INTELLECTUAL PROPERTY

(This section must be signed)

Individuals **outside your company**, including the companies listed above and other third parties, potentially including your competitors and others in your industry, may receive and/or review award submissions. All information submitted should address the program's management, leadership, and processes in a manner that you are comfortable sharing with third parties freely and without restriction, and may not include any classified or proprietary information or materials. Do not include any materials marked Confidential or Proprietary or bearing any similar legend. All responses and other submissions, whether in whole or in part ("Submissions"), shall be deemed not to be confidential, proprietary, and/or nonpublic information of any sort for any purpose.

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Acknowledged, agreed, and submitted by

Aubrey Stewart, 303987 Digitally signed by Aubrey Stewart, 303987
Date: 2023.05.31 14:22:31 -05'00'

Nominee's Signature — 05/31/2023 Date

Nominee's Name (please print): Aubrey Stewart

Title (please print): Director, Boeing Exploration Systems Business Development

Company (please print): The Boeing Company

NOMINATION FORM

Name of Program: Boeing Space Launch System Program

Name of Program Leader: Dave Dutcher

Phone Number: (256) 850-5110

Email: david.g.dutcher@boeing.com

Postal Address: 1000 Redstone Gateway SW, Huntsville, AL 35808

☒ Customer Approved

- Date: 05/30/2023 ____________________
- Customer Contact (name/title/organization/phone): Marcia Lindstrom, Strategic Communications NASA Space Launch System; 256-544-0711

☐ Supplier Approved (if named in this nomination form)

- Date: ____________________
- Supplier Contact (name/title/organization/phone): ____________________

PLEASE REFER TO PROGRAM EXCELLENCE DIRECTIONS
AS YOU COMPLETE THIS FORM.

EXECUTIVE SUMMARY: Make the Case for Excellence
Value: 10 points
Use 12 pt. Times Roman typeface.
What is the vision for this program/project? What unique characteristics and properties qualify this program for consideration?

The Space Launch System (SLS) is the foundational element of NASA's mission to expand the frontier of human exploration across the solar system. SLS has enabled near term missions to establish a human presence on the lunar surface and in orbit around the moon. Further, SLS was designed and has now demonstrated its purpose-built capability to support placing humanity on the surface of Mars to support NASA's broader Exploration Systems open architecture. Boeing is proud to support the SLS program in creating and successfully launching the safest and most capable human-rated super heavy launch vehicle in the world.


Artemis I Lift-off from LC-39B

Core Stage (CS) – The CS was designed and managed using a state-of-the-art digital twin design method that included all structural, propulsion, and avionics systems. This approach to managing the design and later test of the CS significantly decreased the amount of classical component and stage level testing, eliminating expensive alternates such as a main propulsion test article. CS 1 successfully flew as part of the Artemis I mission.

Interim Cryogenic Propulsion State (ICPS) – Derived from the Delta IV 5m upper stage, the ICPS was successfully modified and integrated into the SLS. During this process all aspects of the design were reviewed using Boeing Management Best Practices methodology to ensure the stage was compliant with all relevant NASA requirements to enable its use within the SLS program as evidenced by its acceptance at the Artemis I Flight Readiness Review and successful flight performance.

Exploration Upper Stage (EUS) – In parallel with CS and ICPS activities, Boeing also completed design of the Block 1B EUS. By leveraging management skills between on-going CS & ICPS elements, Boeing was able to complete the design of the EUS, complete a successful critical design review, start-up the operations & tools at NASA's Michoud Assembly Facility (MAF), and produce flight hardware.

2020-2022 Program Management Excellence	
ELEMENT	**ACCOMPLISHMENTS**
Core Stage	• Core Stage Delivery to KSC • Flight Readiness Certification • Integration into Artemis I • **Successful 1st Flight**
ICPS	• Human-Rating • Flight Readiness Certification • Integration into Artemis I • **Successful 1st Flight**
EUS	• Critical Design Review • MAF Operations Started • **Flight H/W Fabrication Start**
System Test	• Core Stage Testing Completed • Stennis Green Run Stage Controller • **Successful CS Green Run Test**

System Test – Comprehensive system test of the CS was completed while at the MAF. A suite of constraint based planning and scheduling tools was developed and utilized. These tools allowed flexibility and agility while reacting to test outcomes to integrate component, sub-system, and integrated system level testing. At the conclusion of MAF testing the CS was shipped to NASA's Stennis Space Center B2 test stand and prepped for hot fire testing. A Boeing developed stage controller system was used to control the CS and key B2 propellant management systems. CS successfully completed multiple hot fire tests which aligned perfectly with predictions from the CS digital twin.

