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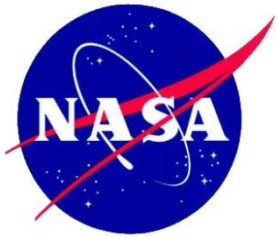
NASA's Management of the Space Launch System Stages Contract

October 10, 2018

Report No. IG-19-001



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RESULTS IN BRIEF

NASA's Management of the Space Launch System Stages Contract

October 10, 2018 IG-19-001 (A-18-008-00)

WHY WE PERFORMED THIS AUDIT

Human exploration of Mars has been a long-term goal of the United States for the past five decades. To achieve this goal, NASA is once again pursuing space travel beyond low Earth orbit, and key to this effort is development of the Space Launch System (SLS)—a two-stage, heavy-lift rocket that will launch the Orion Multi-Purpose Crew Vehicle (Orion) into space. This effort represents the largest development of space flight capabilities NASA has attempted since the first Space Shuttle was produced more than 37 years ago.

NASA contracted with The Boeing Company (Boeing) in 2012 to build two SLS Core Stages—that is, the first stage of the rocket consisting of the fuel tanks and supporting infrastructure—and later an Exploration Upper Stage (EUS), a new and more powerful second stage designed to increase the SLS's upmass capability. Originally, the first uncrewed mission of the combined SLS/Orion system known as Exploration Mission-1 (EM-1) had a launch readiness date of December 2017, while the first crewed mission of the system known as Exploration Mission-2 (EM-2) was projected to launch in mid-2021. However, due to continued production delays with the SLS Core Stage and upcoming critical testing and integration activities, current NASA schedules indicate launch dates of mid-2020 and mid-2022, respectively. With $5.3 billion expended as of August 2018 out of $6.2 billion allocated for the Boeing Stages contract, NASA expects Boeing to reach the contract's value by early 2019—nearly 3 years before the contract is supposed to end—without final delivery of a single Core Stage or EUS. As a result, the SLS Program will require a major increase in funding and renegotiation of the Boeing Stages contract to meet current launch readiness dates for the two Core Stages and EUS.

In this first in a series of audits examining NASA's management of the SLS Program, we reviewed the extent to which Boeing is meeting cost, schedule, and performance goals for development of the SLS Core Stages and EUS and the Agency's compliance with acquisition regulations, policies, and procedures supporting the SLS Program. To complete this audit, we reviewed SLS Program budget and planning documentation, analyzed Boeing contract performance evaluation reports, conducted onsite surveys, and interviewed NASA and Boeing officials.

WHAT WE FOUND

At its current rate, we project Boeing will expend at least $8.9 billion through 2021—double the amount initially planned—while delivery of the first Core Stage has slipped 2 ½ years from June 2017 to December 2019 and may slip further. Between June 2014 and August 2018, Boeing spent over $600 million more than planned on developing Core Stages 1 and 2, and NASA officials have confirmed that in FY 2018 alone Boeing expended $226 million more than planned. Cost increases and schedule delays of Core Stage development can be traced largely to management, technical, and infrastructure issues driven by Boeing's poor performance. For example, Boeing officials have consistently underestimated the scope of the work to be performed and thus the size and skills of the workforce required. In addition, development of command and control hardware and software necessary for Core Stage testing is 2 years behind schedule, while equipment-related mishaps and an extreme weather event contributed to cost and schedule delays. Individually, each of these issues may have caused only minor cost and schedule problems, but taken as a whole they have resulted in a 2 ½-year slip to the SLS Core Stage delivery schedule and approximately $4 billion in cost increases for development of the first two Core Stages. Furthermore, Boeing's cost and schedule challenges are likely to worsen given that the SLS has yet to undergo its "Green Run Test"—a major milestone that integrates and tests the Core Stage components.

Based on Boeing's current expenditure rate, NASA will need to increase the contract value by approximately $800 million to complete the first Core Stage for delivery to the Kennedy Space Center in December 2019. If the EM-1 launch takes place in June 2020, more than $400 million—for a total of $1.2 billion—would need to be added to the contract. This amount would only ensure delivery of Core Stage 1 and would not include the billions more required to complete work on Core Stage 2 and the EUS. Consequently, in light of the Project's development delays, we have concluded NASA will be unable to meet its EM-1 launch window currently scheduled between December 2019 and June 2020.

We found that several poor contract management practices by NASA contributed to the SLS Program's cost and schedule overruns. First, contrary to current federal guidance, NASA lacks visibility into the Boeing Stages contract costs because all three of the company's key activities—development of Core Stages 1 and 2 and the EUS—are co-mingled into the same contract line item number, making it difficult for the Agency to track expenditures. As a result, NASA is unable to determine the cost of a single Core Stage, which will affect the Agency's ability to determine pricing for future Core Stages. Second, we found flaws in NASA's evaluation of Boeing's performance, resulting in NASA inflating the contractor's scores and leading to overly generous award fees. Specifically, in the six evaluation periods since 2012 in which NASA provided ratings, Agency officials deemed Boeing's performance "excellent" in three and "very good" in three other periods, resulting in payment of $323 million or 90 percent of the available award and incentive fees. Considering the SLS Program's cost overages and schedule delays, we question nearly $64 million of the award fees already provided to Boeing. Third, contracting officers approved contract modifications and issued task orders to several contracts without proper authority, exposing NASA to $321.7 million in unauthorized commitments, most of which will require follow-up contract ratification. Finally, as NASA and Boeing struggle with completing the first two SLS Core Stages, the Agency's plans are on hold for acquiring additional Core Stages. Given that NASA officials estimate needing 52 months of lead time from issuing a contract to delivery, the earliest a third Core Stage can be produced is 2023, jeopardizing planned launch dates for future missions that require the rocket, including EM-2 and potentially a science mission to Europa, one of Jupiter's moons, in 2022.

To its credit, the SLS Program has taken positive steps to address management and procurement issues related to the Boeing Stages contract, including making key leadership changes; requesting reviews of Boeing's management, financial, and estimating systems; adding routine, in-depth performance reviews; and changing the procurement process to improve internal controls. However, the impact of these actions on improving Boeing's future contract performance is uncertain.

WHAT WE RECOMMENDED

To increase the sustainability, accountability, and transparency of NASA's efforts to develop the SLS Core Stages and EUS, we recommended the Agency (1) develop a corrective action plan for completing the two Core Stages and EUS; (2) direct Boeing to complete delivery of the two Core Stages and the EUS using realistic schedule assumptions and appropriate cost estimates through the end of the contract in 2021; (3) perform a complete review of the Boeing Stages contract, including an independent federal government cost estimate; (4) renegotiate the Boeing Stages contract based on both Boeing and federal government cost estimates; (5) review all SLS Program contracts overseen by the Marshall Office of Procurement; and (6) reinstitute adjectival ratings by the contracting officer representative and technical monitors of Boeing. To minimize delays tied to Core Stage availability for future missions and to obtain the best value to NASA, we recommended the Agency (7) implement, by October 2018, an acquisition strategy for building additional Core Stages beyond Core Stage 2 that includes consideration for awarding the contract as a fixed-price, end-item deliverable contract with each Core Stage separated into unique task orders. NASA management concurred with six of our seven recommendations. We consider management's comments to Recommendations 2, 3, 4, 5, and 7 responsive; therefore, those recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions. Although management concurred with Recommendation 1, we do not find their comments fully responsive. Finally, NASA management did not concur with Recommendation 6. Accordingly, recommendations 1 and 6 will remain unresolved pending further discussions with Agency officials.

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TABLE OF CONTENTS

Acronyms

CLIN	contract line item number
COR	Contracting Officer Representative
EM-1	Exploration Mission-1
EM-2	Exploration Mission-2
EUS	Exploration Upper Stage
FAR	Federal Acquisition Regulation
FDO	Fee Determination Official
FY	fiscal year
GAO	Government Accountability Office
IDIQ	indefinite-delivery, indefinite-quantity
MWI	Marshall Work Instruction
NFS	NASA FAR Supplement
OIG	Office of Inspector General
PEB	Performance Evaluation Board
SLS	Space Launch System
VAC	Vertical Assembly Center

INTRODUCTION

Human exploration of Mars has been a long-term goal of the United States for the past five decades. To achieve this goal, NASA is once again pursuing human exploration beyond low Earth orbit, and key to this effort is development of the Space Launch System (SLS)—a two-stage, heavy-lift rocket that will launch the Orion Multi-Purpose Crew Vehicle (Orion) into space. This effort represents the largest development of space flight capabilities NASA has attempted since the first Space Shuttle was produced more than 37 years ago.

In 2012, NASA contracted with The Boeing Company (Boeing) to build two SLS Core Stages—that is, the first stage of the rocket consisting of fuel tanks and supporting infrastructure.[1] The Boeing Stages contract is the largest activity within the SLS Program, and as of August 2018 comprised more than 40 percent of all program expenditures. Originally, the first uncrewed mission of the combined SLS/Orion system—known as Exploration Mission-1 (EM-1)—had a launch readiness date of December 2017, while the first crewed mission of the system—known as Exploration Mission-2 (EM-2)—was projected to launch in mid-2021.[2] However, due to continued production delays with the SLS Core Stage and upcoming critical testing and integration activities, current NASA schedules indicate launch dates of mid-2020 and mid-2022, respectively.

In 2016, NASA negotiated an increase in the value of the Boeing Stages contract of approximately $1 billion to account for delays experienced up to May 2016. In 2017, NASA negotiated additional requirements, increasing the contract's value by another $1 billion for development and production of an Exploration Upper Stage (EUS), a new and more powerful second stage designed to increase the SLS's upmass capability. With $5.3 billion out of the $6.2 billion allocated for the Boeing Stages contract expended as of August 2018, NASA expects Boeing to reach the contract's value by early 2019—nearly 3 years before the contract is scheduled to end—without final delivery of a single Core Stage or EUS. As a result, the SLS Program will require a major increase in funding and renegotiation of the Boeing Stages contract to ensure completion of the two Core Stages and EUS in time for their launch readiness dates. For these reasons, NASA designated development of the integrated Core Stage as a critical path activity on the SLS's schedule because it is the project with the most work left to do and least amount of time remaining to complete.

In this first in a series of audits examining NASA's management of the SLS Program, we examined the extent to which Boeing is meeting cost, schedule, and performance goals for development of the two Core Stages and EUS and the Agency's compliance with acquisition regulations, policies, and procedures supporting the SLS Program. See Appendix A for details of the audit's scope and methodology.

[1] Additional components of the SLS are being developed by other commercial companies, as discussed later in this report.

[2] A launch readiness date is the earliest point in time when a rocket will be certified and ready to launch.

Background

The National Aeronautics and Space Administration Authorization Act of 2010 directed NASA to build space flight systems designed to meet the Agency's long-term goal of human exploration of Mars.[3] While the Act set an initial operational date of December 31, 2016, for the SLS, NASA's original development plan for the rocket pushed the launch readiness date back 1 year to December 2017. In 2014, after completion of the SLS's preliminary design, NASA established baseline commitments for cost and schedule.[4] At that time, the Agency officially committed to a launch readiness date of November 2018 at a cost of nearly $9.7 billion to develop one SLS rocket for the EM-1 launch. However, since that time, NASA has delayed the launch readiness window for EM-1 to between December 2019 and June 2020 and now expects to exceed its original estimate for development costs by at least 15 percent.[5] As of August 2018, NASA has spent $11.9 billion developing the initial capability for EM-1, initiating a future configuration of the SLS rocket, and preparing for long-term production using separate contracts for the Core Stage, upper stage, engine development, and manufacture of solid rocket boosters.

SLS Development and Capabilities

To save costs and utilize technologies already in development, Congress directed NASA to develop the SLS by incorporating elements from the retired Space Shuttle Program and the canceled Constellation Program.[6] NASA complied with these directives and designed the SLS by leveraging the following key components and contractors:

- Four *RS-25 engines* originally designed and built for the Space Shuttle Program. NASA contracted with Aerojet Rocketdyne to prepare the engines for use in the SLS, including new controllers that communicate commands and monitor an engine's health and status.
- Two *solid rocket boosters* being built by Northrup Grumman Corporation from components used by the Space Shuttle and Constellation programs.[7] The length of the boosters was extended by adding a fifth segment that increases the amount of solid rocket fuel the boosters can hold, thereby increasing thrust capabilities.
- The *Interim Cryogenic Propulsion Stage* is the upper stage, also known as the second stage, for the initial SLS launches and is based upon a similar design used on the Delta IV rocket. Built by Boeing, the upper stage is a liquid oxygen/liquid hydrogen-based system with a single RL-10 engine and is currently stored at Kennedy Space Center (Kennedy) awaiting integration with the rest of the SLS rocket and Orion capsule for the EM-1 mission.

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[3] National Aeronautics and Space Administration Authorization Act of 2010, Pub. L. No. 111-267, 124 Stat. 2805 (2010).

[4] Per NASA Procedural Requirements 7120.5E, *NASA Space Flight Program and Project Management Requirements w/Changes 1-15* (August 14, 2012), baseline commitments for cost and schedule are made at Key Decision Point C, which occurs after the Preliminary Design Review.

[5] *Baselines and Cost Controls*, 51 U.S.C. § 30104 (2010). Schedule delays of 6 months or more or cost increases of more than 15 percent of development costs require official notification to Congress.

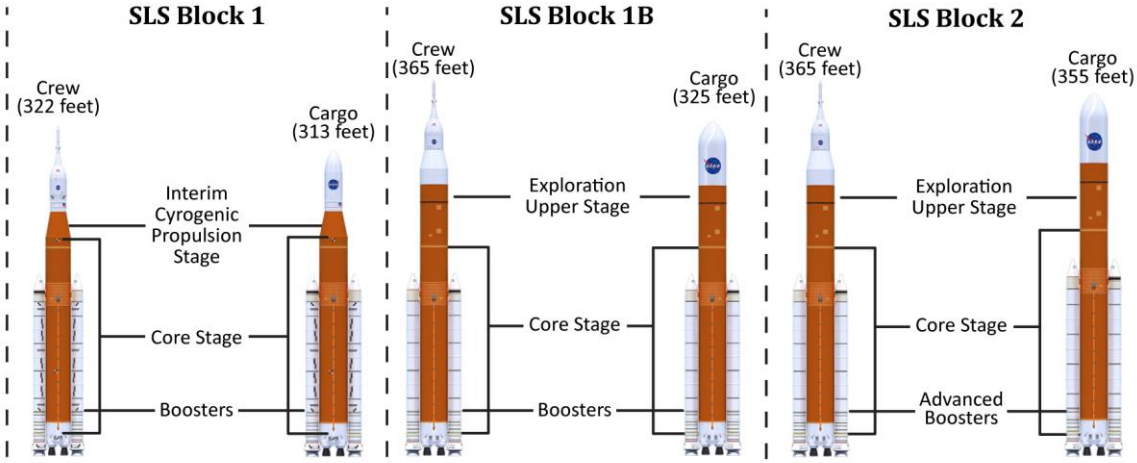
[6] Pub. L. No. 111-267. In July 2011, after 30 years and 135 crewed missions to low Earth orbit, the Space Shuttle Program completed its final flight. Designed to both replace the Space Shuttle and provide a deep space cargo and crew capability, the lunar-centric Constellation Program was canceled in 2010, well before its first mission.

[7] NASA originally awarded this contract to Alliant Techsystems, which merged in 2015 with Orbital Sciences Corporation to become Orbital ATK. In 2018, Orbital ATK was purchased by the Northrup Grumman Corporation.

