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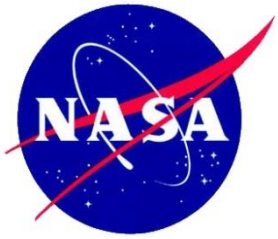
NASA's Management of the Mobile Launcher 2 Contract

June 9, 2022

Report No. IG-22-012



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NASA Office of Inspector General
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RESULTS IN BRIEF

NASA's Management of the Mobile Launcher 2 Contract

June 9, 2022 IG-22-012 (A-21-015-00)

WHY WE PERFORMED THIS AUDIT

Key to NASA's goals of sustaining a human presence on the Moon and future exploration of Mars 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. NASA is developing two mobile launchers at Kennedy Space Center in Florida that will serve as the ground structure to assemble, process, transport to the pad, and launch various iterations of the integrated SLS/Orion system. The launchers consist of a two-story base structure—the platform to support the SLS—and a tower equipped with connection lines; launch accessories; and a walkway for personnel, equipment, and astronauts.

In March 2020, the NASA Office of Inspector General issued a report examining development efforts for both mobile launchers. Construction of the first mobile launcher was completed in 2010 for the since-canceled Constellation Program's Ares I launch vehicle with the structure later modified to support the SLS/Orion system's first three missions known as Artemis. In 2019, NASA awarded a $383 million contract to Bechtel National, Inc. (Bechtel) to design, build, test, and commission a second mobile launcher (ML-2) to support larger variants of the SLS beginning with Artemis IV.

In this audit, we examined the extent to which NASA is meeting cost, schedule, and performance goals for the ML-2 contract. To complete this work, we reviewed budget, contract, acquisition planning, schedule, program status, risk management, and award fee documentation and data from NASA and Bechtel. We also reviewed Earned Value Management System (EVMS) documentation provided by the Defense Contract Management Agency (DCMA) and conducted interviews with NASA, Bechtel, and DCMA officials.

WHAT WE FOUND

NASA is estimated to spend approximately a billion dollars or at least 2.5 times more than initially planned for the ML-2 contract with final delivery of the launcher to NASA expected to take at least 2.5 years longer than initially planned. As of March 2022, NASA had obligated $435.6 million of Bechtel's current $460.3 million contract value and extended the contract's performance period 10 months. However, as of May 2022, design work on the ML-2 was still incomplete and Bechtel officials do not expect construction to begin until the first quarter of fiscal year 2023 at the earliest. To complete contract requirements and deliver an operational ML-2, Bechtel estimates it will need an additional $577.1 million, bringing the structure's total projected cost to $960.1 million coupled with an October 2025 rather than March 2023 delivery date. We expect further cost increases as inevitable technical challenges arise when ML-2 construction begins. Given the time NASA requires for additional testing once the structure is delivered, the earliest the ML-2 will be available for Artemis IV is November 2026.

Compounding Bechtel's projected cost increases and schedule delays, an ML-2 project analysis provided only a 3.9 percent confidence level that the nearly $1 billion cost and October 2025 delivery estimates were accurate. NASA requires projects to develop budgets and schedules consistent with a 70 percent joint cost and schedule confidence level (JCL), meaning a 70 percent likelihood the project will finish equal to or less than the planned costs and schedule. In fact, an Independent Review Team analysis determined the project would require an additional $447 million and

27 months, for a total contract value of $1.5 billion and a launcher delivery date of December 2027—a schedule that would enable an Artemis IV launch no earlier than the end of 2028. Further, while the Exploration Ground Systems (EGS) Program, which manages the ML-2 project, established a formal Agency Baseline Commitment (ABC) for the overall EGS Program—the cost and schedule baseline against which a project is measured—NASA has not established a separate ABC for the ML-2, a recommendation we made in our March 2020 report.

The ML-2's substantial cost increases and schedule delays can be attributed primarily to Bechtel's poor performance on the contract, with more than 70 percent ($421.1 million) of the contract's cost increases and over 1.5 years of delays related to its performance. For example, Bechtel underestimated the ML-2 project's scope and complexity, experienced ML-2 weight management challenges, and experienced staffing turnover and retention issues. Additionally, Bechtel's lack of a certified EVMS since inception of the ML-2 contract—a contractually required tool for measuring and assessing project performance—has limited NASA's insight into the project's cost and schedule issues. Bechtel's performance notwithstanding, NASA's management practices contributed to the project's cost increases and schedule delays. NASA awarded the ML-2 contract while the Exploration Upper Stage—the primary reason NASA needed a second mobile launcher—lacked final requirements, impacting the ML-2 design. With respect to contract management, while NASA withheld award fees for a 6-month performance period in spring 2021 due to Bechtel's poor performance, the Agency did not continue this practice despite the contractor's continued poor performance in the subsequent award period. Therefore, we question nearly $3 million in award fees NASA awarded to Bechtel for this period.

During this audit, we urged NASA to take immediate corrective action given the substantial concerns surrounding Bechtel's performance. Bechtel has developed a recovery plan focused on addressing weight concerns and updating the project's cost and schedule, while NASA is assessing whether to transition to a fixed-price contract in the construction phase. It is too early to tell what impact, if any, these efforts will have on improving the trajectory of the project.

Subsequent to the completion of our audit work, we learned the Agency rated Bechtel's performance for the award fee period ending in March 2022 as "unsatisfactory," resulting in no award fee for this period. Additionally, Bechtel developed a revised interim cost and schedule estimate that projected even higher contract costs and delivery of the ML-2 to NASA in late 2026—more than 3.5 years later than originally promised. While we did not evaluate Bechtel's revised cost and schedule estimate or award fee rating as part of this audit, we will examine both as we continue to monitor NASA's management of the ML-2 contract.

WHAT WE RECOMMENDED

To improve NASA's management of the ML-2 contract and Bechtel's performance, we recommended the Associate Administrator for Exploration Systems Development Mission Directorate: (1) evaluate Bechtel's support for the updated estimate of cost and schedule at project completion and finalize negotiations for Bechtel's currently proposed cost increases and NASA's government-driven changes; (2) before completing and finalizing the ML-2 project-level ABC, update the JCL analysis to reflect realistic life-cycle cost and schedule estimates to ensure effective budgeting and management of the project; (3) to the extent that some or all of the Bechtel contract is converted to a fixed-price contract, ensure the Critical Design Review has been completed in accordance with NASA's life-cycle policies prior to conversion and an independent government cost estimateis established before entering into any new contractual agreements; and (4) ensure acquisition officials minimize the availability of award fees when contract modifications and value increases are the result of shortcomings in contractor performance and require documentation of the rationale for any award fees granted. To increase accountability and improve future selection and management of contracts, we recommended the Assistant Administrator for Procurement (5) issue policy guidance to reinforce current Federal Acquisition Regulation (FAR) and NASA FAR Supplement regulatory guidance for stopping or withholding payments to a contractor for significant deficiencies in business systems, such as the EVMS.