Category Selection Rationale - Boeing selected the Program Management Excellence category in recognition of the program management challenges faced and overcome while **simultaneously managing** the Design, Development, Test & Evaluation (DDT&E) efforts for the **Core Stage**, **Interim Cryogenic Propulsion Stage**, and **Exploration Upper Stage** while activating the **Michoud Assembly Facility**, the **Stennis B2 Test Stand** & **Stage Controller**, and establishing Boeing **Kennedy Space Center Space (KSC) Launch System Operations**.

DIRECTIONS

- **Do not exceed 10 pages in responding to the following four descriptions**.
  - Allocate these 10 pages as you deem appropriate, but it is important that you respond to all four sections.
- DO NOT REMOVE THE GUIDANCE PROVIDED FOR EACH SECTION.
- Use 12 pt. Times Roman typeface throughout.
- Include graphics and photos if appropriate; do not change margins.

VALUE CREATION

Value: 15 points

Please respond to the following prompt:

➢ **Clearly define the value of this program/project for the corporation; quantify appropriately**

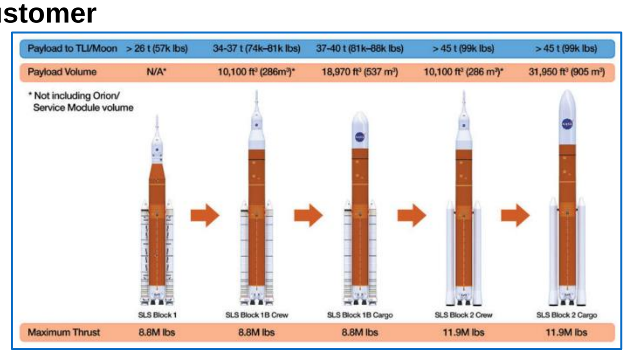
Value to the Corporation

Since 1916 the Boeing Company has been a leader in advancing state of the art aeronautical and aerospace technology and services to the nation and to the world. Boeing's participation in the SLS program is a continuation of this one-hundred-plus year legacy and is a franchise program within the Exploration Systems division.

The SLS program supports Boeing's on-going and long-term objectives as an enterprise to provide space related transportation services and capabilities to the world. Coupled with other Boeing programs such as Starliner and International Space Station operations, SLS has enabled Boeing to position itself for all future transportation and exploration related efforts within the solar system. With SLS as one of the first of many elements supporting the nation's space exploration goals, Boeing's execution on such a complex and high-performance project has positioned the company well for the numerous follow-on contracts being considered by NASA.

➢ **Clearly define the value of this program/project to your customer**

Value to the Customer



SLS Enables NASA's Long-Term Exploration Plan

Boeing's SLS program provides value by delivering to NASA the world's **safest**, most **reliable**, and **most capable human-rated** super heavy lift capability. The SLS is the primary enabling & foundational element of NASA's multi-year vision for human space exploration.

Boeing's Core Stage, Interstage, Interim Cryogenic Propulsion Stage and Exploration Upper Stage contributions to the SLS program make possible many of NASA's long-range plans for human exploration of the solar system. These critical elements were designed in conjunction with NASA to meet strenuous human design standards ensuring the safety, reliability, and long-term viability of the Lunar, Mars, Venus, and outer planet exploration programs. Further, the SLS has been designed from the onset to evolve with the exploration program as the capability needs of the program increase. This pre-planned evolutionary capability of the SLS provides value to NASA by allowing the agency to confidently rely on the SLS element as their focus turns to the development of the remaining elements of the greater exploration system.

Value to Customer	
Value	**Details**
Leveraged Launch Vehicle Experience	• Reduced Development Cost Through Reuse of Existing Launch Vehicle Design Experience • Minimized HW Development Costs by Providing Existing DIV US with Minor Modifications to create the ICPS • Verified, Complex System Test Experience • Tested Vehicle Operation During Hot Fire
Large Scale Integration	• Provided Expertise in The Creation of Very Large-Scale Aerospace Hardware • Integrated Existing Shuttle Hardware into SLS Saving Component Development Cost and Schedule
Diverse Supply Chain	• Provided Expertise Managing Complex Supply Chain • Diversified, International Reach to World Class Suppliers

➢ **Clearly define the value of this program/project to members of your team; quantify if possible**

The Artemis I launch was a major milestone in the Artemis program, which aims to land the first woman and the first person of color on the Moon by 2025. When the Space Shuttle program ended in 2011, many questions arose: how will America continue to further space exploration? Are we now dependent on international partnerships? When we will again launch a human-rated spacecraft from American soil? With the recent developments in private, commercial spaceflight, the answer of transport to Low Earth Orbit (LEO) and the International Space Station was satisfied; but for the longer duration flights – lunar and beyond – the question still remained.