- The *Core Stage* is the first stage of the SLS planned for use on all SLS configurations. Boeing is contracted to build two Core Stages and is also responsible for integrating and testing the Core Stage with the four RS-25 engines and government-provided flight control software.
- The *EUS* is an upgraded upper stage designed by Boeing for use in SLS launches beginning in 2024. The EUS uses four RL-10 engines and will be capable of transporting 35 more metric tons than the SLS configuration that uses the Interim Cryogenic Propulsion Stage.

As shown in Figure 1, NASA plans to incrementally increase SLS performance capabilities through a series of upgrades to its boosters and upper stage. The initial SLS Block 1 configuration, intended for use on EM-1, EM-2, and potentially the Europa Clipper mission, will be able to lift 70 metric tons to low Earth orbit.[8] Future launches beginning in 2024 are expected to use the SLS Block 1B configuration, which includes the EUS, to increase upmass capability to 105 metric tons. Finally, the SLS Block 2 configuration will replace the solid rocket boosters from Blocks 1 and 1B with advanced boosters that will provide the capability to lift 130 metric tons to low Earth orbit and 37 metric tons to Mars.

Figure 1: SLS Versions and Capabilities



	SLS Block 1	SLS Block 1B	SLS Block 2
Launch readiness date	2020	2024	no earlier than 2028
Vehicles needed	3	approximately 5	to be determined
Upgrades	n/a	Exploration Upper Stage	Advanced Boosters
Cargo payload fairing size (width by height)	5.1 meters by 14.3 meters	8.4 meters by 19.1 meters	10 meters by 27.4 meters
Co-manifested payload for crew version	n/a	6 to 10 metric tons	10+ metric tons
Upmass to low Earth orbit requirement	70 metric tons	105 metric tons	130 metric tons
Upmass to trans-lunar injection (cargo)	25 metric tons	41 metric tons	45 metric tons
Upmass to Mars	25 metric tons	35 metric tons	37 metric tons

Source: NASA Office of Inspector General (OIG) analysis of Agency information.

[8] The Europa Clipper mission, for which NASA has not yet decided on a launch vehicle, is an Agency science mission that plans to send a spacecraft to Europa, one of Jupiter's moons, to determine whether the icy moon could harbor conditions suitable for life.

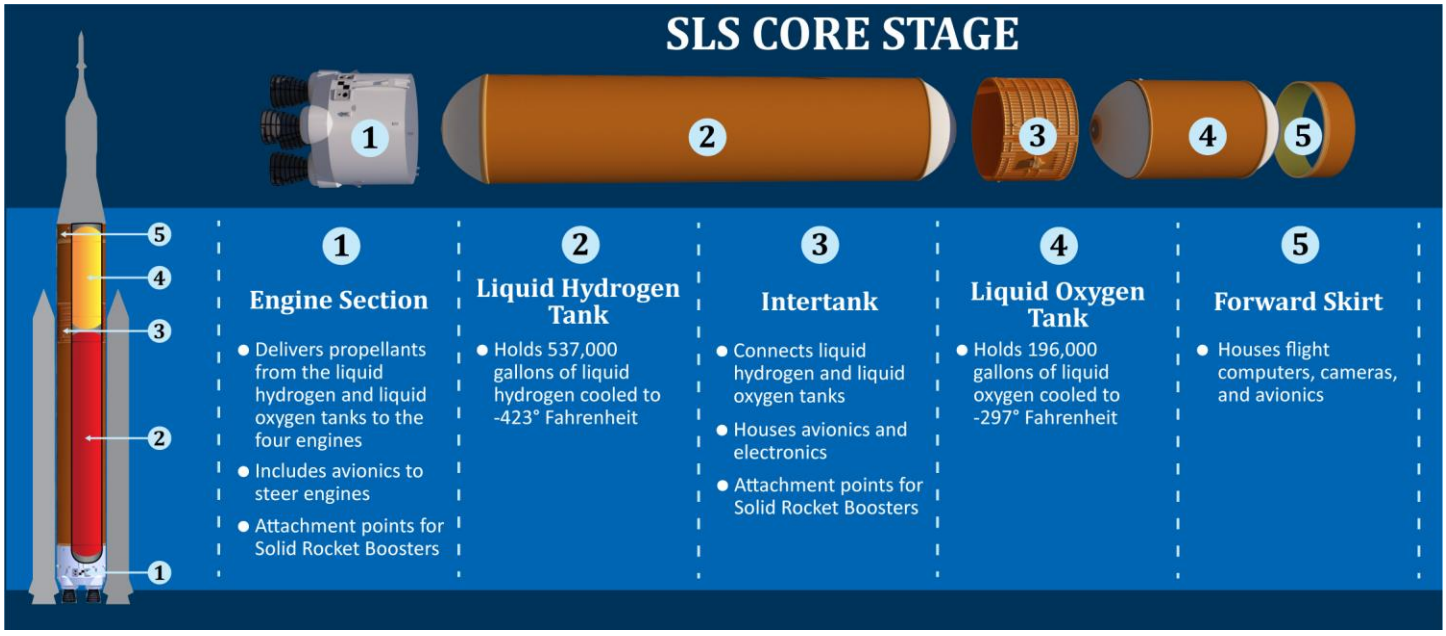
SLS Program Organization and Locations

Building the SLS is an enormous effort, with more than 1,100 contractors in 43 states working on aspects of the rocket. (See Appendix B for a list of the prime contractors.) NASA is responsible for integrating the main engines, solid rocket boosters, Boeing's Core Stage and upper stage, and NASA-run software development. The SLS Program is managed out of the Marshall Space Flight Center (Marshall) in Huntsville, Alabama. Historically, Marshall has served as NASA's lead Center for space transportation design, development, and manufacturing. In addition to the SLS Program Office, Marshall is home to SLS software testing and materials laboratories and test stands for evaluating the Core Stage structures. In addition to Marshall, the SLS Program manufactures and tests components at two other locations: the Michoud Assembly Facility (Michoud) outside New Orleans, Louisiana, manufactures the SLS Core Stage components, while the Stennis Space Center (Stennis) in Mississippi is home to the test stands used to test the RS-25 engines. Separately, Kennedy's Exploration Ground Systems Program provides the Mobile Launcher, the Vehicle Assembly Building for stacking the SLS's stages and boosters, and other ground support activities. A detailed description of these systems is found in our April 2017 report on NASA's plans for human exploration beyond low Earth orbit.[9]

SLS Core Stage

Boeing is the main contractor responsible for designing, manufacturing, testing, and evaluating the SLS Core Stage and EUS. As of August 2018, the Boeing Stages contract accounted for over 40 percent of the $11.9 billion spent on the SLS Program. As shown in Figure 2, the Core Stage is composed of five key elements: (1) engine section, (2) liquid hydrogen tank, (3) intertank, (4) liquid oxygen tank, and (5) forward skirt.

Figure 2: Components of the SLS Core Stage

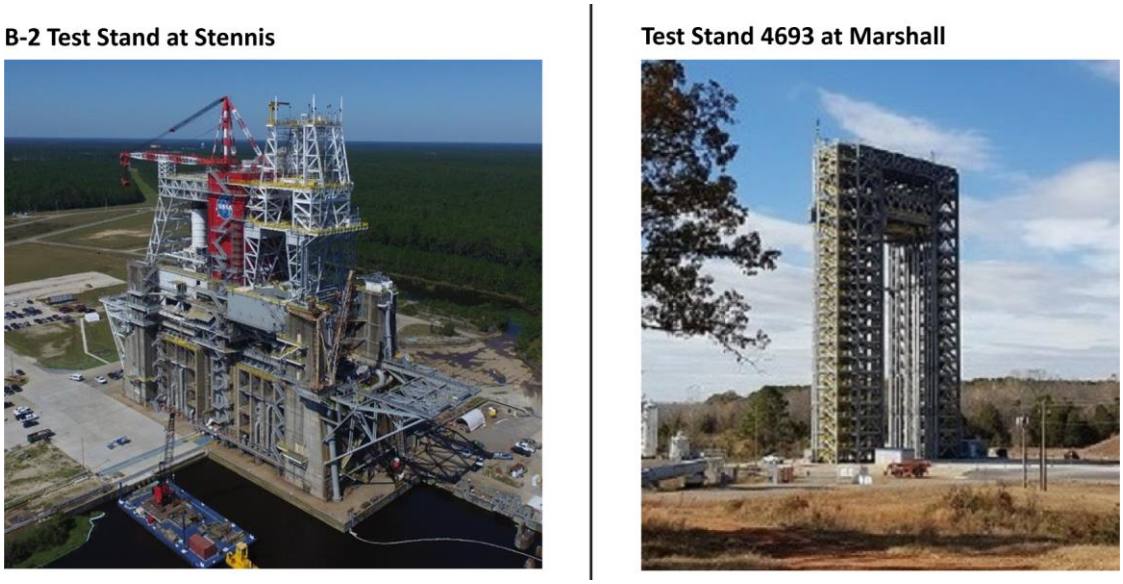


Source: NASA OIG presentation of Agency information.

[9] NASA OIG, *NASA's Plans for Human Exploration Beyond Low Earth Orbit* (April 13, 2017, IG-17-017).

The main components of the Core Stage, including the fuel tanks, are being assembled at Michoud, where NASA constructed the world's largest welding instrument—the Vertical Assembly Center. Welding operations are completed for both the flight components used for EM-1 and the qualification articles that are being tested concurrently at Marshall. As of July 2018, the primary effort at Michoud is assembling the EM-1 engine section. The four RS-25 engines with their new engine controllers will be placed into the engine section after being shipped from their testing location at Stennis. Once integrated with the other components, the completed Core Stage will be transported to Stennis for what is known as a "Green Run Test," which includes pumping fuel into the Core Stage, hot firing the engines for the planned full duration of the flight, and controlling and monitoring the Core Stage's performance.[10] While the Core Stage planned for use in EM-1 is being built, NASA is concurrently conducting qualification testing at Marshall on separate test articles, including the engine section, intertank, and hydrogen and oxygen fuel tanks. Figure 3 shows the test stands that will be used for the Green Run Test at Stennis and the hydrogen fuel tank qualification testing at Marshall.

Figure 3: Test Stands Needed for SLS Qualification



Source: NASA.

Boeing Stages Contract

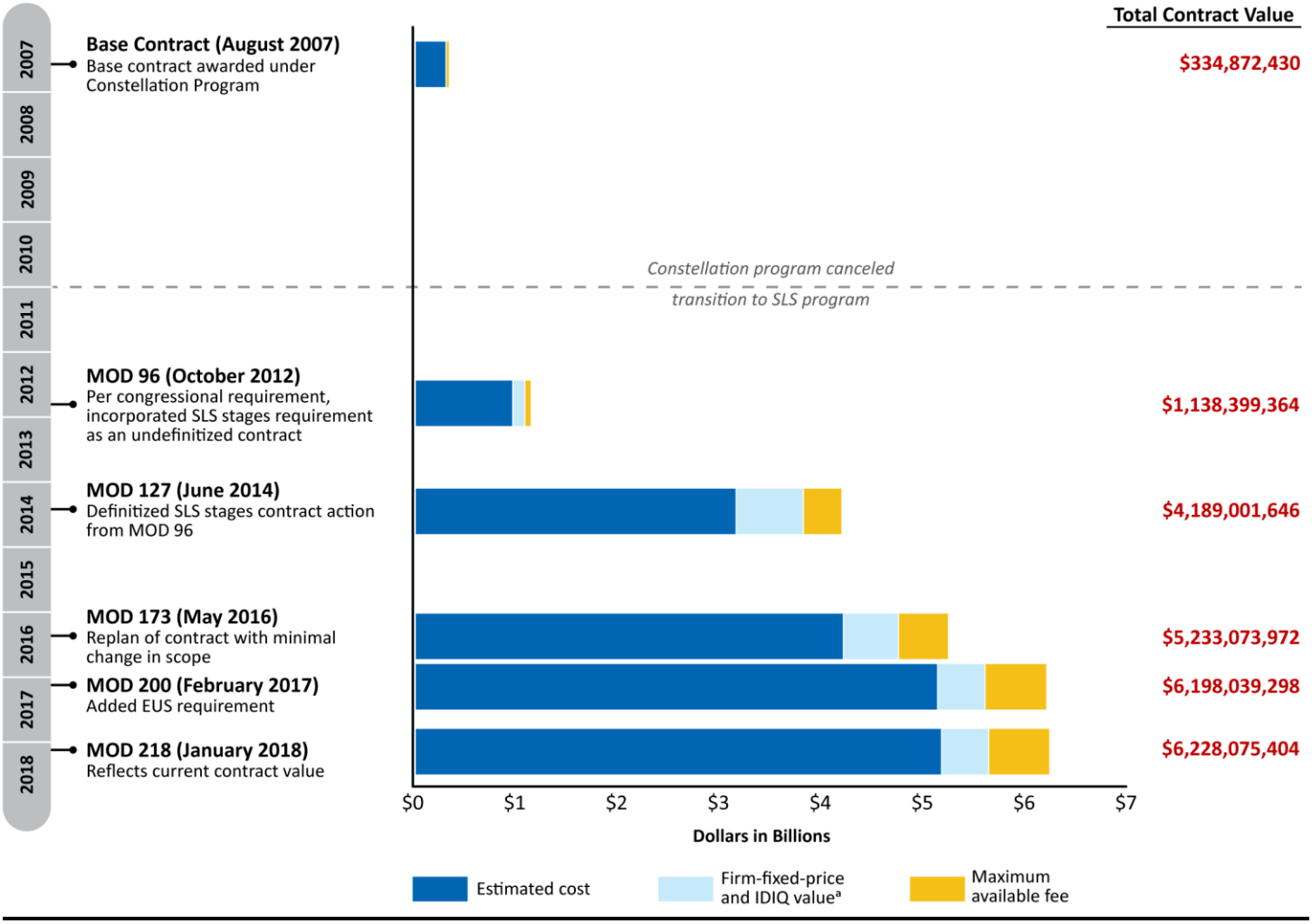
The Boeing Stages contract's current value of $6.2 billion has a performance period lasting until December 31, 2021, a date by which NASA originally anticipated Core Stages for both the EM-1 and EM-2 missions would be completed. The current agreement utilizes a combination of contract types, including cost-plus-award-fee, cost-plus-incentive-fee, indefinite-delivery, indefinite-quantity (IDIQ), and a small amount of firm-fixed-price contract work.[11] Under the contract, Boeing is required to design, build, test, and deliver two integrated Core Stages (Core Stage 1 and Core Stage 2), one EUS, and the

[10] A hot fire test is an actual firing of the rocket engines to gauge their expected performance during flight.

[11] Using this cost-plus approach, NASA approves all designs, manages all development and schedules, and owns the vehicle once delivered by the contractor. While this process gives NASA maximum control over the contractor's design and final product, the majority of the cost, schedule, and outcome risks are borne by the federal government. An IDIQ contract refers to NASA's ability to issue an undefined number of task orders for services up to a specified amount of money. A firm-fixed-price contract provides a set price that does not change even if the contractor's costs increase during performance.

supporting test articles needed to qualify the SLS.[12] Under this complex contract structure, NASA is required to reimburse Boeing for all allowable labor costs, plus pay fees based upon performance (award fees), the completion of activities by certain dates (incentive milestone fees), and material cost targets (incentive fees). This multi-prong fee structure also includes additional award fees for system integration of the Core Stage with other SLS components, such as the RS-25 engines. The fees earned are considered profit for Boeing since all costs, including allowable indirect and administrative costs, are reimbursable under the contract. Figure 4 provides a summary of the current contract value and major modifications to the contract from 2007 through 2018.