We provided a draft of this report to NASA management who concurred with our recommendations and described their planned actions. We consider the proposed actions responsive and will close the recommendations upon completion and verification.

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Acronyms

ABC	Agency Baseline Commitment
COVID-19	Coronavirus Disease 2019
CPARS	Contractor Performance Assessment Reporting System
DCMA	Defense Contract Management Agency
EAC	Estimate at Complete
EGS	Exploration Ground Systems
EUS	Exploration Upper Stage
EVMS	Earned Value Management System
FAR	Federal Acquisition Regulation
FDO	Fee Determining Official
IGCE	independent government cost estimate
IMS	Integrated Master Schedule
IRT	Independent Review Team
JCL	Joint Cost and Schedule Confidence Level
KDP	Key Decision Point
MEVV	multi-element verification and validation
ML-1	Mobile Launcher 1
ML-2	Mobile Launcher 2
NPR	NASA Procedural Requirements
OIG	Office of Inspector General
PDR	Preliminary Design Review
SLS	Space Launch System
VAB	Vehicle Assembly Building
WBS	Work Breakdown Structure

INTRODUCTION

Human exploration of Mars has been a long-term goal of the United States for the past five decades. In May 2019, NASA announced the Artemis program with the goal of returning astronauts to the Moon as part of its broader objective to land humans on Mars. Key to these efforts is the 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.[1] NASA is developing two mobile launchers at Kennedy Space Center (Kennedy) in Florida that will serve as the ground structure to assemble, process, transport, and launch various iterations of the integrated SLS/Orion system. Collectively, these efforts represent the largest development of space flight capabilities NASA has undertaken since the first Space Shuttle was produced more than 40 years ago.

In 2020, the NASA Office of Inspector General (OIG) issued a report examining the development efforts of both mobile launchers.[2] Construction of the first mobile launcher (ML-1) was completed in 2010 for the since-canceled Constellation Program's Ares I launch vehicle, and the launcher was later modified to support the SLS rocket for the first three Artemis mission launches.[3] In 2019, NASA awarded a $383 million contract to Bechtel National, Inc. (Bechtel) to design, build, test, and commission a second mobile launcher (ML-2) to support larger variants of the SLS beginning with the Artemis IV mission. As of March 2022, NASA had extended the original 44-month contract to 54 months, increased its value by $77.2 million, and obligated nearly all the current $460.3 million contract value even though another 22 months remained on the contract and the project had yet to start construction.[4] As a result, the ML-2 project will require a major increase in funding and significant additional time to build the launcher. While the ML-2 is a required component for lunar missions beginning with Artemis IV and key to NASA's goals of establishing a continuous human presence on the Moon, the growing costs and schedule delays of the ML-2 project threaten the Agency's current timetable for launch of Artemis IV.

In this audit, we examined the extent to which NASA is meeting cost, schedule, and performance goals for the ML-2 contract. Details of the audit's scope and methodology are outlined in Appendix A.

Background

NASA has utilized mobile launcher platforms since the 1960s to support the assembly, transport, and launch of the Agency's space vehicles, including three launchers for the Apollo and Space Shuttle programs. These platforms enable NASA to assemble and process launch vehicles in Kennedy's massive Vehicle Assembly Building (VAB) before the crawler-transporter moves the platform with the integrated

[1] Orion consists of a crew module capable of transporting four astronauts, a service module that provides in-space propulsion and storage, and a launch abort system that can jettison the capsule to safety in the event of an anomaly during launch.

[2] NASA OIG, *Audit of NASA's Development of Its Mobile Launchers* (IG-20-013, March 17, 2020).

[3] With the announcement of the Artemis program in May 2019, NASA renamed SLS/Orion Exploration Missions 1 and 2 as Artemis I and Artemis II and planned to land astronauts on the Moon as part of the Artemis III mission.

[4] Numbers may not add up to the noted amounts due to rounding.

launch vehicle in an 8-hour, 4-mile trek to Launch Pad 39B for launch.[5] Previously used by the Apollo and Space Shuttle programs, Launch Pad 39B is being modified to accommodate ML-1 and ML-2 for the Artemis missions. See Figure 1 for an image of the crawler-transporter vehicle moving the SLS and ML-1 for Artemis I from the VAB to the launch pad.

Figure 1: Crawler-Transporter Moving the SLS and ML-1 from the VAB in March 2022

Source: NASA.

Note: The VAB is the large building located in the right corner of the photograph and ML-1 is the tall tower-like structure on top of the crawler-transporter vehicle located in the foreground.

The ML-1 and ML-2 serve as the Artemis program's ground platform structures from which the SLS rocket and Orion spacecraft will launch to the Moon and eventually to Mars. The launchers are designed to support the assembly, testing, checkout, servicing, and launch of the SLS rocket, as well as transport of the integrated SLS/Orion system to the launch pad. They consist of a two-story base structure—the platform to support the SLS—and a tower equipped with connection lines called umbilicals; launch accessories; and a walkway for personnel, equipment, and astronauts entering the crew module during launch preparations. Construction on the ML-1 structure and facility ground support systems was originally completed in 2010 as part of the Constellation Program for use with the

[5] Launch Pad 39B is a part of Kennedy's Launch Complex 39, which also includes Launch Pads 39A and 39C. Launch Pad 39A is currently leased by Space Exploration Technologies Corporation (SpaceX) to support the company's Falcon 9 and Falcon Heavy launch vehicles. Launch Pad 39C is located within the Pad B perimeter and was constructed in 2015 to accommodate smaller launch vehicles.

Ares I rocket.[6] However, after cancellation of the Constellation Program, the ML-1 required extensive modifications to support the SLS Block 1, as the SLS is bigger, more powerful, three times heavier, and employs a different configuration than the Ares I rocket. As of fiscal year 2019, NASA had utilized six major contracts with five contractors to design and construct the ML-1, for a total contract cost of $668.7 million.[7] NASA plans to use ML-1 to launch Artemis missions I, II, and III, the last of which will return humans to the Moon's surface.