The Artemis I launch was a significant achievement for NASA and the United States. Demonstrating that the United States is still a leader in space exploration and that it is committed to returning to the Moon, the launch also inspired people around the world and showed that anything is possible when we work together. While the love and yearning for space was still active in the generations between Shuttle and Artemis, it was difficult to point to a goal when recruiting for the next generation of spaceflight innovators. The Boeing SLS program leaned heavily into reinvigorating the development pipeline, with a robust intern program that resulted in high return internships and even higher rates of transition to full-time employees. Boeing also oversaw the restoration and modernization of NASA's historic Michoud Assembly Facility (MAF) in New Orleans, LA. MAF had been a production juggernaut throughout the Apollo and Shuttle eras, but waning production needs had allowed lines to grow cold and skills to diminish. Boeing partnered with NASA and local industry to create an innovative production model that starts with elementary school involvement in STEM activities, teams with local colleges to provide on-the-job training and certification, and provides existing employees multiple paths for career development.

Artemis and SLS are a huge source of pride for the Boeing teams that support the mission through outreach events, local community engagement, and employee gatherings. The pride and determination of the Boeing SLS team cannot be overstated. This energetic momentum is contagious, and the newly established MAF workforce has evolved into a vigorous and tested team whose throughput and quality increase daily. Through a pandemic, multiple named weather events, and uncertain economic environments, the team was always eager to collaborate and overcome any challenge they faced.

The Artemis I launch served as a sign of hope for the future, reminding us that we are capable of great things and that we can achieve anything as a team. For the Boeing SLS team, the success of Artemis I and the manifest ahead also reminds us that we are all connected and that we share a common destiny.

Teamwork was never more visible than during this period with the successful performance of Core Stage 1 on Artemis I, continued progress in production areas at MAF, and planning for future launches through development of new assembly approaches at NASA's Kennedy Space Center. These achievements were the culmination of years of dedicated effort performed by a seamless team, integral to building the most powerful rocket in history.

More concretely, the SLS program provides direct employment to over 1000 teammates with many others distributed across the entire national and international supply chain.

- **Clearly define the contribution of this program/project to the greater good (society, security, etc.)**

The Artemis I launch was a major milestone in human history and it will have a lasting impact on the world. While the value of human spaceflight is a complex and multifaceted issue, there are several realized benefits to sending humans into space, including:

Scientific Discovery - Human spaceflight allows scientists to conduct experiments in microgravity that would be impossible to do on Earth. This has led to a number of important discoveries, including the development of new drugs and treatments for diseases, and a better understanding of the human body and how it functions in space. The Artemis manifest will utilize the capabilities of SLS to study prolonged human presence in space and provide lasting benefit to humanity as we uncover additional facets of medical and other sciences as we expand our reach to the lunar surface and beyond.

Technological Development - In order to expand human presence into space, we need to develop new technologies, such as better materials, propulsion systems, and life support systems. These technologies can then be used to improve our lives on Earth, such as in the development of new medical devices, renewable energy sources, and more efficient transportation systems. SLS's Core Stage pioneered new production techniques that enabled stronger and lighter-weight structures, and we continue to integrate new innovations as we further the manifest.

Economic Development - Human spaceflight also leads to economic development. By investing in human spaceflight, we can create new jobs, stimulate innovation, and boost economic growth. With partners and suppliers around the country, SLS provides substantial economic impact, making Artemis' SLS truly "America's Rocket."

International Cooperation - Human spaceflight is also a powerful tool for international cooperation, with partnerships existing in a neutral territory above Earth. By working together to achieve common goals in space, we can build bridges between countries and cultures, all while continuing to encourage steadfast alliances toward bettering humanity.

In addition to these tangible benefits, human spaceflight has a number of intangible benefits, such as:

Inspiring the next generation - Human spaceflight can inspire young people to pursue careers in science, technology, engineering, and math (STEM). This is essential for ensuring that we have the talent and skills necessary to continue to innovate and progress as a society. Boeing SLS has been a leader of many STEM events throughout the country, and is proud to list *inspiration* among our priorities.

Enhancing our sense of wonder - Human spaceflight can also help us to better understand our place in the universe. By exploring space, we can learn more about our origins, our future, and our place in the cosmos.