Figure 4: Boeing Stages Contract Modifications, 2007 through 2018



Source: NASA OIG analysis of Agency information.

[a] The firm-fixed-price portion of the contract is $36 million in funds provided under the American Recovery and Reinvestment Act. The IDIQ contract can be used for other work within the scope of the contract and currently has approximately $413 million in value remaining; however, the SLS contracting officer has determined this amount is unavailable for Core Stage development and production.

[12] The Interim Cryogenic Propulsion Stage was built by Boeing under a separate contract.

As shown in Figure 4, in August 2007, NASA awarded to Boeing a contract valued at $335 million as a cost-plus-award-fee contract under the Constellation Program to design, develop, and test the Ares I Upper Stage.[13] However, when President Obama canceled the Constellation Program in 2010, Congress directed NASA to utilize its current Constellation Program contracts for the SLS Program. As a result, NASA issued Modification 96 to the Boeing Stages contract in October 2012 with a total value of $1.1 billion to incorporate the SLS requirements. This agreement was an undefinitized contract action, meaning that the final contract terms and prices were not agreed to before Boeing began work on the SLS.[14] In 2014, the Government Accountability Office (GAO) cautioned NASA about the nearly 2 years it took to develop the details to finalize the contract given that NASA's policy is to try to complete such actions within 6 months.[15] In June 2014, Modification 127 finalized the contract to include delivery of two Core Stages and established an EM-1 launch readiness date of December 2017 at a cost of $4.2 billion.

In May 2016, due to anticipated delays in development and minor technical adjustments in requirements, NASA and Boeing agreed to a replan of the contract in Modification 173, which (1) altered the fee structure to add incentives for materials and delivery milestones, along with additional award fees for system integration; (2) added approximately $1 billion to the contract; and (3) extended the EM-1 launch readiness date to July 2018.[16] In February 2017, NASA signed Modification 200, worth approximately $1 billion, to add EUS development for EM-2, bringing Boeing's total contract value to $6.2 billion. As of August 2018, NASA has expended approximately $5.3 billion (86 percent) of the $6.2 billion. In addition, NASA is currently estimating an EM-1 launch date of June 2020—almost 2 years later than the contracted replan date of July 2018.

The $6.2 billion Core Stages contract value is comprised of multiple contract line item numbers (CLIN) used to identify the tasks to be performed and the costs estimated to complete those tasks. As indicated in Figure 5, CLIN 9 encompasses the development and production of two Core Stages and one EUS with an assigned contract value of $4.3 billion for costs and $512 million for award and incentive fees. Additional CLINs are assigned for other work within the scope of the contract (CLIN 12), initial transition work on the SLS from 2011 to 2012, and work that was completed under the Constellation Program. See Appendix C for additional breakouts of SLS contract values.

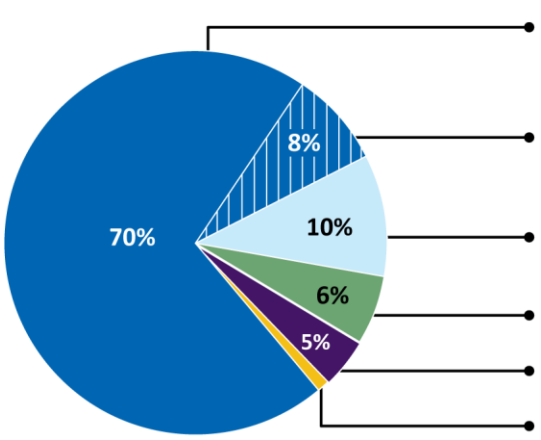
[13] The Ares I was a two-staged crew launch vehicle developed in 2005 as part of NASA's Constellation Program for missions to the International Space Station and the Moon. The Ares I Upper Stage was designed to use one J-2X engine.

[14] According to the NASA Federal Acquisition Regulation (FAR) Supplement (NFS), "undefinitized contract action" means a unilateral or bilateral contract modification or a delivery/task order in which the final price or estimated cost and fee have not been negotiated and mutually agreed to by NASA and the contractor. NFS § 1843.70, *Undefinitized Contract Actions* (2016).

[15] In 2014, GAO concluded that employing SLS contractors for extended periods of time without contract definitization led to increased government risk of rising costs and limited the program's ability to monitor contractor progress. GAO, *Space Launch System: Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability* (GAO-14-631, July 23, 2014). The NFS provides that the NASA goal is to definitize contracts within 180 days, or approximately 6 months, of issuance. NFS § 1843.7005(a), *Definitization* (2018).

[16] The altered fee structure was proposed by NASA after being utilized in the Aerojet Rocketdyne contract to shift production to the RS-25 engine for the SLS. According to NASA, the available fees are divided by labor hour costs (performance award fees), material costs (incentive fees based on cost savings), system integration (performance award fees), and delivery milestones (incentive fees if met) to incentivize Boeing to meet cost and schedule targets for EM-1 and EM-2.

Figure 5: Boeing Stages Contract Value (dollars in millions)



Develop/produce two Core Stages and one EUS (captured under CLIN 9)	$4,338
Award and incentive fees for CLIN 9	512
IDIQ funding for other work within the scope of the contract (captured under CLIN 12)	650
Canceled Constellation Program funding	375
SLS transition, 2011 to 2013	299
1%, Other[a]	54
Total contract value	**$6,228**

Source: NASA OIG analysis of Agency data.

[a] "Other" includes the completed fixed-price portion of the contract and travel-related funding.

Monitoring Boeing's Performance

Boeing's performance on the contract is evaluated on an ongoing basis by NASA to determine the amount of fees they earn each assessment period. These award and incentive fees are in addition to the amounts NASA pays Boeing to reimburse it for actual costs incurred. The current Boeing Stages contract includes multiple types of fees: (1) award fees related to CLINs 9 and 12, including all of the work associated with the two Core Stages and EUS; (2) system integration award fees related to the SLS Core Stage; (3) provisional incentive fees for meeting the material cost targets; and (4) incentive fees for meeting delivery milestones.[17] As of the September 30, 2017, NASA had paid Boeing nearly $323 million in award and incentive fees ($265 million and $58 million, respectively) for work performed, or about 90 percent of nearly $359 million in award and incentive fees ($297 million and $62 million, respectively) available through the end of the most recently completed performance period.[18] Prior to the replan modification in 2016, the only fees available under the contract were award fees for CLINs 9 and 12; incentive and system integration award fees were added as part of the 2016 replan. Under the Boeing contract, the negotiated fee percentage is 12.5 percent of costs.

[17] According to the FAR, in order to improve the accuracy, traceability, and usability of procurement data, procurement instruments shall identify the supplies or services to be acquired as separately identified line items and, as needed, subline items. Line items are established to define deliverables or organize information about deliverables. Each line item describes characteristics for the item purchased, for example, pricing, delivery, and funding information. FAR § 4.10, *Uniform Use of Line Items* (2018). Fees for meeting the material cost targets are provisional, or not finalized, until the period of performance on the contract is completed.

[18] This total fee amount NASA awarded to Boeing does not include $87 million in fees for Ares-related work and transition to the SLS Program.

The amount of award fees a contractor earns are designed to be commensurate with the contractor's level of performance based on NASA-developed evaluation factors. For every award-fee contract, NASA develops an award-fee plan that defines the guidelines under which a contractor's performance is rated; however, much of NASA's review of the contractor's performance is based on subjective rather than objective factors.[19] Each evaluation factor receives a separate score, with the results rolled up into an overall grade that reflects the percentage of the available award fee the contractor is entitled to receive during a particular assessment period. Each evaluation factor has a weighted effect on the final grade. For example, if cost management received a grade of 80 percent it would contribute 20 percent toward the final grade or fee amount (0.80 X 0.25 = 0.20). Table 1 shows the evaluation factors for CLINs 9 and 12 and the system integration award fee. The system integration award fees are part of CLIN 9 but are evaluated separately for performance.

Table 1: Award Fee Evaluation Factors for CLINs 9 and 12 and System Integration Fees

CLINs 9 and 12 Award Fee Evaluation Factors	Factor Weights for CLINs 9 and 12 Award Fee Evaluation Factors		System Integration Award Fee Evaluation Factors	Factor Weights for System Integration Award Fee Evaluation Factors
Management	30%		Management	35%
Cost management	25%		Cost management	25%
Technical performance	35%		Technical performance	40%
Small business/small disadvantaged business subcontracting goals	10%		n/a	n/a

Source: NASA award-fee plans and Performance Evaluation Board reports for Boeing Stages contract.

Award-fee contracts like the Boeing Stages contract require extensive monitoring of a contractor's performance in order to appropriately determine the amount of award fees a contractor is entitled to during a specified period of performance—usually every 6 to 12 months. In accordance with NASA and Marshall guidance, for every evaluation period the SLS Contracting Officer Representative (COR) categorizes the strengths and weaknesses of a contractor as identified by technical monitors assigned to the SLS Program.[20] The COR then provides both a numerical rating and an adjectival (descriptive) rating to the Performance Evaluation Board (PEB) for its consideration.[21] Upon review, the PEB provides its recommendations on the amount of award fee to the Fee Determination Official (FDO) for final approval. Once approved, the fees are provided to the contractor and any unearned fees cannot be rolled over to the next performance period. For the Boeing Stages contract, NASA makes monthly provisional fee payments of 80 percent of the available fee for that period but the SLS contracting officer has the discretion to reduce this payment based on contractor performance. The final amount is determined at the end of the performance period, currently 12 months. In addition, because the Boeing

[19] Marshall Work Instruction (MWI) 5116.1, *Evaluation of Contractor Performance Under Contracts with Award Fee Provisions* (2015). The award-fee plan identifies the procurement, scoring system, weights, organization, and measurable factors, subfactors, and criteria, as applicable, and the definitions of strengths and weaknesses, including significant strengths, significant weaknesses, and observations.

[20] MWI 5116.1. A COR is appointed in writing by a contracting officer with specific duties to help manage the contract, while technical monitors are appointed by the COR to monitor and provide feedback on the contractor's performance.

[21] MWI 5116.1. The PEB is responsible for evaluating the contractor's overall performance for each award-fee evaluation period based on input from the technical monitors, COR, contracting officer, and Stages Element Program Manager. The PEB, led by the Chairperson (SLS Program Manager), is composed of three members—the Director of the Office of the Chief Financial Officer, Chief SLS Engineer, and Director of Marshall Procurement—and two alternates.

Stages contract is classified as a "service" rather than an "end-item" contract, the fees earned by the contractor each period are final and the federal government cannot recoup those fees even if poor performance issues are subsequently identified for that period.[22] Similarly, any award fee not paid during a performance period cannot later be claimed by or awarded to the contractor. Other NASA space flight programs such as Orion use the end-item contract formulation in which interim or provisional payments are made but overall award fee amounts can be adjusted during the final performance period's evaluation. Figure 6 shows the numerical and adjectival ratings found in the Boeing Stages contract.

Figure 6: Boeing Stages Contract Award-Fee Performance Ratings

Source: NASA OIG presentation of Agency criteria.

Since 2012, Boeing, on average, has received a "very good" rating and earned $265 million (89 percent) of the total available award fees for its performance on developing the Core Stages, EUS, system integration, and other work within the scope of the contract (CLINs 9 and 12). In order to achieve a "very good" rating, NASA expects the contractor to exceed many of the criteria used for evaluation and meet, in the aggregate, the contract's overall cost, schedule, and performance requirements. According to the criteria, the contractor should not receive any award fees if it fails to meet these requirements. Likewise, if the contractor's overall performance is no higher than "satisfactory," it should not receive

[22] FAR Part 37 states a service contract "directly engages the time and effort of a contractor whose primary purpose is to perform an identifiable task rather than to furnish an end item of supply." FAR § 37.101, *Service Contracts* (2015). Per the FAR, for service contracts each evaluation is final, whereas for end-item contracts only the last evaluation is final, when true quality of contract performance can be measured after the item is delivered. NFS § 1816.405-273, *Award Fee Evaluations* (2018). At that point, the total contract award-fee pool is available for consideration and the contractor's total performance is evaluated against the award-fee plan to determine total earned award fee.

more than 50 percent of available award fees. Tables 2 and 3 show the total amount of award fees earned by Boeing since 2012 for CLINs 9 and 12, respectively.

Table 2: Boeing Stages Contract Award Fee Performance Ratings for Development Efforts under CLIN 9

Evaluation Period and Schedule	Potential Award Fee Amount	Total Earned Award Fee Amount	Unearned Award Fee Amount	Score	Rating
Preliminary Design Review 11/1/2012–3/31/2013	$11,212,414	$11,212,414	$0	n/a	n/a
Period 1 11/1/2012–9/31/2013	50,455,864	46,419,394	4,036,470	92	Excellent
Period 2 10/1/2013–6/30/2014	65,001,722	60,451,601	4,550,121	93	Excellent
Period 3 7/1/2014–2/28/2015	50,000,000	39,500,000	10,500,000	79	Very good
Period 4 3/1/2015–10/31/2015	39,467,380	35,520,642	3,946,738	90	Very good
Period 5 11/1/2015–9/30/2016	17,678,816	16,441,299	1,237,517	93	Excellent
Period 6 10/1/2016–9/30/2017	28,429,081	24,449,009	3,980,072	86	Very good
Total amounts/average scores	**$262,245,277**	**$233,994,359**[a]	**$28,250,918**	**89**	**Very good**

Source: NASA OIG analysis of Agency data.

[a] The total award fee earned for CLIN 9 does not include the $11.2 million for system integration in 2016 and 2017, which is evaluated separately.

Table 3: Boeing Stages Contract Award Fee Performance Ratings for CLIN 12

Evaluation Period and Schedule	Potential Award Fee Amount	Total Earned Award Fee Amount	Unearned Award Fee Amount	Score	Rating
Period 1 11/1/2012–9/31/2013	$478,504	$440,224	$38,280	92	Excellent
Period 2 10/1/2013–6/30/2014	804,278	747,979	56,299	93	Excellent
Period 3 7/1/2014–2/28/2015	2,407,517	1,901,938	505,579	79	Very good
Period 4 3/1/2015–10/31/2015	3,517,808	3,166,027	351,781	90	Very good
Period 5 11/1/2015–9/30/2016	7,321,120	6,808,642	512,478	93	Excellent
Period 6 10/1/2016–9/30/2017	7,725,425	6,643,866	1,081,559	86	Very good
Total amounts/average scores	**$22,254,652**	**$19,708,676**	**$2,545,976**	**89**	**Very good**

Source: NASA OIG analysis of Agency data.

The Boeing Stages contract also includes two types of incentive fees intended to reward Boeing's ability to meet material cost targets and delivery dates. Unlike award fees, these fees are based on defined, objective criteria. Final material cost targets are not assessed until the end of the contract; however, provisional payments are made monthly. As of August 2018, Boeing has received approximately $64 million (80 percent) in provisional incentive fee payments for material cost targets. The total target incentive fee for material costs of $80 million could increase up to $120 million or decrease to $20 million depending on how well Boeing manages the material costs for the entire contract period. In addition, Boeing can receive incentive milestone fees if it meets specified target delivery dates. For example, NASA did not pay Boeing an incentive milestone fee for delivery of Core Stage 1 to Stennis for testing between September 2017 and November 2017 because it failed to meet the delivery schedule. Of the nine milestones through August 2018, Boeing has met four and earned approximately $6.5 million of an available $19 million (34 percent).