Upgrade of the SLS and ML-2

Beginning with the Artemis IV launch, NASA will evolve the SLS to the bigger and more powerful configuration known as SLS Block 1B. To send a crewed Orion and larger cargo payloads to the Moon, the Block 1B configuration will replace Block 1's Interim Cryogenic Propulsion Stage, which uses one RL-10 engine, with the Exploration Upper Stage (EUS), which uses four RL-10 engines.[8] This larger configuration enables the rocket to launch 40 percent more payload to the Moon. To accommodate the additional size of the Block 1B configuration, NASA determined a second mobile launcher was necessary.[9] The ML-2 will also be used to launch the planned third SLS configuration, known as SLS Block 2, to increase the payload lift capability even further with the addition of upgraded solid rocket boosters through the Booster Obsolescence Life Extension program.[10] In 2018, Congress provided the Agency $350 million to begin ML-2 development and associated SLS activities, and in June 2019, NASA awarded a contract to Bechtel for $383 million to design and build the structure. See Figure 2 for a comparison of the SLS variations.

[6] Announced in 2005, NASA's Constellation Program aimed to develop crew launch, heavy launch, and crew exploration vehicles to return humans to the Moon and for future exploration of Mars and other destinations. While construction of the ML-1 was completed in August 2010, before NASA could outfit the launcher with the needed ground support equipment to make it operational, Congress stopped funding the Constellation Program, including the Ares I launch vehicle, and directed NASA to develop the SLS.

[7] The five major contractors for the ML-1 design and build include: Hensel Phelps; Vencore Services and Solutions, Inc.; Reynolds, Smith & Hills, Inc.; JP Donovan Construction (two contracts); and Jacobs Technology Inc.

[8] The SLS rocket delivers propulsion in stages to send the Orion spacecraft and heavy cargo to the Moon. At liftoff, the core stage and twin solid rocket boosters fire to propel the rocket off the launch pad and send it into orbit. Once in orbit, the upper stage provides the in-space propulsion to set the spacecraft on a trajectory toward the Moon.

[9] The Agency's initial plan was to accommodate the larger SLS Block 1B by modifying the ML-1, but NASA moved away from this approach due to the 2 to 3 years between the Artemis III and Artemis IV launches that would be required to complete modifications to ML-1.

[10] The Booster Obsolescence Life Extension program is a joint effort between NASA and Northrop Grumman to produce a solid rocket booster with an upgraded design to power the evolved configuration of the SLS Block 2.

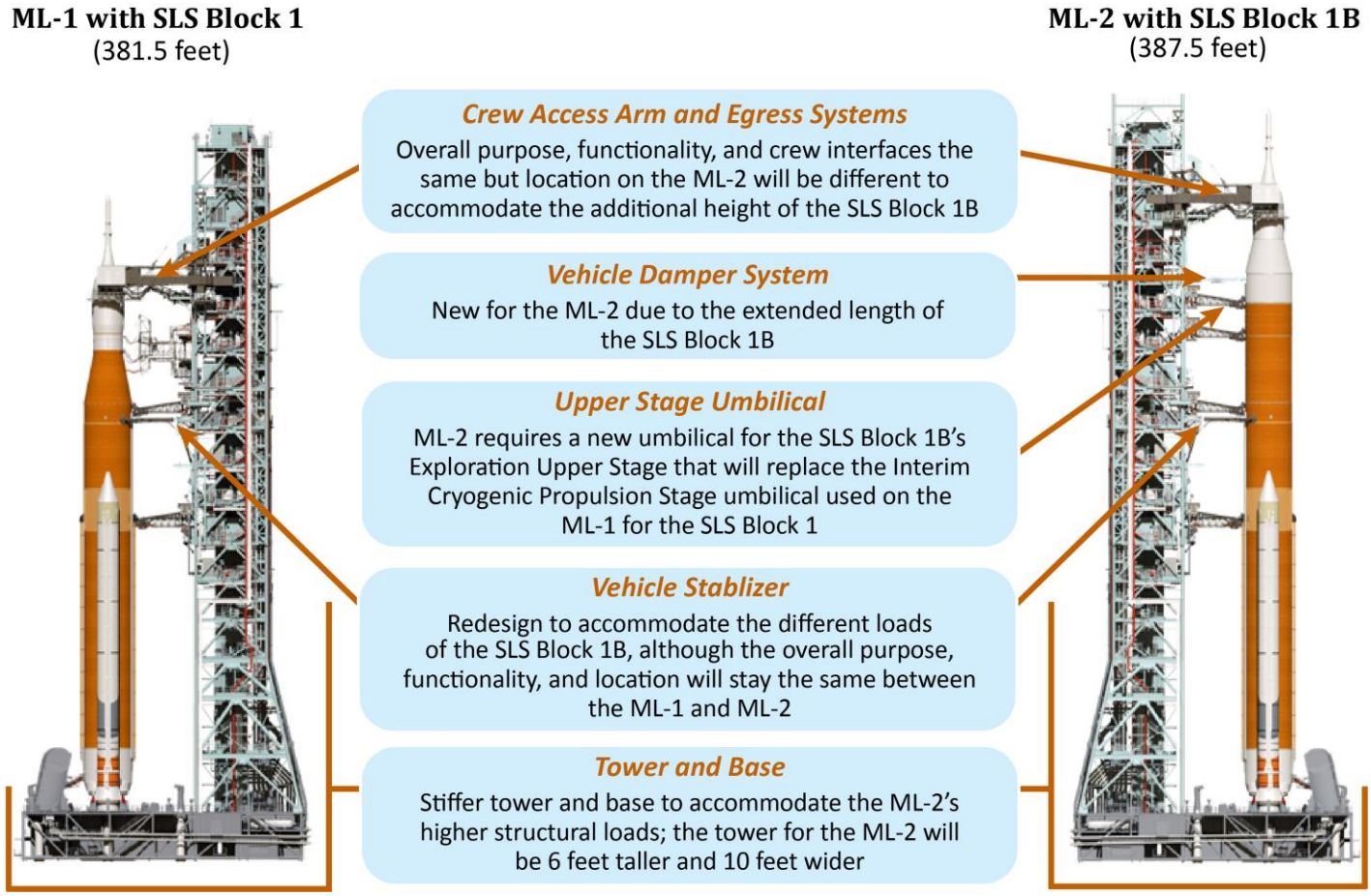
Figure 2: SLS Configuration Comparison between Block 1, Block 1B, and Block 2

	SLS Block 1	SLS Block 1B	SLS Block 2
	(322 feet) 	(365 feet) 	(365 feet) 
Missions	Artemis I, Artemis II, and Artemis III	Artemis IV through Artemis VIII	starting with Artemis IX
Vehicles needed	3	5	to be determined
Upgrades	n/a	Exploration Upper Stage	Booster Obsolescence Life Extension
Mobile launcher	ML-1	ML-2	ML-2
Upmass	70 metric tons to low Earth orbit	105 metric tons to low Earth orbit	130 metric tons to low Earth orbit and 37 metric tons to Mars

Source: NASA OIG presentation of Agency data.