ORGANIZATIONAL BEST PRACTICES AND TEAM LEADERSHIP

Value: 35 points

Use 12 pt. Times Roman typeface

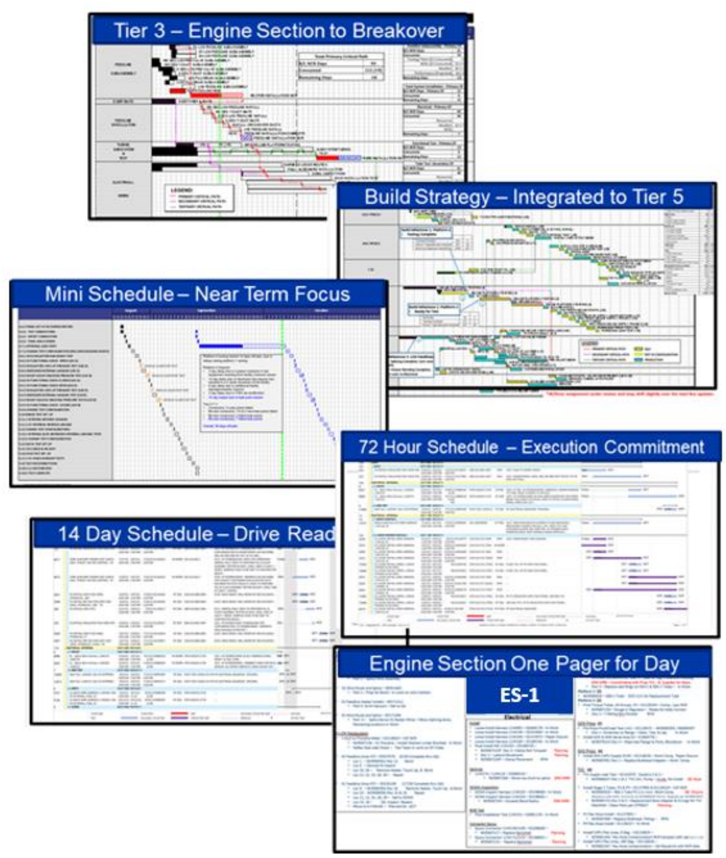
Please respond to the following prompts:

- ***15 points:* Describe the innovative tools and systems used by your team, how they contributed to performance and why**

Digital Twin – SLS program management elected to pursue a high-fidelity digital twin approach throughout all Design, Development, Test & Evaluation (DDT&E) portions of the SLS project. This integrated digital twin of the vehicle was used to predict complex system interactions within the propulsion and avionics systems and inform structural assessments of individual vehicle element and the integrated coupled loads reactions of the entire stage and fully assembled Artemis I launch vehicle. As testing results were available, the digital twin was revised to incorporate all learning from those tests. By using this approach versus older empirical approaches, SLS was able to avoid element and vehicle catastrophic test failures culminating in the successful first time launch of an entirely new class of launch vehicle for the Artemis I mission.

Organization by Integrated Product Team (IPT) – An IPT organizational approach was selected by Program Management due the complexity of the SLS program, Core Stage, ICPS, and EUS. IPT leaders were assigned to each major segment of the stage under assembly. For the Core Stage, Boeing assigned IPT leaders for Final Assembly, Engine Section, Tanks, Forward Structures, and Launch with a similar approach taken for the EUS. The IPT approach permitted team level focus on execution across all technical disciplines in all phases of the program including design, fabrication, structural qualification testing, functional and integrated testing, hot fire of stage at NASA's Stennis Space Center, and finally at KSC in preparation for launch.

Constraints Based Management System (CBMS) – Using predictive metrics, discussed later, the SLS IPT organization utilizes a constraints-based management approach for its weekly performance to plan cadence and its daily tactical execution planning. It is during these broad IPT build plan activities where the fusion of these individual predictive metrics takes place to form the comprehensive integrated constraints view required for such a complex vehicle build. The IPTs responsible for overall execution of the build activities review the output from these predictive metrics multiple times per day. Key information such as critical material shortage forecast updates, realization factors for work order completion, unplanned work impacts such as hurricanes and other such factors are assessed by a multi-discipline team of engineering and operations personnel and the revisions to the plan of the day are made. The SLS CBMS includes 3 major elements:



Detailed Integrated Scheduling System – Higher level tier 3 scheduled activities are broken down to lower tier 5 plans and are revised based on all known

constraints (component shortages, personnel availability, etc.).
Schedule Ownership Process Setup – All stakeholders in factory execution are engaged to review the tier 5 schedule for completeness and executability. The tier 5 plan is revised to address any findings before being authorized for execution on the floor. This effort results in the identification of unconstrained work orders available for future execution.
Daily Visibility Package – To ensure factory-wide comprehension of the developed plan, a visibility package is published daily which outlines not only the plan but the complete list of supporting personnel, work orders, tooling, test equipment, and processes that are planned for that day.