COST AND SCHEDULE OVERRUNS FOR THE BOEING STAGES CONTRACT ARE UNSUSTAINABLE

At Boeing's current expenditure rate, we project that NASA will spend at least $8.9 billion through 2021—double the amount initially planned—while delivery of the EM-1 Core Stage to Kennedy has slipped 2 ½ years from June 2017 to December 2019. Cost increases and schedule delays of Core Stage development can be traced largely to management, technical, and infrastructure issues driven by Boeing's poor performance. Boeing's cost and schedule challenges are likely to worsen given the SLS has yet to undergo its Green Run Test—a major milestone that integrates and tests the Core Stage components. Based on Boeing's current expenditure rate, NASA will need to increase the contract value by approximately $800 million to complete the first Core Stage for delivery to Kennedy in December 2019. To meet an EM-1 launch date of June 2020, NASA would need to place an additional $400 million on the contract—for a total of $1.2 billion. This $1.2 billion would not include the billions more required to complete work on Core Stage 2 and the EUS. Consequently, in light of the Project's development delays, we have concluded NASA will be unable to meet its EM-1 launch window currently scheduled between December 2019 and June 2020.

Core Stage Development Suffers Major Cost Overruns and Schedule Slippage

As of August 2018, NASA had obligated approximately $5.3 billion (86 percent) of the $6.2 billion Boeing Stages contract.[23] With only $354 million remaining on CLIN 9 for building two Core Stages and the EUS, both NASA and Boeing anticipate exceeding the contract ceiling for CLIN 9 sometime between December 2018 and February 2019—3 years before the current scheduled contract end date of 2021 and prior to delivery of a single Core Stage or completion of the EUS. Federal contracting laws prohibit NASA from exceeding the contract value absent a contract modification. Further, an increase to the contract value without substantially changing the scope of work is considered a cost overrun, a scenario under which NASA would pay a reduced or no award fee on the additional costs. Consequently, NASA and Boeing will need to renegotiate the contract terms, amount of cost overrun, and schedule. Based on our audit work, we expect this next contract modification will require both a major increase in value and an extension of the delivery schedule for the two Core Stages and EUS.

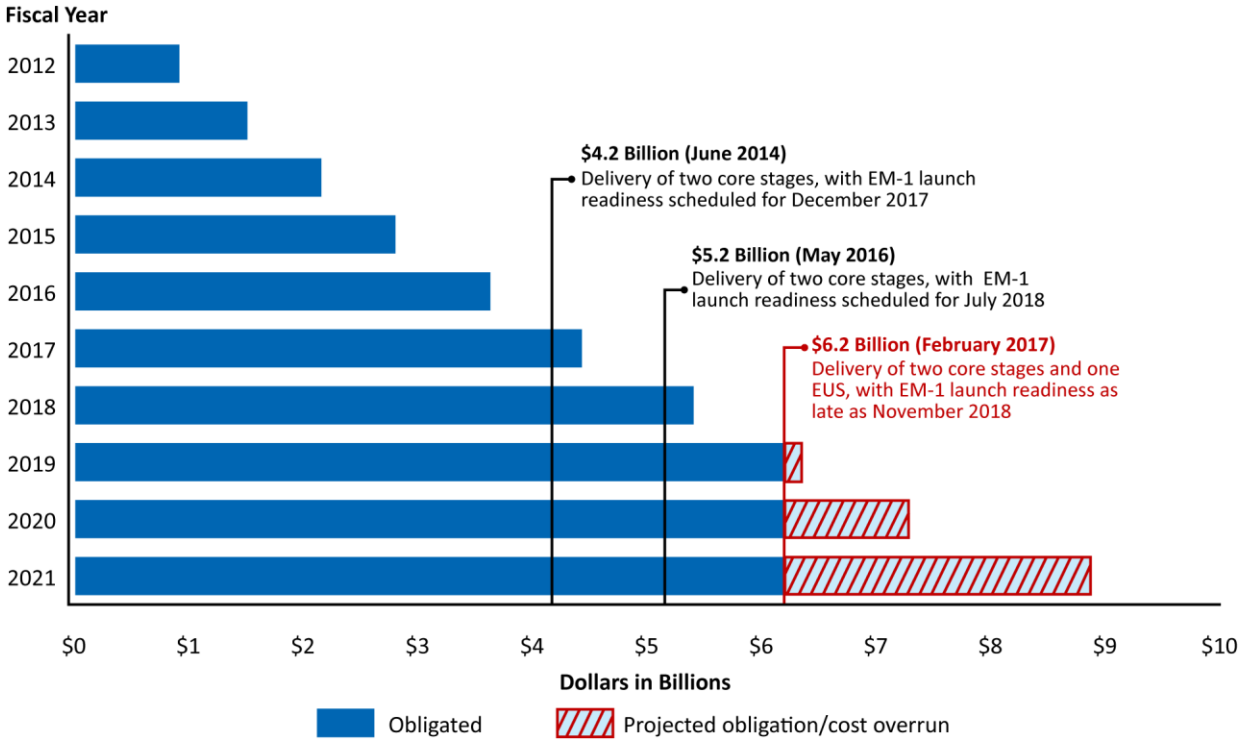
Between June 2014 and August 2018, Boeing spent over $600 million more than planned on developing the two Core Stages.[24] To cover these additional costs, Boeing has been using funds intended for EUS development, while NASA has been relying on SLS Program reserves. In 2018, the SLS Program increased its yearly reserves from 1 percent to 5 percent of development costs, and the resulting fiscal

[23] The remaining value includes $354 million of CLIN 9 work plus associated award fees and $413 million for task orders to cover unplanned work that falls within the scope of the contract, such as SLS software development, acquisition of flight computers, and additional work at Michoud.

[24] Overall, NASA has spent approximately $1 billion more than the 2014 definitized contract value of $4.2 billion, which includes NASA's estimate of $372 million spent on the EUS between fiscal year 2015 and April 2018 and is not included in the $600 million spent to develop the two Core Stages.

year (FY) 2018 reserve of $123 million will be used to cover increased costs for the two Core Stages. In addition, NASA officials have confirmed that in FY 2018 alone Boeing expended $226 million more than planned. If the EM-1 launch is delayed to June 2020, NASA will need to add $1.2 billion to the contract based on the Project's current expenditure rate. Additionally, using the same spending rate through the current contract period, we project that Boeing will expend at least $8.9 billion by December 2021 to complete one Core Stage while continuing work on the second Core Stage and EUS.[25] This amount does not include the additional funds that will be needed to complete the EUS by the first Block 1B mission scheduled for 2024. Figure 7 shows NASA's obligations on the Boeing Stages contract from FY 2012 through August 2018 and the projected obligations using the current spending rate for the remainder of FY 2018 through December 31, 2021.

Figure 7: Actual and Projected Obligations of Boeing's Stages Contract, 2012 through 2021



Source: NASA OIG analysis of Agency obligation data in NASA's accounting system and Boeing cost reporting data.

According to Boeing, the total contract value would be closer to $7 billion because material and labor costs would decrease as the current scope of work winds down through the end of the contract in 2021.[26] Boeing's projection assumes the average expenditure rate for the current scope of work

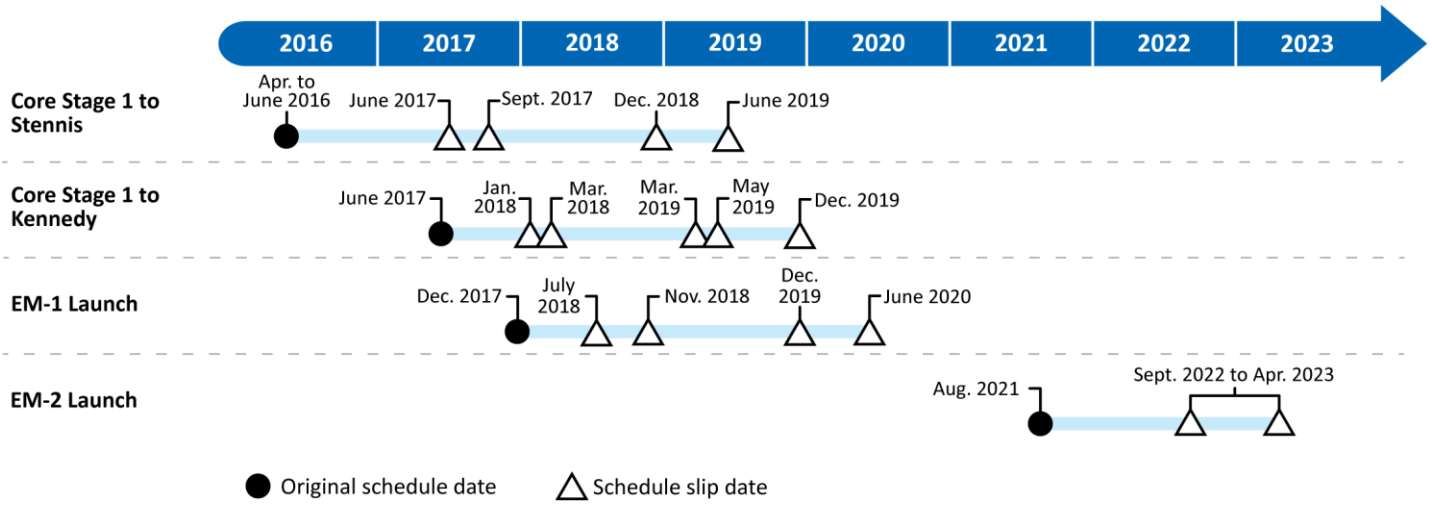
[25] The total estimated cost of $8.9 billion is calculated by adding the total obligations of $5.3 billion through August 2018, applying the average 2018 billing rate of $78 million per month through 2021, and adding the remaining $413 million available on the IDIQ portion of the contract. The unobligated IDIQ amount is reflected in the 2021 projection of Figure 7. As of May 2018, Boeing's work plan estimated that its total contract cost will be $6.6 billion and that 77 percent of the estimated labor hours to deliver two Core Stages and the EUS have already been completed. However, as of July 2018, official NASA estimates show Boeing completing only 48 percent of the technical man hours needed to finish the first Core Stage.

[26] Boeing's $7 billion projection included the total contract value of $6.2 billion, $400 million in projected cost overruns tracked through the company's Earned Value Management System and monthly reports, and an additional $400 million to account for costs associated with manifest changes to use the SLS Block 1 configuration for EM-2 and to delay first use of the SLS Block 1B and EUS to roughly 2024.

(CLIN 9) will fall about 60 percent to $28.8 million a month from the 2018 average of $78 million a month.[27] However, in our judgment such a decrease in costs is extremely optimistic because CLIN 9 activities will not wind down by the end of the contract in 2021. Specifically, for CLIN 9, Boeing still needs to complete integration, Green Run testing, and delivery of Core Stage 1 by mid-2020 and Core Stage 2 by 2022. Additionally, the EUS work and related costs will continue to at least 2024 as NASA plans to use the EUS on the first SLS Block 1B launch. Indeed, NASA's past experience has shown that development costs for large space flight programs increase rather than decrease once integration and testing occurs and new problems are identified.

In addition to increased costs, the SLS Program also experienced a series of significant schedule delays (see Figure 8). While NASA officials attribute the schedule slips primarily to Boeing's technical and managerial problems with Core Stage 1, Boeing officials told us the initial delays were caused by insufficient funding. Specifically, in late 2014, Boeing reported to NASA that the contract was underfunded for 2015 and therefore the contractor could not maintain its delivery schedule for the two Core Stages. However, we found that while at the beginning of FY 2015 Boeing anticipated receiving $150 million less than requested, by the end of FY 2015, the company had received $706 million, only $53 million less than requested for its work to build two Core Stages. In addition, due to a congressional "plus-up" the following year, Boeing received approximately $200 million more than what NASA estimated was needed to meet the original 2017 launch schedule. Further, in May 2016 NASA added almost $1 billion in additional contract value—bringing the total contract value to $5.2 billion—with only minimal changes in the scope of work while also delaying the launch readiness date for EM-1 by 7 months from December 2017 to July 2018. According to NASA officials, the schedule slippage cannot be explained by a lack of adequate funding.

Figure 8: Boeing Schedule Slips, 2016 through 2023



Source: NASA OIG presentation of Agency information.

[27] From September 2018 to December 2021, Boeing's projection assumes the remaining $354 million contract value on CLIN 9 and an additional $800 million, totaling $1.154 billion, will be spent to deliver the two Core Stages and EUS. Historical expenditures on CLIN 9 work have not fallen to the level suggested in Boeing's projection and instead have averaged $61.8 million a month since 2012.

Cost Increases and Schedule Delays Primarily Caused by Poor Contractor Performance

We found Boeing's poor performance is the main reason for the significant cost increases and schedule delays to developing the SLS Core Stage. Specifically, the Project's cost and schedule issues stem primarily from management, technical, and infrastructure issues directly related to Boeing's performance. Individually, each of these issues may have caused only minor cost and schedule problems, but taken as a whole these issues have resulted in approximately $4 billion in cost increases for development of the first two Core Stages and EUS and a 2 ½-year schedule slip for delivery of the first Core Stage to Kennedy.

Several key management issues contributed to the Project's cost and schedule dilemma:

- Boeing officials have consistently underestimated the scope of the work to be performed and thus the size and skills of the workforce required to perform specialized work such as electrical tasks and building the rocket's Thermal Protection System.[28] For example, when Boeing realized that it needed a larger workforce to build the Core Stage, the contractor had difficulty attracting qualified technical and support employees, preventing it from quickly adding additional personnel. Specifically, once a decision was made to hire new employees, it took 4 to 6 months for Boeing to reach adequate staffing levels, which according to NASA officials, was a significant weakness. In an effort to keep the Core Stage on schedule, SLS Program officials allocated an average of $10 million per month from August 2017 through July 2018 to increase Boeing's labor hours, including additional shifts at Michoud. However, despite the increased labor hours, the Project's schedule remains delayed. This is partly due to a lack of work efficiency, as recent NASA and Boeing work assessments found that while approximately 80 percent of scheduled tasks begin on schedule, only 35 percent to 57 percent are completed on time.
- Boeing has been unable to consistently provide NASA realistic cost and schedule estimates for completing the two Core Stages and EUS. For example, as of July 2018, a NASA technical monitor found that Boeing had completed only 48 percent of Core Stage 1 compared to a planned completion rate of 83 percent. In contrast, neither NASA's or Boeing's Earned Value Management System track the progress and costs of Core Stage 1, making it impossible to monitor the Project's status through official estimating systems.[29] This discrepancy is due to inaccurate Boeing data used as the basis for NASA's reporting. In May 2018, the Defense Contract Management Agency reported that Boeing's estimated costs to complete work on the two Core Stages and the EUS were unrealistic and overly optimistic due to inaccurate and incomplete information in Boeing's Earned Value Management System.[30] This lack of reliable information makes it more difficult to provide realistic cost and schedule estimates to NASA managers and external stakeholders. Illustrative of this situation is the 2016 replan of the

[28] The Thermal Protection System is insulation that prevents heat generated during launch from affecting the stability of the cryogenic propellants and compromising the rocket's structural integrity.

[29] Used by both NASA and Boeing for the SLS Program, the Earned Value Management System is an integrated management control system for assessing, understanding, and quantifying the technical progress achieved with project dollars.

[30] Defense Contract Management Agency, *Earned Value Management System (EVMS) Surveillance Report on Boeing Stages Contract* (May 25, 2018). The Defense Contract Management Agency provides a broad range of contract-procurement management services for the Department of Defense and NASA.