Similar to the ML-1, the ML-2 will be equipped with connection lines that attach to the SLS's core stage, boosters, upper stage, and Orion spacecraft. These umbilicals, or swing arms, on the launcher's tower will provide the SLS and Orion with the power, data, remote monitoring and control, propellants, fluids, gases, sound suppression, imagery, and communications necessary for launch. Although serving the same functionality as ML-1, the ML-2 will be designed to meet Block 1B and Block 2 requirements. For example, the EUS extends the SLS's height by approximately 40 feet, affecting the locations of critical swing arms and requiring the addition of two new arms. Additionally, due to the added height, wind will have a greater effect on the rocket, resulting in a redesign of the vehicle stabilizer system to reduce motion. Further, the ML-2 base's backbone, or truss structure, has been redesigned to support the larger, more powerful rocket, along with the addition of a vehicle damper system to absorb and lessen wind-induced movement of the SLS/Orion system. See Figure 3 for a capability comparison between ML-1 and ML-2.

Figure 3: Capability Comparison of ML-1 and ML-2



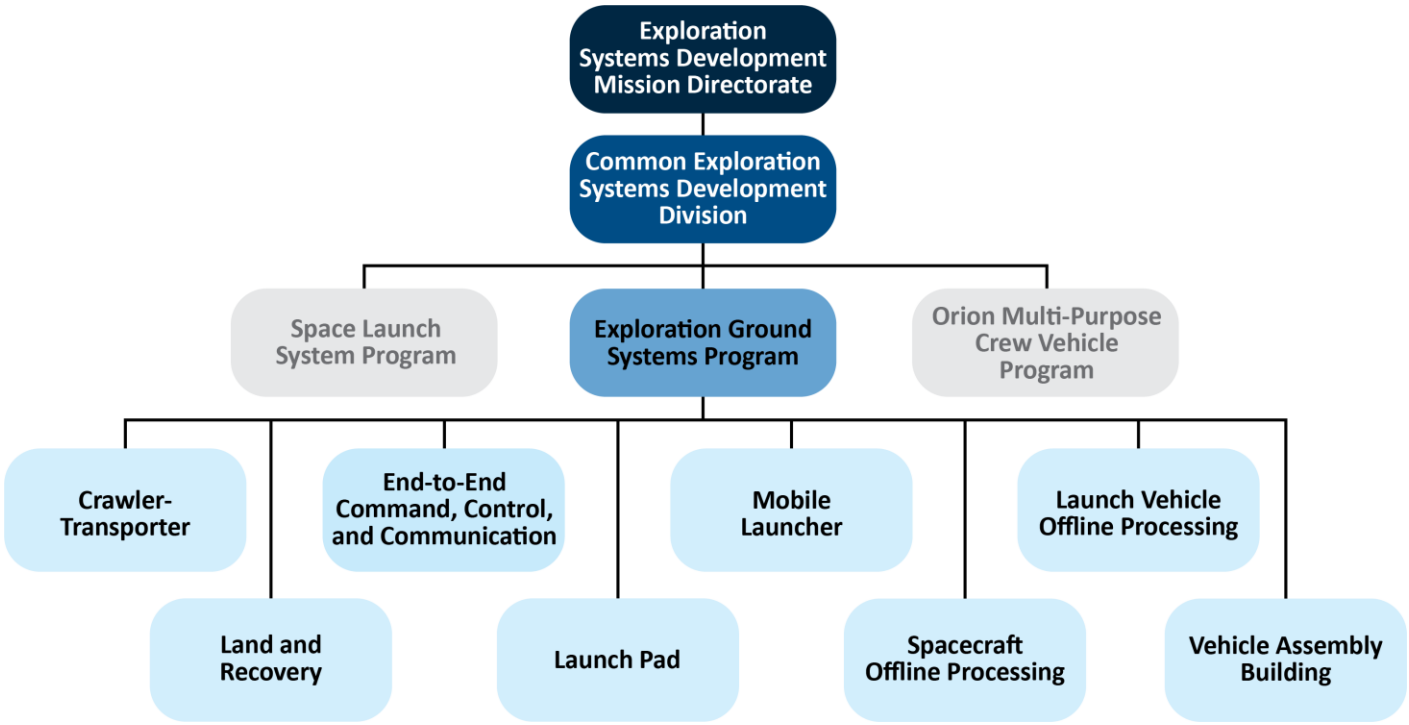
Source: NASA OIG presentation of ML-2 project information.

ML-2 Project Management and Organizational Structure

NASA's Exploration Systems Development Mission Directorate oversees the concurrent development of the SLS, Orion, and Exploration Ground Systems (EGS) programs that are part of the Common Exploration Systems Development Division.[11] Based at Kennedy, the EGS Program develops and operates the facilities and ground support equipment, including ML-1 and ML-2, necessary to assemble, transport, launch, and recover rockets and spacecraft. The EGS Program is comprised of multiple elements that provide development and operational products in support of SLS and Orion. This includes the design, development, build, hardware/software integration, verification and validation, test, and transition to operations for ML-1 and ML-2. Figure 4 provides the ML-2 project's organizational structure, while Appendix B describes NASA's project life cycle.

[11] In September 2021, NASA split the Human Exploration and Operations Mission Directorate into two separate directorates—the Exploration Systems Development Mission Directorate and the Space Operations Mission Directorate. Exploration Systems Development will manage systems development for programs critical to the Artemis missions and will plan the Moon to Mars exploration approach. Space Operations will focus on launch and space operations, including the International Space Station, the commercialization of low Earth orbit, and sustaining operations on and around the Moon.

Figure 4: ML-2 Management and Organizational Structure



Source: NASA OIG presentation of ML-2 project information.

Bechtel Design and Build Contract

In June 2019, NASA awarded a cost-plus contract to Bechtel for $383 million with a performance period from July 2019 through March 2023.[12] The terms of the contract stipulate that Bechtel is required to design, build, test, and ensure the ML-2 is operational in preparation for the Artemis IV launch. Under this contract structure, NASA reimburses Bechtel for all allowable labor and material costs. In addition, the contractor may receive periodic award fees based upon its performance. The original contract value included $23.3 million in available award fees, which would be considered profit for Bechtel. As of March 2022, NASA had added $77.2 million to the contract value and extended it by approximately 10 months, bringing the total value to $460.3 million and the period of performance to January 2024.[13] Both the cost increase and schedule extension were the result of government-driven changes.