Results – After full implementation of this new Constraints Based IPT Management tool suite and approach, the SLS program achieved efficiency increases varying between 53% and 77% depending on the segment of the SLS vehicle build.

- ***10 points:* Define the unique practices and process you used to develop, lead and manage people?**

Boeing has put considerable effort into creating, cultivating, and expanding the workforce needed for a successful mission manifest.

From the beginning, Boeing assembled a small, diverse and multi-discipline expert team to determine the most efficient methodologies needed from proposal to launch. Team priorities – including use of LEAN processes, safety initiatives, and a Help Needed atmosphere – were made visible and ingrained into the culture as the team expanded. Diversity was also a keystone as the program matured; well-experienced experts were paired with employees recently hired from college to allow for knowledge-transfer and mentorship. As the benefit of that talent pipeline became apparent, Boeing implemented an additional hiring ramp by creating an intern program that allowed for a summer-long tenure, not only allowing for student visibility into aerospace, but also providing a pathway for experienced Boeing teammates to learn new methods and techniques from the interns. This program became a robust on-ramp for talent, and prior to the pandemic boasted a return rate of 92% for interns summer over summer, and a conversion rate of 94% for interns to full time employees.

Our local outreach is also focused on maintaining a diverse and well-populated talent pipeline. Partnerships with over 12 local community colleges and trade schools in the Huntsville, AL, and New Orleans, LA, areas have provided students with on-the-job training and certification opportunities.

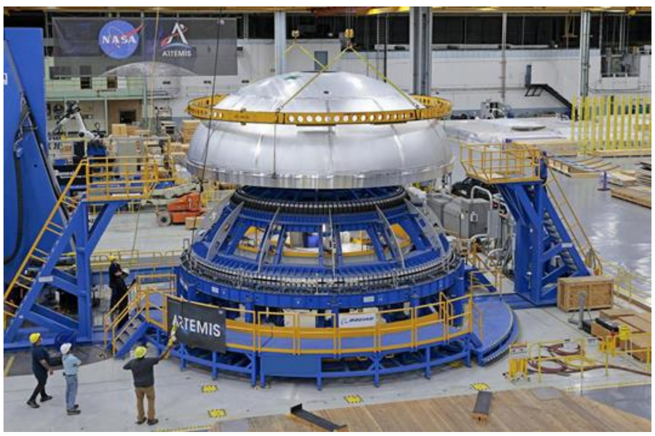
Internally, the program found ways to engage a growing, geographically-diverse team by instituting a series of lunch-and-learn sessions called the "Rocket Learning League," where any employee can volunteer to teach a topic that might be of interest to others. This provides excellent opportunities for engineers seeking Technical Fellowship experience, or high-performing employees seeking more leadership visibility to speak in front of large crowds. These sessions are archived and often referenced by new employees looking for deeper insight into a specific area or topic.

- ***10 points:* How did you leverage skills and technologies of your suppliers?**

Diverse SLS Supply Base	
Number of Unique Supplier Components	29,686
Domestic Suppliers	1083
International Suppliers	8

The SLS program has actively engaged a global supply chain to bring together a robust and diverse supply chain in support of this very complex engineering design challenge. With nearly 30,000 unique, complex and high-performance components utilized within the launch vehicle, SLS has made optimum use of this highly skilled and innovative supply chain. Presently the SLS program has over 1,000 suppliers distributed across the United States along with another 8 key international suppliers located across the world. Having access to this global supply chain has allowed SLS to meet the stringent safety and performance requirements of the program. Key technological breakthroughs by our supply chain were achieved such as the development the world's largest friction stir welding tool, 8.4m dome weld tools, and computer numerical controlled (CNC) shot peen formed dome gore panels. Additionally, Boeing was able to leverage other key suppliers and their expertise to minimize development and schedule risk by reusing key components from the Space Shuttle program including the RS-25, RL10, Thrust Vector Control System, and Cryogenic Auxiliary Power Supply among others. Although many of these components required modification and re-qualification for SLS, the benefits to the program were significant.