Boeing Stages contract. Just prior to the replan, Boeing reported that its estimated cost at contract completion would match the original contract value of $4.2 billion without any overruns; however, at that same time, NASA had already determined that Boeing had $200 million in cost overruns.[31]

In addition to these management issues, we identified four technical issues that contributed to increased costs and schedule delays in the Boeing Stages contract:

- Development of the command and control hardware and software needed to conduct the Core Stage Green Run Test at Stennis—known as the "Stage Controller"—is 18 months behind the 2016 schedule. As a result, operational readiness at Stennis has slipped to at least May 2019, with a possible further delay of up to 90 days due to ongoing technical challenges. NASA officials said Boeing underestimated the scope of effort needed to develop the Stage Controller and failed to assign enough staff to the Project early in its development. Boeing officials told us they now understand all the requirements necessary to complete development of the Stage Controller and have made leadership changes to keep the Project on track going forward.
- While installing rocket fuel tubing in the engine section of Core Stage 1, Boeing found contamination in one of the contractor-supplied tubes that resulted from improper cleaning prior to shipment. A subsequent investigation found similar contamination in other tubes, leading Boeing to inspect all fuel tubes, including ones already installed. This resulted in corrective actions for 293 of the 907 tubes, causing a 2- to 3-month delay.
- Boeing uses Michoud's Vertical Assembly Center (VAC), the world's largest robotic welding tool, to piece together the Core Stage's fuel tanks, engine sections, and forward skirt with friction stir welding.[32] However, the welding machine had to be taken apart due to a misalignment that prevented parts of the Core Stage from being lifted to its full length for welding. The misalignment was discovered shortly after the VAC was completed in September 2014. This issue caused a 9-month delay.
- In 2016, welding in the VAC was again halted when Boeing discovered that the strength of the welds in random areas of the Core Stage were below design requirements. Specifically, a new friction stir welding tool had malfunctioned, causing lower strength welds in the completed liquid hydrogen tank. As a result, Boeing reverted to the original friction stir welding tool configuration and welding resumed in April 2017. Overall, this issue caused a 3- to 5-month delay.

[31] The projected $200 million increase was not tracked as a cost overrun because Boeing reduced its proposed replan costs by roughly the same amount. However, tracking cost overruns over the lifetime of a contract to determine what cost increases are not subject to award fees is a best practice.

[32] As opposed to traditional welding techniques that melt materials as they are joined together, the VAC utilizes a friction stir welding tool that uses frictional heating combined with pressure to produce high-strength bonds that are virtually free of defects. Friction stir welding creates high-quality, high-strength joints and is superior to traditional welding techniques when working with light-weight aluminum alloys used in the aerospace and space industries.

Compounding Boeing's management and technical issues, other equipment-related mishaps and an extreme weather event contributed to cost and schedule delays:

- In March 2017, a welding tool in the VAC was damaged when it collided with a test panel fixture. The tool was repaired and returned to service but the incident resulted in a 2-week delay in the liquid oxygen tank build sequence. In addition, in May 2017, the same liquid oxygen tank build was delayed for an additional 2 months when the tank's aft dome was damaged when it came into contact with tooling in the VAC.
- In February 2017, a tornado damaged several buildings at Michoud causing a 2-month delay.

Projected Cost and Schedule Delays

Additional delays can be expected as a result of NASA's strategy to concurrently build both SLS test and flight articles in an effort to expedite the schedule and reduce costs. Moreover, as identified in previous reporting, the integration and testing phases of a space flight program are historically when problems are discovered.[33] Most NASA space flight programs attempt to test and qualify a sub-system for flight before fabricating the actual flight article. This ensures that NASA understands the performance of the article during simulated flight conditions and provides the opportunity to remedy any technical issues discovered during testing. For example, the Orion Program has generally followed this approach (i.e., developing separate test and flight articles), with NASA conducting a flight test of an Orion capsule in December 2014. In contrast, NASA has not followed this approach for many aspects of the SLS Program. Instead, SLS officials cite experience in previous large-scale space flight development programs and the use of models to ensure designs meet performance requirements. In the case of the SLS Core Stage 1, the liquid fuel tanks for the EM-1 launch have already been constructed; however, a separate set of fuel tanks constructed for testing have yet to be shipped to Marshall for structural qualification testing. If any significant issues with these tanks are identified during testing, the tanks already constructed for the EM-1 launch will need to be modified, resulting in costly rework and delays. However, NASA officials noted that structural testing to date meets performance requirements.

The SLS Program has experienced two recent incidents that illustrate the significant problems that occur when concurrently building both test and flight articles. After installing a component in the engine section, workers at Michoud were notified by Boeing that a part that controls the movement of the RS-25 engines had failed qualification testing and would need to be replaced. Since the engine section is on the critical path, any delay caused by having to replace this item has a direct impact on the launch schedule.[34] In addition, the flight computers delivered to Michoud for final integration were returned to Boeing for rework because of repeated failures during qualification and acceptance testing. Looking forward, the first completed Core Stage under development also doubles as the test article for the EM-1 launch when it undergoes its Green Run Test planned for 2019, the first and only time a complete Core Stage will be tested before it is delivered to Kennedy for final assembly with the EM-1 launch vehicle.

[33] IG-17-017.

[34] Critical path is the sequence of tasks that determines the longest duration of time needed to complete a project. It is important to identify the critical path and the resources needed to complete the critical tasks along the path if a project is to be completed on time and within its allocated resources.

FLAWED CONTRACT MANAGEMENT PRACTICES CONTRIBUTED TO SLS COST INCREASES, SCHEDULE DELAYS, AND EXCESSIVE AWARD FEES

We found that several poor contract management practices by NASA contributed to the SLS Program's cost and schedule overruns. First, contrary to Federal Acquisition Regulation (FAR) guidance, NASA lacks visibility into the Boeing Stages contract costs because all three of the company's key activities—development of the two Core Stages and the EUS—are co-mingled into the same contract line item number (CLIN). Second, despite significant cost increases and schedule delays, as of September 2017 NASA had rated Boeing's performance as "excellent" in three periods and "very good" in three others and awarded it $323 million or 90 percent of the available award and incentive fees. Given the SLS Program's cost overages and schedule delays, we question nearly $64 million of these award fees already provided to Boeing. Third, contracting officers approved contract modifications and issued task orders to several contracts without proper authority. Finally, as NASA and Boeing struggle with completing the first two SLS Core Stages, the Agency's plans are on hold for acquiring additional Core Stages, which in turn jeopardizes launch schedules for future missions that require the rocket, including potentially the Europa Clipper mission and EM-2. While NASA has taken some positive steps since January 2018 to address these longstanding issues—including requesting a review of Boeing's estimating system, adding an experienced manager to monitor SLS production, and changing the procurement process to improve internal controls—the impact of these actions on improving Boeing's future contract performance is uncertain.

NASA Lacks Visibility into Boeing Stages Contract Costs

NASA does not require Boeing to report detailed information on development costs for the two Core Stages and EUS, making it difficult for the Agency to determine if the contractor is meeting cost and schedule commitments for each deliverable. In accordance with current FAR guidance and consistent with leading management practices for a contract of this scope and cost, each contract deliverable should have its own CLIN in order to track costs and evaluate a contractor's performance. However, when NASA definitized the Boeing Stages contract in 2014, individual CLINs were recommended but not required by the FAR.[35] As such, NASA procurement officials combined these activities under a single CLIN to achieve a simplified approach that it hoped would reduce administrative reporting. As a result, under the Boeing Stages contract, all costs related to the two Core Stages and EUS are reported through one funding line—CLIN 9—which makes tracking current expenditures difficult. Moreover, given this cost-reporting structure, the Agency is unable to determine the cost of a single Core Stage.

[35] When the contract requirements were set in 2014, FAR § 4.1001 stated CLINs should provide unit prices or lump sum prices for separately identifiable contract deliverables and associated delivery schedules or performance periods.

Internally, Boeing tracks all individual costs but submits a combined statement of labor hours and material costs through CLIN 9 for all its development activities. NASA approximates costs based on numerous monthly and quarterly reviews with the contractor to track the progress of each individual deliverable. While Boeing procurement officials told us that using one CLIN for the two Core Stages and EUS streamlines reporting and therefore reduces costs, in our judgment, this approach jeopardizes accurate reporting and obscures contract costs compared to the Agency's official cost commitments. In addition, without more accurate cost breakouts for each deliverable, it will be difficult for NASA to use the data to determine pricing for future Core Stages.

The lack of visibility into actual costs will also affect the accuracy of NASA's reporting to Congress. As the largest contractor for the SLS launch vehicle, Boeing's cost increases and schedule delays are already contributing to the SLS Program exceeding its cost commitment of $9.7 billion for all EM-1 related costs, but the size of the cost increase is difficult to determine.[36] By fall 2019, NASA officials project the SLS Program will exceed its commitment for development costs by 15 percent, or more than $1 billion. As a result, NASA will need to alert Congress because an overage of this size requires congressional notification. The Agency provided Congress similar notice in 2017 for the 13-month schedule slip for EM-1 beyond the previously agreed-upon November 2018 launch date.[37]

Contract Award Fees Do Not Accurately Reflect Boeing's Performance

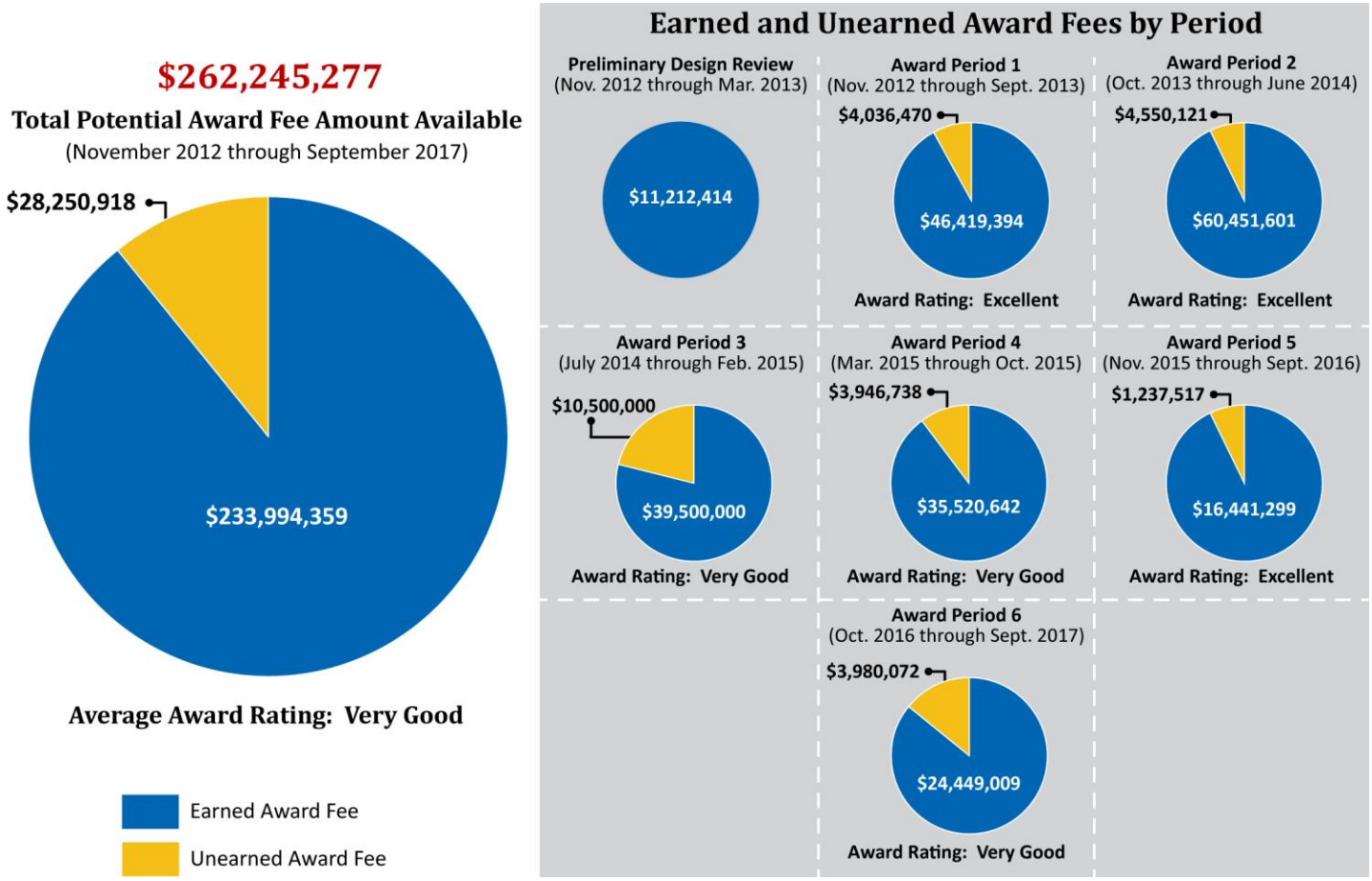
In light of significant cost increases and schedule slippage that, as previously discussed, can be attributable in large part to Boeing, we found NASA to be overly generous with the award fees provided to the contractor between 2012 and 2017. While we did not identify problems with the evaluation factors defined in the Boeing Stages contract's award-fee plan, we found flaws in NASA's procedures for scoring the factors, resulting in NASA inflating Boeing's performance scores. Consequently, we question nearly $64 million in CLIN 9 award fees provided to Boeing during this 5-year period—$52.5 million for core stage development and $11.2 million in system integration award fees (see Appendix D). Despite having spent $600 million more than the original $4.2 billion estimate for two Core Stages set in the 2014 contract modification and running more than 2 years behind schedule, NASA has awarded Boeing $323 million in award, milestone, and incentive fees. Of that amount, Boeing earned $245 million in award fees, representing 89 percent of the total award fees available during that time period for development of two Core Stages and the EUS. The remainder includes $20 million for CLIN 12 task order performance and $58 million in incentive fees for meeting material cost targets and delivery dates.

Boeing's performance in three of the seven periods for the main award fee—CLIN 9—was deemed by NASA as "excellent" as shown in Figure 9. Overall, Boeing has received an average performance rating of "very good" for the past 5 years of the contract.

[36] Costs tied to the development of the Core Stage and the production of the first Core Stage are tracked against the SLS Program's official cost commitment to Congress of $9.7 billion for EM-1. However, production costs of the second Core Stage and the EUS are outside this commitment even though all the costs are combined into CLIN 9 for tracking progress and billing. In 2017, we raised concerns about the SLS Program's spending outside cost commitments (IG-17-017).

[37] 51 U.S.C. § 30104, *Baselines and Cost Controls* (2010). Schedule delays of 6 months or more or cost increases of more than 15 percent of development costs require official notification to Congress. If development costs exceed 30 percent, NASA is required to stop funding for the activity after 18 months unless Congress authorizes new funding and the Agency sets new estimated costs and schedule for the program.

Figure 9: Boeing Award Fees for Stages Development Assessment Periods November 2012 through September 2017



Source: NASA OIG analysis of NASA performance determination letters for contract evaluation periods 2012 through 2017.