[12] Bechtel was not part of the ML-1 modifications project. Using a cost-plus approach, NASA approves all designs, manages all development and schedules, and owns the launcher once delivered by the contractor. While this process gives NASA maximum control over the contractor's design and final product, the majority of cost, schedule, and outcome risks are borne by the federal government.

[13] Numbers may not add up to the noted amounts due to rounding.

NASA decided to utilize a single design-build contract approach for ML-2, a departure from the Agency's traditional design-bid-build approach that was utilized for the ML-1 and a first for contracts of this magnitude based out of Kennedy.[14] Under the more traditional design-bid-build contract, design and construction are sequential and contracted for separately with two contracts. Comparatively, a design-build contract is a method in which NASA utilizes a single contract for both project design and construction. As we reported in our March 2020 report, the Agency's decision to utilize the nontraditional design-build approach was the result of lessons learned from its ML-1 modification experiences, including the desire to remedy communication and integration issues that occurred with the ML-1 project.[15] Additionally, ML-2 project officials noted that time constraints associated with the Artemis schedule contributed to their decision to choose a design-build contract rather than the traditional design-bid-build approach, assuming that awarding one contract—rather than multiple contracts—would streamline procurement time and integration and reduce schedule time.[16] Furthermore, utilizing a design-build approach enables long-lead procurements to start during the design phase.

Monitoring Bechtel's Performance

NASA evaluates Bechtel's contract performance on an ongoing basis and develops a formal award fee performance evaluation report every 6 months to determine the award fee score and the amount of award fee the contractor will receive. The award fee is intended to incentivize and reward Bechtel for timely, safe, high-quality, and cost-effective performance. As of February 2022, NASA had completed five of the nine award fee periods, and Bechtel earned $8.2 million out of an available award fee total of $16.8 million.

The contractor's award fee total is determined by multiple criteria NASA has developed to evaluate contractor performance. For the ML-2 contract, NASA uses four weighted evaluation factors—technical and management, schedule, cost control, and small business utilization—to determine the total award fee score for each evaluation period. Each weighted factor is evaluated separately and given a numerical value that the evaluation team recommends to the Award Fee Board and ultimately the Fee Determining Official (FDO). Per the NASA Federal Acquisition Regulation (FAR) Supplement, the FDO has the final determination of the award fee score and rating.[17] Table 1 shows the evaluation factors and their respective weighted value.

[14] 48 C.F.R § 36.102, *Definitions* (2001).

[15] IG-20-013.

[16] In March 2019, the Administration announced an accelerated goal for NASA to land humans on the Moon's South Pole by 2024 rather than the Agency's original 2028 goal.

[17] NASA's Award Fee Board evaluates the contractor's performance every award fee period based on input from the technical monitors, contracting officer's representative, contracting officer, and ML-2 Project Manager. The FDO meets with the board before making a final decision on the award fee amount. NASA FAR Supplement 1816.405-273, *Award Fee Evaluations* (2021).

Table 1: Award Fee Evaluation Factors for ML-2 Contract

Evaluation Factor	Weight
Technical and Management	40%
Schedule	25%
Cost Control	25%
Small Business Utilization	10%

Source: ML-2 contract award fee plan.

The ML-2 contract employs an "end-item" award fee structure under which the fees earned by the contractor during award fee periods—known as interim award fee periods—are not final until final completion of the contract.[18] The FDO determines the performance score and award fee after consulting with the contracting officer's representative and Award Fee Board. Figure 5 shows the criteria and numerical score required for each adjective rating. For the ML-2 contract, the EGS Program Manager serves as the FDO. Once the FDO completes an award fee determination letter, the contracting officer is responsible for preparing a contract modification that includes the award fee adjective rating, weighted evaluation score, and award fee amount. At the end of the contract—during the final award fee period—all prior interim award fee evaluations can be superseded by the earned score determined at contract completion. For example, award fees not previously earned during the interim periods could be earned at the final evaluation. However, in a prior OIG report we found that NASA's practice of including unearned funds from interim award fee periods in the final award pool promotes a philosophy that cost and schedule overages will be overlooked so long as the end product performs well.[19]

[18] Per the NASA FAR Supplement, for end-item contracts only the last evaluation is final when true quality of contract performance can be measured after the item is delivered. Once the last evaluation is final, 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 the total earned award fee. With end-item contracts NASA pays the contractor up to a maximum of 80 percent of what is earned at the end of each award fee evaluation period and holds the remaining amount until the final evaluation. Whereas with service contracts, each period's evaluation is final and NASA pays the contractor the full amount earned; unearned fees cannot be rolled over to the next performance period. NASA FAR Supplement 1816.405-273, *Award fee evaluations*, and 1816.405-276, *Award fee payments and limitations* (2017).

[19] NASA OIG, *NASA's Use of Award-fee Contracts* (IG-14-003, November 19, 2013).

Figure 5: Award Fee Performance Ratings

Source: NASA OIG presentation of FAR 16.401, Table 16-1, award fee criteria.

Prior NASA OIG Audit

In March 2020, NASA OIG reported on the Agency's development of both mobile launchers.[20] This audit found that NASA had greatly exceeded its cost and schedule targets for the ML-1 due to the Agency's acquisition approach for the launch platform and immature SLS requirements. With respect to what then was a nascent ML-2 project, we noted that at the time NASA had taken positive steps to address lessons learned from the design and development of ML-1 but was missing opportunities to improve project management and oversight of the ML-2 project. The 2020 audit made four recommendations to NASA to improve potential outcomes for ML-2 development. Two years later, two of the recommendations—(1) ensure life-cycle and milestone reviews incorporate programmatic and technical risks and (2) develop an Agency Baseline Commitment (ABC) separate from the EGS Program—remain open. NASA requested extensions to resolve these recommendations until the end of April 2022, and as of May 2022, the recommendations were still open.

[20] IG-20-013.

MOBILE LAUNCHER 2 WILL COST MORE THAN DOUBLE WHAT WAS PLANNED AND WILL NOT MEET CURRENT ARTEMIS IV LAUNCH SCHEDULE

NASA is estimated to spend approximately a billion dollars, or 2.5 times more than initially planned, for the ML-2 contract and final delivery of the launcher to NASA will take at least an additional 2.5 years, resulting in the launcher not being available for the current Artemis IV launch date of August 2026.[21] NASA OIG projections estimate the ML-2 will not be available for launch until November 2026 at the earliest; however, it is unlikely that the Agency will meet this date as construction on the launcher has yet to begin and further delays can be expected. These cost increases and schedule delays can be attributed primarily to Bechtel's poor performance on the contract but were also compounded by NASA's decision to award the ML-2 contract before EUS requirements were finalized. Further, NASA's usage of an award fee has not improved Bechtel's performance, and given the ML-2 project's cost overages and schedule delays, we question nearly $3 million of award fees already earned by the contractor.