Key Supplier Contributions	
Component / Tool	**Description**
Vertical Assembly Center	World's Largest Friction Weld Tool
State of The Art White Light Scanning	Non-Contact Assembly Scanning Necessary to Join Complex 8.4m Diameter Vehicle Element
Dome Gore Panels	Novel Shot Peen Forming
8.4m Gore Weld Tool	Conventional & Self-Reacting Friction Stir Weld Tool



(NASA Photo) Friction Stir Welding of 8.4m SLS Domes

Vertical Assembly Center at NASA's Michoud Assembly Facility

DEALING WITH PROGRAM COMPLEXITY
(VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY, or VUCA)

Value: 25 points
Use 12 pt. Times Roman typeface
Please respond to the following prompts:

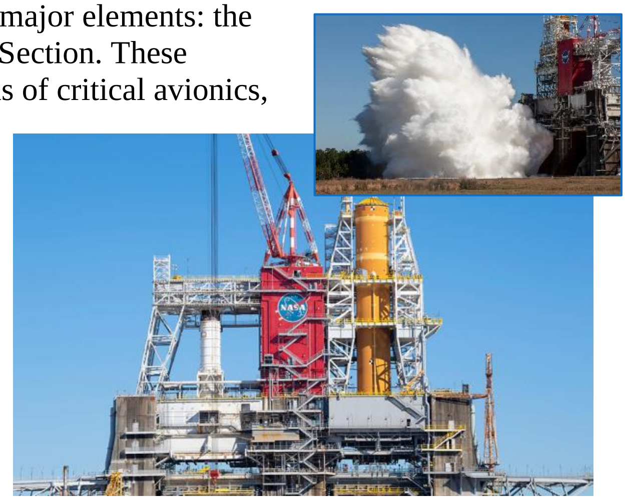
- ***10 points:*** **Describe UNIQUE areas of VUCA faced by your program and why. (Please avoid the issues surrounding Covid-19 pandemic, which was faced by all programs.)**
- ***15 points:*** **Explain how your team responded to these challenges. What changes did you make, what were the results?**

Boeing faced a number of unique challenges during the execution of the SLS program. These included the need to incorporate evolving loads & environments data, system scale, unique weather challenges, and activation of multiple sites to name a few.

Dynamic Design Management – The SLS Core Stage was designed in parallel with the design of the balance of the SLS launch vehicle. Although initial loads and dynamic predictions were made, these important design requirements evolved as additional analysis and test results were completed and incorporated into the Artemis I vehicle level coupled loads analyses. Throughout the design, build and qualification of the SLS integrated vehicle, Boeing performed over 10 separate design and verification

analysis cycles as the flight loads and environments evolved. In each of the analysis cycles, Boeing assessed impacts to current structural, avionics, and propulsion systems. Where new loads and environments exceeded available component margin, Boeing revised its design, updated all affected components in the supply chain, and continued the development cycle of the stages.
In anticipation of this requirement volatility and based on experience with other launch vehicle design programs, Boeing Program Management implemented a risk-based approach to stabilize the design of the stage. All critical components were assessed at the beginning of the program and where additional performance and design margin could be gained at minimal impact those components were modified to provide protection against this volatility. This management approach was also used across all elements of the primary structure allowing the vehicle to absorb a number of loads changes throughout the development cycle. By anticipating these changes, this approach minimized impacts across the stages.

System Complexity – At 8.4m in diameter and 64.6m in length, the SLS Core Stage is the largest and most complex 1st stage designed, built, and successfully flown in several decades. The processing and handling of this element of the SLS vehicle presented numerous challenges to the SLS program management team. The Core Stage of the SLS is comprised of 5 major elements: the Forward Skirt, LOX Tank, Intertank, LH2 Tank, and the Engine Section. These elements are assembled separately and together contain thousands of critical avionics, hydraulics, and hydrogen/oxygen connections. Each of these flight critical connections must be rigorously tested to NASA human-rating standards. Following the completion of the elements, additional connections are required and must also be tested as part of the fully integrated stage assembly. As an example, being the first launch, the Core Stage was fully instrumented with 999 flight instrumentation sensors networked to telemetry avionics boxes requiring over 45 miles of cabling. Each sensor installation required routing, full channelization and calibration.


Core Stage 1 Being Loaded into SSC B2 Test Stand

In order to track and manage these critical systems and sub-systems Boeing developed specialized planning and tracking applications. These applications, in conjunction with our large-scale manufacturing execution system ensured that all critical systems were tested and all required verification data was readily available throughout the build and in-place at each stage of the verification process culminating in a successful flight readiness review and flight.