According to NASA guidance and criteria in the Boeing Stages contract's award-fee plan, these types of ratings should indicate that Boeing was under cost and ahead of schedule in developing the two Core Stages and the EUS. However, when we applied the contract's performance plan criteria for award fees, we determined that, at best, Boeing should have received a "satisfactory" rating (no more than 50 percent of award fees available) for performance periods 3 and 5; a "good" rating (no more than 75 percent of award fees available) for period 4; and an "unsatisfactory" rating (no award fee) for performance period 6 in 2017 when the contract's costs increased drastically and the official EM-1 schedule slipped by 13 months. For example, in periods 3, 5, and 6 NASA acknowledged Boeing had millions of dollars in cost overruns, yet Boeing received "good," "very good," or "excellent" ratings for the cost management evaluation factor. In periods 3 through 6, Boeing continued to experience schedule slippages that progressed from months to years due to technical issues, but again Boeing received "good" or "very good" ratings for technical performance. As such, as shown in Table 4, we question $52.5 million of award fees provided to Boeing for CLIN 9 for performance periods 3, 4, 5, and 6. While NASA's ratings of Boeing's performance would indicate that the contractor was on/under cost, on/ahead of schedule, and exceeding their expected technical performance, in reality Boeing has experienced numerous technical and management issues that have contributed to significant cost overruns and schedule delays. Looking forward, Boeing could earn up to an additional $113.8 million in award fees tied to CLIN 9 contractor performance through 2021.

Table 4: Questioned Costs for CLIN 9

Evaluation Period and Schedule	Earned Award Fee Amount	Score (Rating)	OIG Assessment Using NASA's Evaluation Criteria	OIG Score (Rating)	Questioned Costs
Preliminary Design Review: 11/1/2012–3/31/2013	$11,212,414	n/a	No substantial issues.	No change	$0
Period 1: 11/1/2012–9/31/2013	46,419,394	92 (Excellent)	No substantial issues.	No change	0
Period 2: 10/1/2013–6/30/2014	60,451,601	93 (Excellent)	No substantial issues. At the end of this period, the contract was definitized with Modification 127 and the EM-1 launch readiness date was set for December 2017.	No change	0
Period 3: 7/1/2014–2/28/2015	39,500,000	79 (Very good)	Boeing increased their expenditures by $118 million through unapproved changes to their expenditure plan, ultimately resulting in the re-planning effort. Various technical and program management issues occurred, such as the VAC tool (8-10-month schedule delay), cracks on the intertank panel (6-month delay on the fabrication schedule) and design of the avionics hardware (several months delay).	50 (Satisfactory)	14,500,000
Period 4: 3/1/2015–10/31/2015	35,520,642	90 (Very good)	Performance issues led to schedule delays. Technical issues with the avionics hardware and Thermal Protection System qualification and production added risk to the delivery schedule of Core Stage 1, including a lack of qualified technicians. Re-planning efforts continued.	75 (Good)	5,920,107
Period 5: 11/1/2015–9/30/2016	16,441,299	93 (Excellent)	Boeing identified a cost overrun of $130 million but NASA evaluated the overrun as $202 million. The replan was finalized adding $1 billion to the contract value and moving the EM-1 date to July 2018. Technical issues and schedule slips continued related to avionics box qualification, weld strengths on the liquid oxygen tanks, supplier delays for the intertank panels, Thermal Protection System development and VAC welding. The schedule was losing about 1 week a month.	50 (Satisfactory)	7,601,891
Period 6: 10/1/2016–9/30/2017	24,449,009	86 (Very good)	Cost overruns exceeded 10 percent of the FY 2017 cost plan. Technical monitors reported significant manufacturing-related weaknesses that caused Core Stage delivery to Stennis to slip from September 2017 to December 2018—a 14-month delay. This in turn contributed to delaying the EM-1 launch readiness date to at least March 2020.	Under 50 (Unsatisfactory)	24,449,009
Total amounts/ average scores	**$233,994,359**	**89 (Very good)**	**Boeing has experienced numerous technical and management issues that have led to Boeing exhausting the contract's value nearly 2 years early without delivering a Core Stage and delaying the EM-1 launch to at least June 2020.**	**68 (Good)**	**$52,471,007**

Source: NASA OIG analysis of NASA Official FDO/PEB letters and reports per period and performance evaluation reports per period.

Moreover, we found that contrary to Marshall guidance, the COR assigned to the SLS Program did not provide her own adjectival performance period ratings (unsatisfactory, satisfactory, good, very good, or excellent) to the Boeing Stages contract's PEB.[38] The PEB is responsible for subjectively evaluating the contractor's overall performance using the criteria established in the award-fee plan to determine award fees. The PEB recommends an adjectival rating and numerical score to the FDO, who provides the final rating used to determine the award fee. However, instead of the COR providing the rating, the NASA supervisor for the Boeing Stages contract, in conjunction with the contracting officer were the main individuals providing final recommended rating scores to the PEB.[39] Contrary to Marshall policy, the COR generally consolidated and categorized the technical monitors' input, which under her guidance did not include ratings and was limited only to reporting strengths and weaknesses of Boeing's overall performance. While the COR has the flexibility under Marshall guidance to not require the technical monitors to offer adjectival ratings, in our judgement, the lack of ratings by the technical monitors contributed to inflated ratings scores and an inaccurate assessment of Boeing's performance by the PEB and FDO. In August 2018, we discussed our findings with NASA officials involved in managing the PEB process at Marshall and they agreed with our assessment. Further, the PEB Executive Coordinator and the SLS Procurement Supervisor stated they had no knowledge of the COR's guidance to the technical monitors.

Senior NASA officials offered several explanations for the award fees given to Boeing. First, they stated that the SLS is the largest launch system in the history of space flight, noting that the design, development, manufacturing, test, and operations of the system are highly complex and represents a national investment in a long-term commitment to deep space exploration. The officials also cited first-time production challenges associated with design development, manufacturing development, restarting a sub-tier supply base, testing, and initial operations. Specific to the incremental evaluation of performance, senior NASA officials identified a series of contributing factors considered during evaluation of Boeing's performance: (1) the contractor made significant improvements after identifying a first-time building challenge; (2) given the SLS is being rated for human space flight, NASA was involved in evaluating and dispositioning technical challenges, and improvements in requirements were made with a focus on long-term safety and efficiency; and (3) positive consideration was given for a wide variety of factors important to the Agency, such as support for small and disadvantaged businesses and recognition of the performance of management and leadership in overcoming challenges. While we appreciate the many significant challenges inherent in developing the Core Stages and EUS, we disagree that the factors cited by these NASA officials warrant the "very good" and "excellent" evaluation scores and high award fees provided to Boeing given the SLS Program's substantial delays and cost overruns.

In addition to the inflated CLIN 9 award fees, we have concerns regarding the entirety of the Boeing Stages contract's system integration award fees, which has a total value of $47.5 million through 2021. As such, to date, we question the $11.2 million, or 89 percent, Boeing has received for 2016 and 2017. This performance award fee was added in 2016 through Modification 173—also known as the 2016 replan—in order to place an increased emphasis on integration activities. However, the award-fee plan

[38] MWI 5116.1 requires the technical monitors, under direction from the COR, to evaluate contractor performance in each evaluation factor of their assigned area and use the adjectival rating definitions unless otherwise instructed by the COR. The guidance further requires the COR to direct evaluation of a contractor; determine the significance of each strength, weakness, or observation based on the technical monitor's input; and apply adjectival ratings to a contractor's performance. Adjectival ratings are the following descriptive terms used by NASA in its evaluations: excellent, very good, good, satisfactory, and unsatisfactory (see Figure 6).

[39] A contracting officer is warranted to enter into obligations and contracts on behalf of the federal government, while the COR is usually a member of a program's staff appointed and trained to monitor the contractor's performance and assist the contracting officer in managing the contract.

for the system integration award fee lacks clear assessment criteria, including the scope of work related to earning the fee. We also found the fee to be largely duplicative of the CLIN 9 award fee discussed previously. Essentially, two separate fee pools are rewarding Boeing for the same work. Further, at the time of the 2016 replan, these additional fees contributed to the change in the total award-fee rate to 13.1 percent instead of the initially negotiated rate of 12.5 percent.[40]

Finally, NASA is precluded from revising the award-fee scores and recouping any of the fees already awarded due to the fact the Agency categorized the Boeing Stages contract as a "service" contract.[41] In accordance with acquisition regulations, because NASA is receiving end items—two Core Stages and one EUS—the Agency should have characterized the Boeing Stages contract as an end-item rather than a service.[42] Based upon previous experience with other space flight programs that had high award fees at the end of an evaluation period, NASA officials thought using a service contract would ultimately lower the fee rate. However, officials underestimated the amount of delays and increased costs that would occur in the Boeing Stages contract. Without a mechanism for ensuring all award fees are interim leading up to final delivery of Core Stage 1, the Agency is unable to recoup previously awarded fees, including the nearly $64 million in award fees we question in this report. As NASA considers renegotiations for additional Core Stages, ensuring all award fees are interim leading up to the final delivery would provide the opportunity to recoup fees if the Agency ultimately determined Boeing performed poorly.

NASA Contracting Officers Exceeded Their Authority

In support of the SLS Program, three NASA contracting officers entered into negotiations or contractual obligations with companies that far exceeded the limit of their warrants.[43] In addition, two other contracting officers increased the value of contracts for task orders already awarded, a practice that has since been ended as a result of a NASA OIG investigation and related management referral.[44] Consequently, several executed contracts and contract modifications are considered unauthorized commitments and must be ratified in order to constitute valid government obligations.[45] This ratification process will require additional negotiations with the various SLS contractors that could increase costs and cause further delays to the SLS Program. Examples of these improper contract-related issues and their respective corrective actions include the following:

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[40] According to NASA planning documents written prior to the contract Modification 173, the system integration award fee was not designed to be tied to any billable costs on the Boeing Stages contract. It effectively awarded additional profit for integration activities that were already covered in the CLIN 9 award fees creating in effect a double payment. The total award-fee rate of 13.1 percent included the $47.5 million in system integration award fees, the award fees already on the contract, and the material and milestone incentive fees.

[41] According to the NFS, for service contracts, all evaluations are considered final and the contractor keeps 100 percent of fee earned in each period. Conversely, award fees for end-item contracts are made at the conclusion of the contract and supersede any provisional and interim payments. Designed to measure the overall performance of the contractor, only the overall evaluation is considered final for end-item contracts. NFS § 1852.216-77 *Award Fee for Service Contracts* (2018).

[42] Whereas FAR Part 37 defines service contracts as those that directly engage the time and effort of a contractor whose primary purpose is to perform an identifiable task rather than to furnish an end item of supply. FAR § 37.101.

[43] A warrant is a written authority provided to a contracting officer that specifies the amount of money he or she is authorized to commit on behalf of the federal government.

[44] NASA OIG Office of Investigations Management Referral, *Procurement Irregularities* (O-MA-17-0320-S, March 1, 2018).

[45] According to the FAR, "ratification" as used in this subsection means the act of approving an unauthorized commitment by an official who has the authority to do so. "Unauthorized commitment" means an agreement is not binding solely because the government representative who made it lacked the authority to enter into that agreement on behalf of the government. FAR § 1.602-3, *Ratification of Unauthorized Commitments* (2014).

- From 2009 to 2016, a contracting officer exceeded his $2.5 million warrant by making multiple unauthorized commitments in the amount of $318 million for contracts for Michoud operations, Interim Cryogenic Propulsion Stage production, and advanced booster development. This individual was also the primary contracting officer for the Boeing Stages contract. An issue with exceeding warrants was initially discovered in December 2016 during an internal annual self-assessment reviewed and signed by the Marshall procurement manager. However, this situation was not acted upon or timely disclosed to NASA OIG as prescribed by the NASA FAR Supplement.[46] Based on an August 2017 referral from the Marshall Acquisition Integrity Program, NASA OIG initiated an investigation and provided its findings to Marshall management in October 2017.[47] As a result, Marshall officials terminated the contracting officer's warrant and reassigned him pending final outcome of an inquiry into his actions and follow-up negotiations to ratify the contractual actions committed over his warrant authority. As of August 2018, Center management has not taken disciplinary action against the contracting officer.
- In 2005 and prior to the start of the SLS Program, a contracting officer with a warrant of $1 million executed a $3.7 million modification to a Michoud facility maintenance contract. His warrant was terminated, he retired from government service, and the contract has since ended. As a result, no ratification was required.
- In 2017, a contracting officer working on the Boeing Stages contract failed to obtain negotiation authority for an action involving $2 million of work that would have exceeded his warrant by $1 million if a commitment was made. The contracting officer's warrant was revoked, and no ratification was required because the issue was discovered before the contract modification was executed.

While contrary to NASA policy, we found that the actions of these contracting officers were not undertaken to personally benefit the employees or contractors. However, exceeding the amount of a contracting officer's warrant represents significant internal control weaknesses in the Marshall Office of Procurement and the SLS Program that bypassed required procurement policy and legal reviews.[48] Additionally, these actions exposed NASA to unauthorized commitments on contracts valued at $321.7 million—most of which will require follow-up contract ratification.

Acquisition Strategy for Future SLS Core Stages Is Uncertain

Due to NASA's focus on overcoming the challenges associated with the current Boeing Stages contract and ensuring delivery of the first two Core Stages, the Agency has yet to implement an acquisition strategy for acquiring additional Core Stages beyond Core Stage 2. Given that NASA officials estimate requiring 52 months of lead time from issuing a contract to delivery, the earliest a third Core Stage can be produced is 2023, which may cause delays in missions expected to use the SLS rocket.
NASA's acquisition strategy for additional Core Stages can include modifying the existing contract or awarding a new contract to either Boeing or a new contractor. Either way, SLS Program officials need to

[46] NSF § 1801.602-3.

[47] NASA's Acquisition Integrity Program is a part of the Agency's Office of General Counsel.

[48] Marshall Office of Procurement policy requires legal review of any contract action valued over $1 million. Marshall Office of Procurement, *Review and Execution of Procurement Documents* (PS-OWI-05, July 31, 2017).

undertake a detailed and independent cost estimate and a request for proposal to competitors or develop justification for awarding a sole-source contract. Moreover, because the original contract with Boeing was not competed but awarded as a sole-source contract modified from its work on the Constellation Program, it is unlikely that other companies will be in a position to effectively compete for this unique production contract to build Core Stages to NASA's design specifications.[49] Finally, as a sole-source contract, NASA did not follow routine procurement practices such as detailing the scope of work prior to award or separating deliverables into individual CLINs. Consequently, NASA will be hard-pressed to determine the price of producing a single Core Stage—information that will be key for the Agency to understand the cost and affordability of additional Core Stages. Delays in addressing these challenges will affect NASA's future mission needs for beyond low Earth orbit launch vehicles, particularly if both the Europa Clipper mission and EM-2 are ready to launch by 2022 as NASA plans.