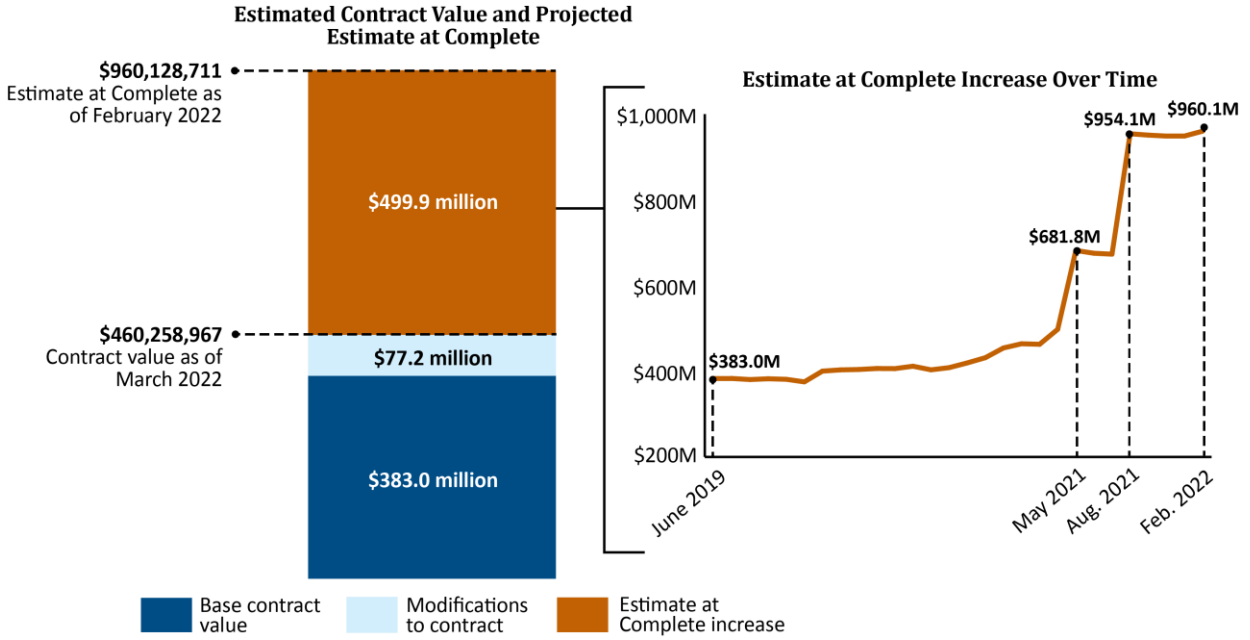
ML-2 Will Cost Over Half a Billion Dollars More than Planned and Faces Delays of at Least 2.5 Years

As of March 2022, NASA had obligated $435.6 million (94.6 percent) of Bechtel's current $460.3 million contract value, leaving only approximately $24.7 million for the remaining 22 months of performance. However, as of May 2022, design work on the ML-2 was still incomplete and Bechtel does not expect construction to begin until the first quarter of fiscal year 2023 at the earliest. To complete the requirements of the contract and deliver an operational ML-2, Bechtel estimates $577.1 million will need to be added to the initial $383 million contract value, bringing the structure's total projected cost to $960.1 million—a 150.7 percent increase (see Figure 6).[22] We expect even greater cost increases because NASA anticipates the potential for additional changes due to finalization of EUS requirements and technical challenges once ML-2 construction begins. In light of these issues, NASA is reevaluating the ML-2 project's budget and schedule estimates to provide a more accurate representation of the projected increases.

[21] The August 2026 Artemis IV date is considered by NASA to be "notional," as they have not yet announced a formal launch date for the mission.

[22] As of February 2022, the additional $577.1 million includes $565.8 million of additional projected costs Bechtel included on its monthly costing reports to NASA, known as NASA Form 533M reports, as their "Estimate at Complete" beginning in October 2021. The remaining $11.3 million is related to additional proposed engineering changes from NASA. Further, while the ML-2 contract with Bechtel comprises the vast majority—approximately 88 percent—of the overall ML-2 project costs, the project requires an additional $134 million for NASA contingency funds and government furnished equipment, such as vehicle support posts and umbilicals, facilities upkeep and maintenance, and salaries for civil servant employees involved in the launcher project.

Figure 6: ML-2 Estimated Contract Value and Projected Estimate at Complete

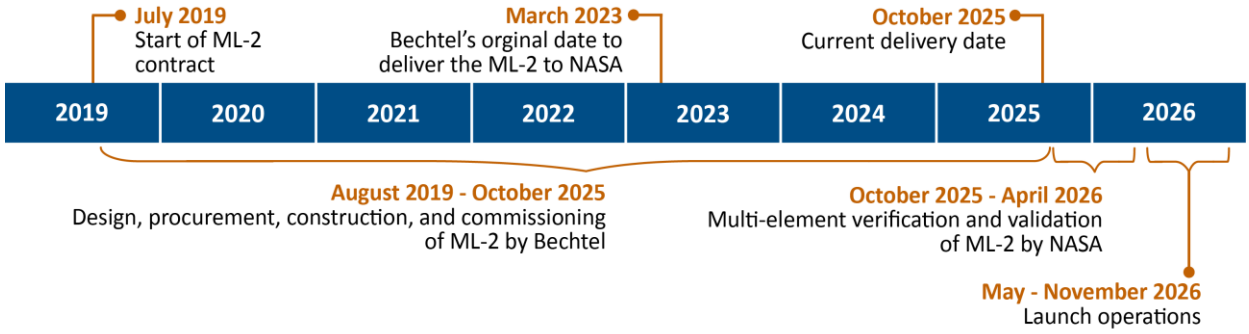


Source: NASA OIG presentation of ML-2 contract modifications and Bechtel monthly cost reporting data.

Note: Dollar amounts are rounded.