Unique Weather Challenges - Operations at the Michoud Assembly Facility posed many weather-related challenges during the fabrication of Core Stage 1 and 2. While this facility is well suited for SLS program use, its location in proximity to the Gulf of Mexico required SLS program management to have severe weather contingency plans in place throughout the builds. At the height of the construction of Core Stage 1, MAF was impacted by Tropical Storm Cristobal (June 2020), Hurricane Zeta (October 2020), and Hurricane Ida (August 2021). These named storms resulted in significant disruption to all operations at the MAF including flooding and building damage to some of the critical areas of the facility. SLS Program Management reacted by exercising prepared contingency plans for personnel, tooling, test equipment and flight hardware to minimize these impacts. The majority of specialized tooling used in the construction of the SLS was purposefully designed for mobility. This approach to manufacturing was utilized to pick-up and relocate entire elements of the SLS Core Stage to safe locations after facility damage assessments were made. In conjunction with NASA, flight hardware elements were relocated to undamaged areas of the facility using special purpose mobile transporters. Shipside testing equipment and support areas were also relocated while facility repairs were accomplished. This rapid reconfiguration of operations mitigated production schedule losses by over 4 months resulting in minimal impact to on-going operations.

(NASA Photo) Storm Damage at Michoud Assembly Facility

Facility Activation – Numerous facilities were required to fabricate, test, and eventually launch the SLS. These included NASA's Michoud Assembly Facility, NASA's Stennis Space Center, and s NASA's Kennedy Space Center. All of these activation efforts were completed simultaneously while the vehicle was being designed and built.

Michoud Assembly Facility **(MAF)** – At the conclusion of the Space Shuttle program, many of the former space vehicle assembly capabilities of the site were no longer needed and many capabilities were suspended. Vehicle specific large tools such as the Vertical Weld Center, Vertical Assembly Center, Circumferential Dome Weld Tool, and Gore Weld Tool were procured, installed, and activated. Trained personnel required to operate these specialized tools and test equipment were in short supply in the local area.
To meet this challenge, Boeing worked closely with NASA and the state of Louisiana to bring the facility to a fully operational state to support SLS needs. Boeing embarked on an aggressive hiring and training program to meet the skilled work force needs by supplementing needed key skills from other Boeing locations around the nation and developing training programs with local colleges resulting in a sustainable source of highly skill technicians and engineers.

These and other approaches implemented by the SLS Program Management team resulted in the hiring of hundreds of local technicians and engineers enabling a gradual draw down of surge resources from other areas of the enterprise. This key initiative successfully established a continuing and sustainable source of highly skilled personnel ensuring SLS success.

Stennis Space Center **(SSC)** – Another unique aspect of the SLS program is that no Main Propulsion Test Article (MPTA) was utilized during program development. In lieu of an MPTA, the first flight Core Stage was transported via the Pegasus barge to the B2 test stand at the Stennis Space Center where it was emplaced, instrumented, fueled and hot fired twice with one full duration burn. The planning, vehicle preparation, and execution required to successfully bolt down this powerful 1st stage booster was executed flawlessly while experiencing similar weather challenges while exposed to the elements on the test stand. In order to safely fuel, operate and hot fire the stage, a complex control system was required. The Boeing Software team developed Stage Controller software to accomplish these complex controls. This software package received all telemetry from the stage, presented that data to control room personnel, and issued console operator commands back to the stage in a direct simulation of what was to come later during flight operations at the Kennedy Space Center.

As a result of this hot fire checkout approach, the need for the MPTA was eliminated and also enabled the entire stage including avionics control units, flight computers, thrust vector control system, and propellant tank pressurization systems to be operated in an integrated fashion simulating flight conditions to the maximum extent possible without flying. Throughout this phase of SLS, Boeing personnel gained direct experience in the operation of the SLS which would prove invaluable during subsequent ground and flight operations at the Kennedy Space Center.

Kennedy Space Center (KSC) – Immediately following the successful hot fire testing at the Stennis Space Center, the first flight Core Stage was transported via NASA's Pegasus barge to the Kennedy Space Center where it was taken to the Vertical Assembly Building. While Boeing has long had a presence at KSC, these personnel were primarily focused on Space Station operations and KSC support. In anticipation of needing an SLS focused and trained workforce to activate KSC operations and launch support, Boeing Program Management developed a plan to temporarily transfer key personnel from KSC to both the MAF and SSC to support build and hot fire operations and gain the direct hands on experience which would be needed at this phase of the program. This approach was very successful as was demonstrated by the short durations required to accomplish the preplanned refurbishment of ablative materials consumed during the two hot fires at SSC. Following completion of hot fire refurbishment, final preparations were made and the fully activated KSC team supported KSC in the stacking, integration, and successful launch of the full up Artemis I launch vehicle. The simultaneous activation of Boeing SLS operations at the Michoud Assembly Facility, Stennis Space Center, and the Kennedy Space Center occurred in parallel with the on-going design and build of the flight vehicle. This was a challenge to meet evolving site-specific support requirements but one that was met with demonstrated success.