Positive Steps Taken to Address Procurement and Management Issues

To its credit, the SLS Program has taken positive steps to address management and procurement issues related to the Boeing Stages contract. During the course of our audit, SLS Program and Marshall Office of Procurement officials acknowledged many of the issues discussed in this report and began taking corrective action to better manage the contract:

- Key leadership changes since January 2018 include a new government contracting officer, procurement officer, and acting SLS Stages Element Manager who oversees efforts to build the SLS stages. In addition, the SLS Program's business manager has taken over managing the Stages Element's business office until a replacement manager is found. Also, in June 2017, NASA hired a seasoned production manager at Michoud who previously led production of the external tank for the Space Shuttle.
- In March 2018, following a quarterly review, the SLS Program chartered an independent review of Boeing contract deliverables citing issues with Boeing's cost and schedule estimating reports. As a result, NASA sent a letter to Boeing raising concerns about these reports. SLS Program officials also requested a review of the Boeing Stages contract by the Defense Contract Management Agency to identify weaknesses in Boeing's Earned Value Management System. In May, their surveillance report cited two issues that resulted in corrective action requests that, if left uncorrected, would result in inaccurate schedules and cost projections. Additionally, eight other risks and eight self-disclosed issues by Boeing will be tracked for near-term improvement.
- In March 2018, the new Stages Element Manager took several actions to improve SLS Program oversight: (1) established five corrective action "Tiger Teams" composed of Boeing and NASA experts to improve performance at Michoud; (2) increased the number and focus of performance reviews—a monthly "deep dive" into critical issues, twice-weekly internal manufacturing reviews, and weekly external review with stakeholders; and (3) requested an audit of Boeing's quality systems by NASA's SLS Stages Element Chief Safety Officer.
- In June 2018, NASA sent a letter to Boeing stating the company's performance for delivery of Core Stage 1 was deficient and endangered performance of the contract. In response, Boeing stated it recognized the need to improve schedule performance for the SLS Core Stage 1 and

[49] The initial contract awarded in 2007 for the development and production of the Ares I Upper Stage was competed but the transition to SLS work was a sole-source award with a justification for other than full and open competition due to Congress requiring NASA to utilize existing Constellation Program contracts.

stated that the company was implementing a number of corrective actions, including reorganizing the staff supporting the effort and implementing 27 measures to improve the schedule. Furthermore, in September 2018 Boeing proposed several cost savings measures and initiatives to improve performance. Additionally, NASA and Boeing have initiated discussions on a way forward for the Boeing Stages contract to address reaching the contract's full value in early 2019, the impact of projected cost overruns, and the need to better track the cost and progress of each Core Stage and EUS.

- Officials with Marshall's Office of Procurement acknowledged contracting officers were exceeding their warrants, removed the warrants of those individuals, and implemented several actions to improve visibility and accountability of SLS contracts. As a result, the office has assigned new contracting officers to oversee and manage the SLS contracts, including a new contract team for the Boeing Stages contract. The new contracting officers are now more closely analyzing and tracking the risk of Boeing exceeding the contract value and are keeping SLS Program officials updated on Boeing's spending.

While too early to determine if these actions will ultimately improve Boeing's performance, they represent positive steps in helping to correct the shortcomings highlighted in this report.

CONCLUSION

In support of NASA's goal of manned space flight beyond low Earth orbit, the Agency has been working since 2010 to develop a heavy-lift rocket. As of August 2018, NASA has spent $11.9 billion on the SLS, but will require significant additional funding to complete the first Core Stage—more than 3 years later than initially planned and at double the anticipated cost.

We acknowledge that the development and production of a new Core Stage comes with many uncertainties and challenges that must be overcome during first-time production and this understandably leads to greater cost and schedule risk. Nonetheless, development of the SLS Core Stage has been more difficult than Boeing anticipated, and we found most of the schedule delays were the result of a variety of interrelated management, technical, and infrastructure issues traceable to the company. Although taken separately these issues would result in modest delays and cost increases, taken together they have had a compounding effect on the SLS schedule and budget. Furthermore, additional delays are likely as significant integration and testing activities—including the Green Run Test—in which technical issues are regularly found, have yet to occur.

In addition to Boeing's poor performance, we found a number of unacceptable procurement practices by NASA officials at Marshall that added to contract cost and schedule issues. These practices included not tracking the costs of specific deliverables for each Core Stage and EUS, contracting officers exceeding their warrants, paying significant award fees despite contractor poor performance, and the lack of an approved plan for future Core Stage production. We question nearly $64 million in award fees provided to Boeing since 2012 for the "very good" and "excellent" performance ratings it received while the SLS Program was experiencing substantial cost increases, technical issues, and schedule delays. Without significant corrective action, NASA's efforts to build its first two Core Stages and the EUS will cost significantly more and take considerably longer than anticipated.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE AND OUR EVALUATION

To increase the sustainability, accountability, and transparency of NASA's efforts to develop the two Core Stages and EUS, we recommended the Associate Administrator for Human Exploration and Operations Mission Directorate and the Deputy Associate Administrator for Exploration Systems Development, in conjunction with Marshall Center Director, Marshall Office of Procurement, and SLS Program, undertake the following actions:

1. Develop a corrective action plan for completing the two Core Stages and EUS and brief that plan to Boeing and senior NASA officials to gain their approval.
2. Direct Boeing to complete delivery of the two Core Stages and the EUS using an Earned Value Management System with realistic schedule assumptions and appropriate cost estimates through the end of the contract in 2021.
3. Complete a review of the Boeing Stages contract that includes an independent federal government cost estimate to confirm the funding amounts needed to complete all deliverables.
4. Renegotiate the Boeing Stages contract based on both Boeing and federal government cost estimates that includes
    a. separating each deliverable (Core Stage 1, Core Stage 2, and EUS) into its own CLIN for tracking costs, performance, and award fees;
    b. removing the system integration award fee structure and capping potential award fees at 12.5 percent of estimated costs;
    c. determining the amount of cost overruns to date and ensuring no future fees are paid on this amount;
    d. reducing the performance evaluation period to 6 months with interim reports at 3 months; and
    e. removing provisional performance award-fee payments to reflect the current contractor's performance.
5. Review all SLS Program contracts overseen by the Marshall Office of Procurement to ensure that
    a. no contracting officer has exceeded his or her warrant authority,
    b. the Marshall Office of Procurement implements a process to prevent future unauthorized commitments from contracting officers exceeding warrants,
    c. contract ratifications for any prior unauthorized commitments are completed, and
    d. the contracting officer who exceeded his warrant by $318 million is removed from any work related to the SLS Program.
6. Reinstitute adjectival ratings by the COR and technical monitors in order to accurately reflect the contractor's performance. Ensure the COR submits a grade based upon feedback from the technical monitors.

To minimize future delays tied to Core Stage availability for the Europa Clipper mission, EM-2, or other future human exploration missions and to obtain the best value to the Agency, we recommended the Associate Administrator for Human Exploration and Operations Mission Directorate and the Deputy Associate Administrator for Exploration Systems Development

7. implement, by October 2018, an acquisition strategy for building Core Stages beyond Core Stage 2 for future missions that includes consideration for awarding the contract as a fixed-price, end-item deliverable contract with each Core Stage separated into unique task orders with specific performance milestones.

We provided a draft of this report to NASA management who concurred with six of our seven recommendations. We consider management's comments to Recommendations 2, 3, 4, 5, and 7 responsive; therefore, those recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

Although management concurred with Recommendation 1, we do not find their comments fully responsive. Specifically, although NASA stated it informed Boeing of performance issues in early 2018 and directed the company to develop a corrective action plan, the Agency's response does not mention whether the plan will be briefed to senior NASA and Boeing officials. We believe a lack of action by senior leadership in both organizations to correct identified problems remains a significant cause of the SLS Program's cost increases and schedule delays. Unless senior officials at NASA and Boeing are involved and collectively agree to the solutions, launch dates will continue to slip and the costs will increase, raising questions about the Program's long-term sustainability. Given these concerns, this recommendation will remain unresolved pending further discussions with Agency officials.

Management did not concur with Recommendation 6, stating that the Marshall policy does not require technical monitors to provide adjectival ratings and asserting that the SLS Program's current rigor in substantiating Boeing's strengths and weaknesses ensures accurate contractor performance reporting. While we understand the Marshall policy permits but does not require this action, we do not believe it in the best interest of the taxpayer to limit the input for assessing contractor performance under a contract that could exceed $9 billion. Our concerns are compounded by the fact that the current audit found evidence that the Agency's performance ratings of Boeing were highly inflated over at least 5 years and failed to meet NASA criteria and that the COR's ratings were improperly influenced by senior SLS Program officials. It is unclear why NASA would not want the benefit of the technical monitors' adjectival ratings for their assigned performance areas, as these monitors are specifically appointed to evaluate Boeing's performance. At the same time, the provision of adjectival ratings does not bind the FDO—rather, the FDO is still free to exercise their professional judgment and take into account other factors in making the final award determination. In our judgment, these adjectival ratings can provide important information to the COR, PEB, and FDO to help determine a fair and accurate assessment of contractor performance for each rating period. Accordingly, this recommendation will remain unresolved pending further discussions with Agency officials to develop a better solution to address the disconnect between NASA's award fees and Boeing's performance.

Management's response to our report is reproduced in Appendix E. Technical comments provided by management have been incorporated, as appropriate.

Major contributors to this report include Ridge Bowman, Space Operations Director; Kevin Fagedes, Project Manager; Susan Bachle; Mike Beims; Frank Martin; Robert Proudfoot; Sarah McGrath; and Cedric Campbell.

If you have questions about this report or wish to comment on the quality or usefulness of this report, contact Laurence Hawkins, Audit Operations and Quality Assurance Director, at 202-358-1543 or laurence.b.hawkins@nasa.gov.

Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from April 2018 through August 2018 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence that provides a reasonable basis for our findings and conclusions. We determined that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

This report is the first in a series of reviews examining NASA's management of the SLS Program. In this first report, we assessed to what extent Boeing is meeting its cost, schedule, and performance goals for the development of the Core Stage and EUS and the SLS Program's compliance with acquisition regulations, policies, and procedures regarding the Boeing Stages contract. Our review was conducted at Marshall, Stennis, Michoud, and NASA Headquarters. In preparation for the audit, we conducted routine coordination with the Associate Counsel to the Inspector General and the OIG Office of Investigations.

To assess Boeing's cost performance for developing the Core Stage and EUS, we reviewed SLS Program, NASA Office of the Chief Financial Officer, and contractor cost and budget documentation. We reviewed current and past budget planning documents for the SLS Stages Element Office and the SLS Program as a whole. Additionally, we reviewed Boeing's financial management reports and Earned Value Management System cost estimates. We analyzed the Stages Element Office and Boeing Stages contract obligations and disbursements through NASA's financial accounting system. To determine the status of the Boeing Stages contract, we interviewed NASA contracting officers from Marshall Office of Procurement; officials from the SLS Program, Planning, and Control Office; and managers from the Stages Element Office. Additionally, we interviewed the Boeing Program Manager and contracting staff regarding the cost performance of the Stages Contract. We reviewed documentation concerning the surveillance audit of Boeing's Earned Value Management System performed by the Defense Contract Management Agency and interviewed their representatives concerning their findings. To evaluate NASA's award fee determinations for the Boeing Stages contract, we reviewed the award-fee plan, PEB reports, and performance determination letters. We also interviewed the FDO, SLS Program officials, contracting officers, the COR, and technical monitors.

To assess whether Boeing was meeting its schedule milestones and goals, we reviewed past and current schedules. Specifically, we reviewed contract milestones, past and current integrated master schedules, and quarterly program status reviews. We interviewed the Boeing Program Manager for the Boeing Stages contract and the Boeing On-Site Manager at Michoud to gain their perspective on whether or not they will be able to meet the current schedule milestones for the Core Stage. We interviewed NASA officials, including the supervisor for the Stage Controller, the manager for the SLS Program, Planning, and Control Office, and the Michoud Deputy Manager for Production and Manufacturing. At Stennis we interviewed the NASA SLS Core Stage Test Director and the Aerojet Rocketdyne On-Site Manager to gain their perspectives concerning the planned schedule for the Green Run Test as well as any concerns they may have.

To determine any technical issues, managerial issues, or incidents that may have caused past schedule delays in the development of the Core Stage, we reviewed performance evaluation reports for the Boeing Stages contract as well as news articles and NASA press releases. We interviewed the Boeing Program Manager for the Boeing Stages contract and the Boeing On-Site Manager at Michoud to understand their reasons for past schedule delays and the impacts each had on the schedule. We also interviewed NASA officials, including the Deputy Manager for Production, COR, technical monitor at Michoud, and Stage Controller Supervisor.

Use of Computer-Processed Data

We used computer-processed data to perform this audit, and that data was used to materially support findings, conclusions, and recommendations. First, we reviewed and analyzed NASA obligation and disbursement data for FY 2012 through FY 2018 in NASA's financial accounting system for the Stages Element Office and Boeing Stages contract. Then, we compared these results with SLS Program budget data and Boeing Stages contract information from FY 2012 through FY 2018 provided to us in the form of briefing charts and Excel spreadsheets received from NASA officials. We then analyzed and verified the data with the NASA budget analysts and procurement officials and through independent calculations. We also obtained monthly contractor financial management reports, including selected billing statements from FY 2012 through FY 2018.

Review of Internal Controls

We evaluated the internal controls associated with NASA's management of the SLS, specifically the extent to which Boeing is meeting its cost, schedule, and performance goals for the development of the SLS Core Stage. The control weaknesses we found were identified and discussed previously in this report. Our recommendations, if implemented, will correct the identified control weaknesses.

Prior Coverage

During the last 5 years, NASA OIG and GAO have issued 11 reports of significant relevance to the subject of this report. We found one additional relevant report issued prior to 2013 from the NASA OIG and two from the GAO. Unrestricted reports can be accessed at https://oig.nasa.gov/audits/reports/FY18 and http://www.gao.gov.

NASA Office of Inspector General

Construction of Test Stands 4693 and 4697 at Marshall Space Flight Center (IG-17-021, May 17, 2017)

NASA's Plans for Human Exploration Beyond Low Earth Orbit (IG-17-017, April 13, 2017)

NASA's Management of the Orion Multi-Purpose Crew Vehicle Program (IG-16-029, September 6, 2016)

NASA's Launch Support and Infrastructure Modernization: Assessment of the Ground Systems Needed to Launch SLS and Orion (IG-15-012, March 18, 2015)

Extending the Operational Life of the International Space Station Until 2024 (IG-14-031, September 18, 2014)

NASA's Decision Process for Conducting Space Launch System Core Stage Testing at Stennis (IG-14-009, January 8, 2014)

NASA's Use of Award-fee Contracts (IG-14-003, November 19, 2013)

NASA's Challenges to Meeting Cost, Schedule, and Performance Goals (IG-12-021, September 27, 2012)

Government Accountability Office

NASA: Assessments of Major Projects 2018 (GAO-18-280SP, May 1, 2018)

NASA: Assessments of Major Projects 2017 (GAO-17-303SP, May 16, 2017)

NASA Human Space Exploration: Delay Likely for First Exploration Mission (GAO-17-414, April 27, 2017)

Space Launch System: Resources Need to be Matched to Requirements to Decrease Risk and Support Long Term Affordability (GAO-14-631, July 23, 2014)

Federal Contracting: Guidance on Award Fees Has Led to Better Practices but Is Not Consistently Applied (GAO-09-630, May 29, 2009)

NASA Procurement: Use of Award Fees for Achieving Program Outcomes Should Be Improved (GAO-07-58, January 17, 2007)

APPENDIX B: SLS PRIME CONTRACTORS

Table 5 summarizes the SLS component responsibilities by the SLS's prime contractors, along with period of performance and the potential contract values as of April 2018. Of the total $12.2 billion contracted, Boeing is receiving the majority at $6.6 billion, or 54 percent.