In addition to the launcher's significant cost increases, Bechtel expects a schedule delay of at least 2.5 years for delivery of the ML-2 to NASA. When the ML-2 contract was first awarded in June 2019, Bechtel was required to deliver the ML-2 structure to NASA by March 2023; however, as of February 2022, the company's projected delivery date is October 2025. After Bechtel delivers the launcher to NASA, the ML-2 project will need at least an additional 6 to 9 months to ensure the launcher's systems are safe and work as intended—a process known as verification and validation. Next, the ML-2 project needs approximately 7 more months to complete launch operations, such as placing the SLS on the ML-2 and moving it to the launch pad on the crawler-transporter. As a result, due to the contract delays, in combination with NASA's required steps after delivery, the earliest an Artemis IV launch could occur would be November 2026 (see Figure 7).

Figure 7: NASA OIG Projected ML-2 Project Schedule (as of February 2022)



Source: NASA OIG analysis of NASA and Bechtel schedule information.

In the near term, NASA remains in the design phase as key life-cycle milestones associated with this stage for ML-2 have been delayed. For example, the Interim Critical Design Review has been delayed 6 months from March 2022 to September 2022.[23] Additionally, the start of construction on the ML-2 has been delayed multiple times, and as of May 2022, Bechtel officials do not expect construction to begin until the first quarter of fiscal year 2023 at the earliest. Furthermore, the contractor was experiencing a day-for-day slip in schedule as they mitigate design challenges. NASA and Bechtel are exploring several options to combat these schedule delays, including conducting parallel work, increasing labor hours for additional shift work, and evaluating reuse of ML-1 components. However, each of these options carry their own risks of future cost and schedule impacts that could further delay the project.

NASA Has Not Allocated Enough Time for Verification and Validation Testing

After Bechtel hands over the ML-2 by October 2025, NASA will need to complete multi-element verification and validation (MEVV) testing before preparations for the Artemis IV launch can begin. MEVV provides the Agency an opportunity to ensure that the ML-2 is safe and works as intended.[24] Experiences and lessons learned from the ML-1 project suggest that the ML-2 project has not allocated enough time for MEVV. According to ML-2 project officials, they are currently allotting 6 to 9 months for this process. However, as we reported in March 2020, MEVV for the ML-1 project took at least 16 months, roughly double the amount of time the ML-2 project currently has planned.[25] At the time of our prior report, the ML-2 project had allotted 12 months for MEVV, 3 to 6 months more than the current ML-2 schedule anticipates. Additionally, delays in construction, Bechtel testing, availability of personnel, and readiness of the VAB could further threaten the MEVV process, potentially delaying the ML-2 project's schedule by an additional 8 months, resulting in the ML-2 not being ready for Artemis IV launch preparations until November 2026 at the earliest.

ML-2 Joint Cost and Schedule Confidence Level Suggests Additional Cost Increases and Schedule Delays

Compounding Bechtel's projected cost increases and schedule delays, the ML-2 project's analysis completed in December 2021 only provided a 3.9 percent confidence level that the project's nearly $1 billion estimated cost and October 2025 delivery estimates were accurate. NASA requires projects to develop budgets and schedules consistent with a 70 percent joint cost and schedule confidence level (JCL)—in short, a 70 percent likelihood the project will finish equal to or less than the planned cost and

[23] The Critical Design Review demonstrates that the design is sufficiently mature to proceed to full-scale fabrication, assembly, integration, and testing, and that the technical effort is on track to meet performance requirements within identified cost and schedule constraints.

[24] MEVV testing refers to a verification and validation process. Verification tests are the official "for the record" testing performed on a system or element to show that it meets allocated requirements or specifications including physical and functional interfaces. Validation tests are conducted under realistic or simulated conditions on any end product to determine the effectiveness and suitability of the product for use in mission operations by typical users and to evaluate the results of such tests. It ensures that the system is operating as expected when placed in a realistic environment.

[25] IG-20-013.

schedule.[26] In order to attain the required 70 percent confidence level, the ML-2 project's preliminary JCL analysis, presented during the programmatic Preliminary Design Review (PDR) in December 2021, indicated that an additional $101 million and 8 months would be needed to meet the project's goals, increasing contract costs to $1.1 billion and Bechtel's delivery of the launcher to mid-2026.[27] However, by February 2022, an Independent Review Team (IRT), convened by Kennedy officials, determined that the ML-2 project's analysis was underestimated.[28] The IRT made several changes to the project's JCL, including adjusting for inflation or deflation of costs, accounting for historical Kennedy project performance and Bechtel performance, and incorporating additional project risks identified by the IRT.[29] As a result, the IRT's JCL assessment indicated the project would require an additional $447 million and 27 months, for a total contract value of nearly $1.5 billion and a launcher delivery date of November 2027. Therefore, based on the IRT assessment and considering the time NASA would need to complete MEVV and launch operations, the Artemis IV launch could occur no earlier than the end of 2028.

As of March 2022, NASA officials were working to incorporate the IRT's recommendations into the analysis used to develop the project's ABC. NASA officials have also established a Recovery Evaluation and Integration Team comprised of procurement and project management officials to make additional recommendations to senior leadership. When the team completes its review, NASA plans to update the JCL analysis with any additional recommendations.

ML-2 Project Has Yet to Establish an Agency Baseline Commitment

While the overall EGS Program has established a formal ABC—that is, the cost and schedule baseline committed to Congress and the Office of Management and Budget against which a project is measured—NASA has not established a separate ABC for the ML-2 project.[30] In our March 2020 report

[26] NASA Procedural Requirements (NPR) 7120.5F, *NASA Space Flight Program and Project Management Requirements* (August 3, 2021) requires space flight projects to conduct a JCL analysis at Key Decision Point C for which the estimated life-cycle cost is more than $250 million. This policy also requires projects with a life-cycle cost of $1 billion or more to update their JCL at the Critical Design Review and communicate the updated value to the Agency Program Management Council for the ABC. Further, when a project with an estimated life-cycle cost greater than $250 million is rebaselined, a JCL should be calculated and evaluated as a part of the rebaselining approval process.

[27] The PDR demonstrates that the preliminary design meets all system requirements with acceptable risk and within the cost and schedule constraints and establishes the basis for proceeding with detailed design. NASA split the ML-2 project's PDR into two phases—technical and programmatic. The ML-2 project's technical PDR was in March 2021 and focused on the technical maturity of the project, including discussions on the status of the different subsystems that comprise the launcher, while the programmatic PDR was in December 2021 and focused on project cost, schedule, and Joint Cost and Schedule Confidence Level analysis along with project risks.

[28] NASA tasked the IRT with conducting a thorough review of the project's cost, schedule, risks, and JCL. Comprised of NASA personnel from Headquarters, Kennedy, Armstrong Flight Research Center, Goddard Space Flight Center, Marshall Space Flight Center, and Johnson Space Center, the ML-2 IRT consists of 11 members with a variety of expertise, including engineering, safety and mission assurance, and health and medical. The IRT conducted a review of the ML-2 project by assessing the project's cost and schedule estimates, identifying new risks and uncertainties, and completing an IRT JCL analysis that modified the project-provided JCL.

