the work will be performed, and reflective of the way in which program/ project costs, schedule, technical, and risk data are to be accumulated, summarized, and reported.

APPENDIX D
OPEN WORK

B1.0 TO BE DETERMINED (HEADING-APPX STYLE - ALL CAPS AND BOLD)

Table B1-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within carets. The TBD item is numbered as applicable (i.e., **<TBD- 001>** is the first undetermined item assigned in the document). As each TBD is resolved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

Note: When documenting open work, the book manager shall identify those items whose completion is dependent upon the delivery of data from the CxPO, or another CxP project. This dependency shall be clearly identified in the description portion of that open task. This information is important for closure tracking purposes; it will allow the Ares Projects to distinguish between those open items over which it has full control and those it does not. It will also enable the creation of summaries of open work data dependencies between the Ares Projects and the CxPO, and, between Ares and other CxP projects.

Table B1-1. To Be Determined items.

TBD	Section	Description
TBD-001	1.4.4	Ares V Acquisition Plan
TBD-002	1.7	ESMD Mishap Preparedness and Contingency Action Plan (document and number)
TBD-003	1.7	ESMD Mishap Response and Contingency Action Plan (document and number)
TBD-004	2.4.2	Appendix for Ares I personnel estimates
TBD-005	3.8	Date for Ares Flight Readiness Review (FRR)
TBD-006	3.9	Ares V Operational Concepts Document
TBD-007	3.12.1	ESMD ICE Security Plan
TBD-008	3.12.1	ICE IT Security Plan
TBD-009	3.12.1.1	Ares Project Protection Plan
TBD-010	App B	Insert Document Number for ESMD Mishap Response and Contingency Action Plan
TBD-011	App B	Insert Document Number for ESMD Mishap Preparedness and Contingency Action Plan
TBD-012	App B	Insert Document Number for Constellation

		Environmental Assurance Management Plan
TBD-013	App B	Insert Document Number for Ares Project Protection Plan
TBD-014	App B	Insert Document Number for Ares Software Assurance Plan

B2.0 TO BE RESOLVED

Table B2-1 lists the specific To Be Resolved (TBR) issues in the document that are not yet known. The TBR is inserted as a placeholder wherever the required data is needed and is formatted in bold type within carets. The TBR issue is numbered as applicable (i.e., **<TBR-001>** is the first unresolved issue assigned in the document). As each TBR is resolved, the updated text is inserted in each place that the TBR appears in the document and the issue is removed from this table. As new TBR issues are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBRs will not be renumbered.

Table B2-1. To Be Resolved issues.

TBR	Section	Description
TBR-001	3.12.1	Is ICE/Primavera certified for SBU?
TBR-002	3.12.1	Is ICE/Primavera/IMP/IMS certified for SBU?
TBR-003	3.12.1	Is ICE/wInsight certified for SBU?
TBR-004	3.12.1	Is ICE/CxIRMA certified for SBU?
TBR-005	3.12.1	Is ICE/Pro/Engineer certified for SBU?
TBR-006	3.12.1	Is ICE/ECAD certified for SBU?
TBR-007	3.12.1	Is ICE/Integration Broker certified for SBU?