Table 5: SLS Prime Contractors

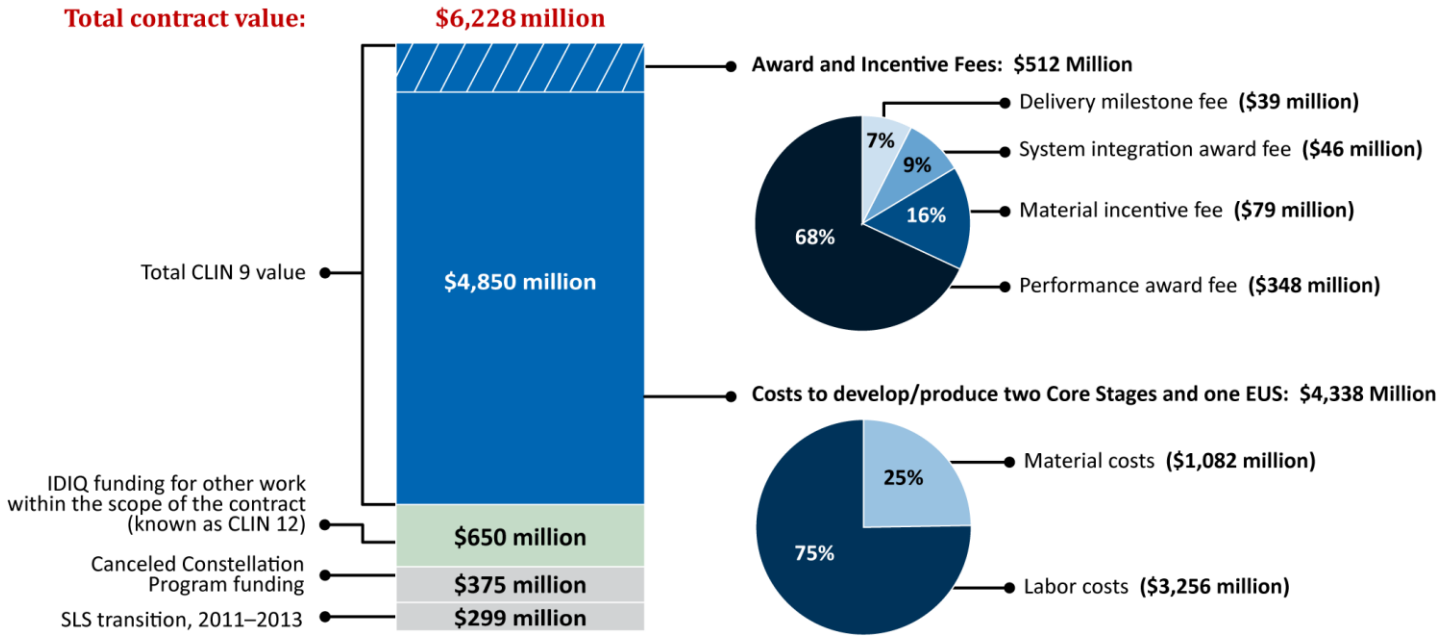
Contractor	SLS Components	Period of Performance	Contract Values
The Boeing Company	2 Core Stages and 1 EUS	9/1/2007–12/31/2021	$6,228,075,404
ATK Launch Systems, Inc.	Solid rocket boosters	4/17/2006–12/31/2023	3,489,688,799
Aerojet Rocketdyne	16 RS-25 engines	6/2/2006–9/30/2018	2,047,347,059
The Boeing Company	Interim cryogenic propulsion stage	10/1/2012–11/30/2021	362,390,032
Teledyne Brown Engineering, Inc.	Launch vehicle stage adapter	2/1/2014–12/31/2018	89,303,016
		Total value of contracts	**$12,216,804,310**

Source: NASA OIG representation of information compiled from the NASA Enhanced Procurement Data Warehouse and contract reviews.

APPENDIX C: BOEING STAGES CONTRACT CLINS 9 AND 12 BREAKOUT

Figure 10 provides a detailed breakout of the Boeing Stages contract value for CLINs 9 and 12. Specifically, of the total $6.2 billion contract ceiling, approximately $4.9 billion is related to CLIN 9—the primary fund for the production of the two Core Stages and one EUS—of which $4.3 billion is the cost for labor and materials and the remaining $512 million is for performance awards and incentive fees. Approximately $650 million of the contract value is for IDIQ task orders—cost and fees—used to cover unplanned work that falls within the scope of the contract. The remaining contract value of approximately $700 million is related to past costs associated with the canceled Constellation Program and the transition from the Constellation Program to the SLS Program in FY 2011 through FY 2013. There is an additional $54 million of contract value related to completed fixed-price work and travel expenses.

Figure 10: Boeing Stages Contract CLINs 9 and 12 Breakout



Source: NASA analysis of Agency-provided data.

APPENDIX D: SCHEDULE OF QUESTIONED COSTS/DOLLAR-RELATED FINDINGS

Table 6 summarizes the questioned costs identified during our audit and discussed in this report. These costs are the result of the improper award fees NASA provided to Boeing between 2014 and 2017, even though they were experiencing significant cost, schedule, and technical performance challenges.

Table 6: Questioned Costs and Associated Recommendations

Issue	Recommendation #	Questioned Costs
Unsupported award fees provided to Boeing for performance under CLIN 9 for periods 3 through 6 (2014 through 2017).	4a, 4c, 4d, and 4e	$52,471,007
Unsupported award fees provided to Boeing for the separate system integration award fee for periods 5 and 6 (2016 through 2017).	4b	11,175,130
	Total	**$63,646,137**

Source: NASA OIG analysis.

Note: Questioned costs are expenditures that are questioned by the OIG because of an alleged violation of law, regulation, or contractual requirement governing the expenditure of funds, costs that are not supported by adequate documentation at the time of our audit, or are unallowable, unnecessary, or unreasonable.

APPENDIX E: MANAGEMENT COMMENTS

National Aeronautics and Space Administration
Headquarters
Washington, DC 20546-0001

October 2, 2018

Reply to Attn of: Human Exploration and Operations Mission Directorate

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Human Exploration and Operations

SUBJECT: Agency Response to OIG Draft Report, "NASA's Management of the Space Launch System Stages Contract" (A-18-008-00)

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Management of the Space Launch System Stages Contract" (A-18-008-00), dated August 30, 2018.

The Space Launch System (SLS) is the largest launch system in the history of spaceflight. The design, development, manufacturing, testing, and operations of the system are highly complex and represent a national investment in a long-term commitment to deep space exploration. NASA is designing and implementing a manufacturing capability to efficiently produce, test, and qualify spaceflight hardware for long-term use, to human rating standards, on a scale never achieved before. This requires not only production of SLS core stages but also development and implementation of component, system, integrated system, and large scale highly instrumented test articles, and development of long-term production capacity. First-time production technical challenges associated with design development, manufacturing development, restarting a sub-tier supplier base, testing, and initial operations have been experienced. Because of the criticality of human spaceflight, NASA has actively participated in resolving these first-time production technical challenges. Throughout the SLS development and production efforts, NASA's primary goal has been to implement processes and procedures that will support long-term production needs in a safe manner.

NASA had already recognized the opportunity to improve contract performance management in this large-scale program prior to this OIG's audit. The OIG draft report is a fair assessment of NASA's management of the SLS Core Stages contract and of associated challenges, and the OIG's recommendations are consistent with the work NASA has underway.

In the report, the OIG makes seven recommendations to NASA intended to increase the sustainability, accountability, and transparency of the Agency's efforts to develop the SLS

Core Stages and Exploration Upper Stage (EUS); and to minimize, to the extent possible, future delays tied to Core Stage availability for the Europa, Exploration Mission (EM)-2, or other future human exploration missions and to obtain the best value to the Agency.

Specifically, the OIG recommends the following:

To increase the sustainability, accountability, and transparency of NASA's efforts to develop the SLS Core Stages and EUS, the OIG recommends the Associate Administrator for Human Exploration and Operations and the Deputy Associate Administrator for Exploration Systems Development, in conjunction with Marshall Center Director, Marshall Office of Procurement, and SLS Program, undertake the following actions:

Recommendation 1: Develop a corrective action plan for completing the two Core Stages and EUS and brief that plan to Boeing and senior NASA officials to gain their approval.

Management's Response: NASA concurs with this recommendation. As stated in the "Positive Steps Taken to Address Procurement and Management Issues" section of the OIG's report, NASA apprised Boeing of existing performance challenges in early 2018 and directed Boeing to develop a corrective action plan to address systemic issues to better control cost and schedule. This recommendation will be satisfied by the completion of a current study that demonstrates the manufacturing facility capability to meet applicable schedules.

Estimated Completion Date: NASA estimates a completion timeframe of January 2019.

Recommendation 2: Direct Boeing to complete delivery of two Core Stages and the EUS using an Earned Value Management System with realistic schedule assumptions and appropriate cost estimates through the end of the contract in 2021.

Management's Response: NASA concurs with this recommendation. As stated in the "Positive Steps Taken to Address Procurement and Management Issues" section of the report, NASA chartered independent reviews of Boeing's performance reporting practices to include Defense Contract Management Agency evaluations of the contractor's Earned Value Management system. These measures, coupled with activities initiated to address the contract overrun posture and enhance contract insight, will meet the intent of this recommendation.

Estimated Completion Date: Meeting the objective of this recommendation is dependent on timing of contract activities identified in our response to Recommendation 4.

Recommendation 3: Complete a review of the Boeing Stages contract that includes an independent federal government cost estimate to confirm the funding amounts needed to complete all deliverables.

Management's Response: NASA concurs with this recommendation. NASA previously had an independent cost estimate for the program but will now update based on observed contractor performance. NASA plans to conduct an independent cost estimate that will be used to assess resource requirements associated with the scope of the Core Stage contract referenced in Recommendation 4.

Estimated Completion Date: Meeting the objective of this recommendation is dependent on timing of contract activities identified in our response to Recommendation 4.

Recommendation 4: Renegotiate the Boeing Stages contract based on both Boeing and federal government cost estimates that includes:

a. separating each deliverable (Core Stage 1, Core Stage 2, and EUS) into its own contract line item (CLIN) for tracking costs, performance, and award fees;

b. removing the system integration fee structure and capping potential award fees at 12.5 percent of estimated costs;

c. determining the amount of cost overruns to date and ensuring no future fees are paid on this amount;

d. reducing the performance evaluation period to 6 months with interim reports at 3 months; and

e. removing provisional performance award fee payments to reflect the current contractor's performance.

Management's Response: NASA concurs with this recommendation. As stated in the "Positive Steps Taken to Address Procurement and Management Issues" section of the report, NASA has made progress in addressing Boeing Stages performance management and cost overruns. Potential contract modification options include segregating each delivery component into a unique CLIN, modifying fees and award fee structure, establishing a six-month evaluation period, and removing provisional fee payments. All contract actions will be compliant with Federal Acquisition Regulations. This recommendation will be satisfied, to the extent practicable, by contract restructure, which includes appropriate approvals by Boeing management and NASA officials. NASA will be in a better position to address potential monetary benefits identified in the report as the acquisition approach evolves.

Estimated Completion Date: The estimated completion timeframe is July 2019.

Recommendation 5: Review all SLS Program contracts overseen by the Marshall Office of Procurement to ensure that:

a. no contracting officer has exceeded his or her warrant authority,

b. require the Marshall Office of Procurement to implement a process to prevent future unauthorized commitments from contracting officers exceeding warrants,

c. ensure contract ratifications for any prior unauthorized commitments are completed, and

d. the contracting officer who exceeded his warrant by $318 million is removed from any work related to the SLS Program.

Management's Response: NASA concurs with this recommendation, as follows:

a. All applicable contracts and grants were reviewed in mid-2017, and all citations were investigated and dispositioned. All instances requiring ratification have been documented and are in the process of being ratified.

b. Governing instruments are in place to ensure Federal Acquisition Regulation, NASA FAR Supplement, and Agency requirements compliance. Focus training has also been conducted to reiterate limits and responsibilities afforded under a Contracting Officer's Certificate of Appointment.

c. Ratification of actions is currently in work.

d. The contracting officer in question had their warrant revoked and was removed from the Procurement Office in November 2017 and will be removed from the SLS Program.

Estimated Completion Date: The estimated completion timeframe is January 2019.

Recommendation 6: Reinstitute adjectival ratings by the Contracting Officer's Representative (COR) and technical monitors in order to accurately reflect the contractor's performance. Ensure the COR submits a grade based upon feedback from the technical monitors.

Management's Response: NASA non-concurs with this recommendation. This report acknowledges that the COR has the flexibility under Marshall Space Flight Center guidance to not require technical monitors to develop adjectival ratings. The Marshall Work Instruction (MWI) governing evaluation of contractor performance includes

directions to task monitors to provide adjectival ratings, unless otherwise instructed by the COR. However, all task monitor findings require clear substantiation. Rigor in substantiating strengths and weaknesses, as outlined in the MWI, ensures accurate contractor performance reporting.

Estimated Completion Date: N/A.

To minimize future delays tied to Core Stage availability for the Europa, EM-2, or other future human exploration missions and to obtain the best value to the Agency, the OIG recommends Associate Administrator for Human Exploration and Operations and the Deputy Associate Administrator for Exploration Systems Development:

Recommendation 7: Implement, by October 2018, an acquisition strategy for building Core Stages beyond Core Stage 2 for future missions that includes consideration for awarding the contract as a fixed-price, end-item deliverable contract with each Core Stage separated into unique task orders with specific performance milestones.

Management's Response: NASA concurs with the recommendation, but implementation will not be completed by October 2018. NASA acknowledges an alternate procurement approach is desirable for managing costs on a development effort such as the SLS Core Stage. NASA is in the process of identifying a procurement approach to manage procurement costs and provide flexibility in an environment of changing missions and manifests that may necessitate design changes and require procurement flexibility. A fixed-price, end item deliverable contract structure is one of the options available to the SLS Program to obtain best value for the Government. NASA will implement an acquisition strategy for future missions in 2019.

Estimated Completion Date: The estimated completion timeframe is October 2019.

NASA attempted to obtain a lower cost for the SLS by removing reporting requirements such as not having EUS cost to be separately reported. The annual award fee, instead of every six months, was another attempt to reduce cost. The observed contractor performance showed that this approach, although it reduced contract value, did not allow the insight needed into contractor performance. If the contractor performance would have been better, this approach would have reduced cost to the Government. NASA will learn from this experience in future procurements. NASA will continue to look for best value processes in our contracts. As stated earlier, NASA was proactively amending our approach to contract performance management prior to the audit and see many of the OIG recommendations as validation of the changes that we had in work.

We have reviewed the draft report for information that should not be publicly released. As a result of this review, we have not identified any information that should not be publicly released.

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Lynne Loewy on (202) 358-0549.

for Jamie Mumford

William H. Gerstenmaier

cc:
Human Exploration and Operations Mission Directorate/Mr. Hill
Office of Procurement/Ms. Manning
Marshall Space Flight Center/Ms. Singer
Marshall Space Flight Center/Ms. Craig
Marshall Space Flight Center/Mr. Honeycutt
Stennis Space Flight Center/Dr. Gilbrech

APPENDIX F: REPORT DISTRIBUTION

National Aeronautics and Space Administration

Administrator
Associate Administrator
Deputy Associate Administrator
Acting Chief of Staff
Associate Administrator for Human Exploration and Operations Mission Directorate
Deputy Associate Administrator for Exploration Systems Development
Assistant Administrator for Procurement
Director, Marshall Space Flight Center
Director, Michoud Assembly Facility
Director, Stennis Space Center
Program Manager, Space Launch System

Non-NASA Organizations and Individuals

Office of Management and Budget
    Deputy Associate Director, Energy and Space Programs Division

Government Accountability Office
    Director, Office of Acquisition and Sourcing Management

Congressional Committees and Subcommittees, Chairman and Ranking Member

Senate Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

Senate Committee on Commerce, Science, and Transportation
    Subcommittee on Space, Science, and Competitiveness

Senate Committee on Homeland Security and Governmental Affairs

House Committee on Appropriations
    Subcommittee on Commerce, Justice, Science, and Related Agencies

House Committee on Oversight and Government Reform
    Subcommittee on Government Operations

House Committee on Science, Space, and Technology
    Subcommittee on Oversight
    Subcommittee on Space

(Assignment No. A-18-008-00)