Core Stage Departs MAF for Artemis I Mission to the Moon

METRICS

Value: 15 points

Use 12 pt. Times Roman typeface

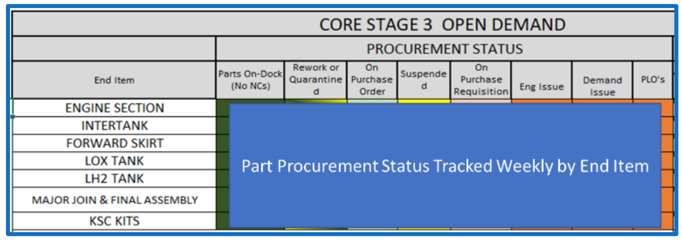
Please respond to the following prompts, where predictive metrics indicate items that provide a view of how yesterday's actions and today's actions will affect the future timeline, cost or other requirement.

Provide charts/graphs that illustrate performance to these metrics:

- **What are your predictive metrics?**

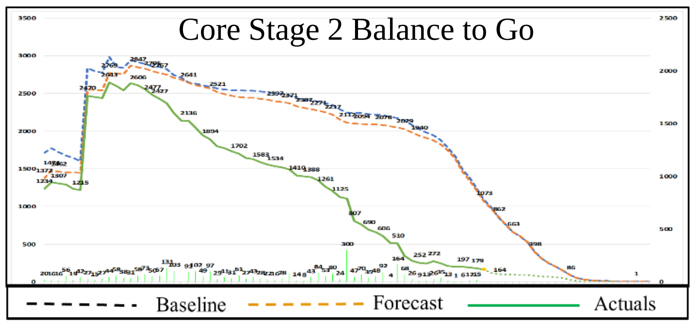
Boeing utilizes a number of predictive metrics in order to actively manage the SLS program. These include standalone measures to assess specific areas of focus but also include the fusion of these measures to achieve a broader view of program performance.

Critical Materials Management – Boeing maintains a robust and diverse supplier management (SM) organization that is responsible for delivery management of nearly 30,000 unique components used in the SLS build. To accomplish this, Boeing SM has a number of reporting mechanisms in place to track individual supplier performance and provide predictive forecasts for component delivery. Areas such as unanticipated material shortage, qualification test delays, and outside processing facility availability are a few of the routine issues encountered by the Boeing SM organization. Using the available information, Boeing SM proactively provides Boeing IPT leadership with weekly forecast updates for all SLS components to use in managing SLS assembly. Having this detailed insight into our critical materials availability informs the SLS IPTs allowing them to proactively adjust the complex build and test sequences for the vehicle using the previously mentioned constraints-based management tools.



SLS Critical Materials Tracked Weekly

Task and Labor Hour Demand Forecast – Boeing's material execution system tracks performance to plan for all activities on the factory floor. This information is aggregated daily and provided to IPT leadership. After assessing daily performance to plan, MAF Operations & IPT's are able to revise future plans in order to rebalance efforts across the 2,000,000+ square foot factory ensuring overall adherence to the production plan.



Long Range and Tactical Plans Adjusted Daily

Detailed Schedule – Boeing performs 5 tiers of scheduling within the SLS program. The tier 5 schedule provides the lowest level of scheduling and issues on the factory floor to coordinate the complexities of assembling the Core Stage (CS) and Upper Stages of the SLS. Each work order is evaluated for complexity and a forecast of required labor hours for each is compiled using industrial engineering standards for similar operations across the Boeing Company. These work order durations are then integrated using a precedence network-based factory modeling tool, Aurora, to provide a regular forecast for project progress.

➢ **How did you perform against these metrics?**

Results –After full implementation of this new Constraints Based IPT Management tool suite and approach, the SLS program has achieved efficiency increases varying between 53% and 77%.

CS1 to CS2 Performance Improvements (Aug '22 Data)	
Description	**Change**
CS1 to CS2 Labor Hours	**53% Improvement**
CS1 to CS2 Discrepancy Counts	**72% Reduction**
CS1 to CS2 Rework Hours	**77% Reduction**

Summary – Boeing Program Management excellence was demonstrated through its significant contributions to the Artemis I mission by successfully leading the design, build, test, and flight of the **most capable human-rated** launch vehicle to the moon and back on the **very first attempt**.