[29] The IRT cited the following concerns with the project's JCL analysis: (1) inflation and deflation impacts are not reflected properly in the model, (2) potential risk impacts to the ML-2 project's cost and schedule are higher than projected, (3) upcoming project tasks are more complicated and could have greater impact, and (4) the JCL's schedule logic is not properly linked, resulting in an overly constrained model.

[30] An ABC is a set of requirements, including cost, schedule, and technical content, that form the foundation for NASA's commitment to Congress and the Office of Management and Budget that a project can be developed for a set amount of money and time.

we recommended the ML-2 project establish a separate ABC to enhance cost and schedule visibility, which the Agency agreed to implement.[31] We reasoned that the ML-2 project exceeds the cost threshold of $250 million to establish an ABC under NASA guidance, and without an ABC, Agency officials are not required to examine the reasons for significant funding and schedule increases or reductions in ML-2 technical capabilities.[32] Once a project-specific ABC is established, Agency project managers must immediately notify the NASA Administrator if there is reasonable cause to believe that a cost or ABC threshold is likely to be exceeded.[33] Specifically, NASA is required by law to notify Congress if the project's development costs are likely to exceed 15 percent or be delayed 6 months beyond the commitment date. If the project's costs are likely to exceed 30 percent, NASA is not allowed to spend any additional money beyond 18 months without congressional reauthorization.[34]

Even though NASA agreed with our recommendation to develop an ABC for ML-2 by May 2021, Agency officials deferred that work to focus on Bechtel's updated cost estimates and requested an extension to April 2022. As of May 2022, the recommendation remained open, and we anticipate another extension as negotiations with Bechtel on the cost estimates are ongoing. With the exorbitant cost increases and schedule delays now facing the project, absent an ABC, NASA is not required to notify Congress and request approval to rebaseline the project's scope, costs, and schedule. In this case, NASA officials said that even though a separate ML-2 project ABC has not been established, as part of the 2021 Agency budget preparations, the EGS Program presented to Agency officials the need for significant additional funding to complete the ML-2 project. As a result, in September 2021 NASA identified the funding increase required for ML-2 as part of its budget submission to the Office of Management and Budget.

Bechtel's Poor Performance Has Increased Costs and Driven Schedule Delays

We found Bechtel's poor performance is the main reason for the significant projected cost increases and schedule delays to the design and development of the ML-2. Specifically, of the $577.1 million total projected cost increase and over 2.5 years of schedule delay, more than 70 percent ($421.1 million) and over 1.5 years of delay is related to poor contractor performance, primarily Bechtel's underestimation of the ML-2 project's scope and complexity. According to Bechtel officials, a portion of the projected cost increase is due to the impacts of Coronavirus Disease 2019 (COVID-19).

[31] IG-20-013.

[32] NASA is required to create, track, and report on the life-cycle costs and schedule commitments for any program or project with a budget exceeding a life-cycle cost of $250 million. 51 U.S.C. § 30104(a)(3 and 4), *Baselines and cost controls* (2010). NASA policy further requires space programs and projects to set a formal ABC at Key Decision Point C for cost and schedule after formulation is complete but before development begins. NPR 7120.5F.

[33] 51 U.S.C. § 30104(d)(1).

[34] After the Administrator notifies Congress of a likely 15 percent increase, the Administrator must submit an updated cost and schedule status for the program or project within 6 months of the Agency's determination. If the program or project is likely to exceed 30 percent of development costs, NASA must submit to Congress a rebaseline of program or project scope, expected costs, and schedule commitments before Congress will reauthorize spending. 51 U.S.C. § 30104(e).

Bechtel Underestimated Scope and Complexity of the ML-2 Project

According to both NASA and Bechtel management, Bechtel underestimated the overall scope and complexity of designing and building the ML-2 at the onset of the project. In spring 2021—nearly 2 years after contract award—Bechtel provided NASA with updated cost and schedule estimates to complete the project (known as the Estimate at Complete or EAC) as part of its monthly costing reports to NASA. These updated reports revealed significant anticipated cost increases in the areas of minor subcontractors, labor hours, equipment, material and supplies, and estimated management reserve. Moreover, while Bechtel continued to work on the ML-2 design, company officials explained to NASA management as part of their performance evaluation that they are "not designers and do not normally perform these kinds of designs."

The updated reports contained the following details:

- *Minor subcontractors*. Bechtel originally estimated the minor subcontractor costs required to complete the ML-2 contract would be $34.1 million. However, as of February 2022, estimated subcontractor costs had grown to $84.3 million, a nearly 150 percent increase from the original estimate. Additionally, it was only after awarding Bechtel the contract that NASA learned the company would be relying on vendors to complete much of the design work.[35] NASA expressed concern over this approach given the Agency's past experiences with the ML-1 project that also highly relied on vendors. According to NASA officials, the project's requirements were incorrectly imposed by Bechtel on their vendors which resulted in unplanned rework, increased labor hours, delays to the design schedule, and increased costs. As of March 2022, Bechtel had utilized dozens of vendors on the project for design and other areas.
- *Labor hours*. Bechtel originally estimated that approximately 2 million labor hours (equaling $152.2 million) would be required to complete the ML-2 contract. As of February 2022, Bechtel estimated the total labor hours required to complete the ML-2 would exceed 3.8 million hours, a recalculation that would increase total labor costs by $133.3 million to approximately $285.5 million, a nearly 90 percent increase from the original labor estimate. NASA noted during a 2021 performance assessment of Bechtel that instead of assigning engineering personnel with the appropriate skills and experience, Bechtel merely increased the quantity of engineering staff to address design challenges. Specifically, while Bechtel originally planned for fewer than 100 engineering personnel, as of February 2022 it had assigned approximately 300 engineers to the project even though performance had continued to decline.
- *Equipment*. Bechtel originally estimated equipment costs to complete the ML-2 contract would be $117.9 million. As of February 2022, estimated equipment costs had increased by $152.7 million to a total of $270.6 million, a 130 percent increase from the company's original estimate to complete the ML-2 contract. Under the equipment category, Bechtel includes costs related to the procurement of steel, aluminum, wiring, and other construction-related material. Some of these cost increases can at least partly be attributed to COVID-19 impacts, such as the rising price of steel, oil, and gas, and delays in responsiveness from suppliers. Bechtel's original estimate for steel has increased by $10 million to $29 million, and more recent estimates show

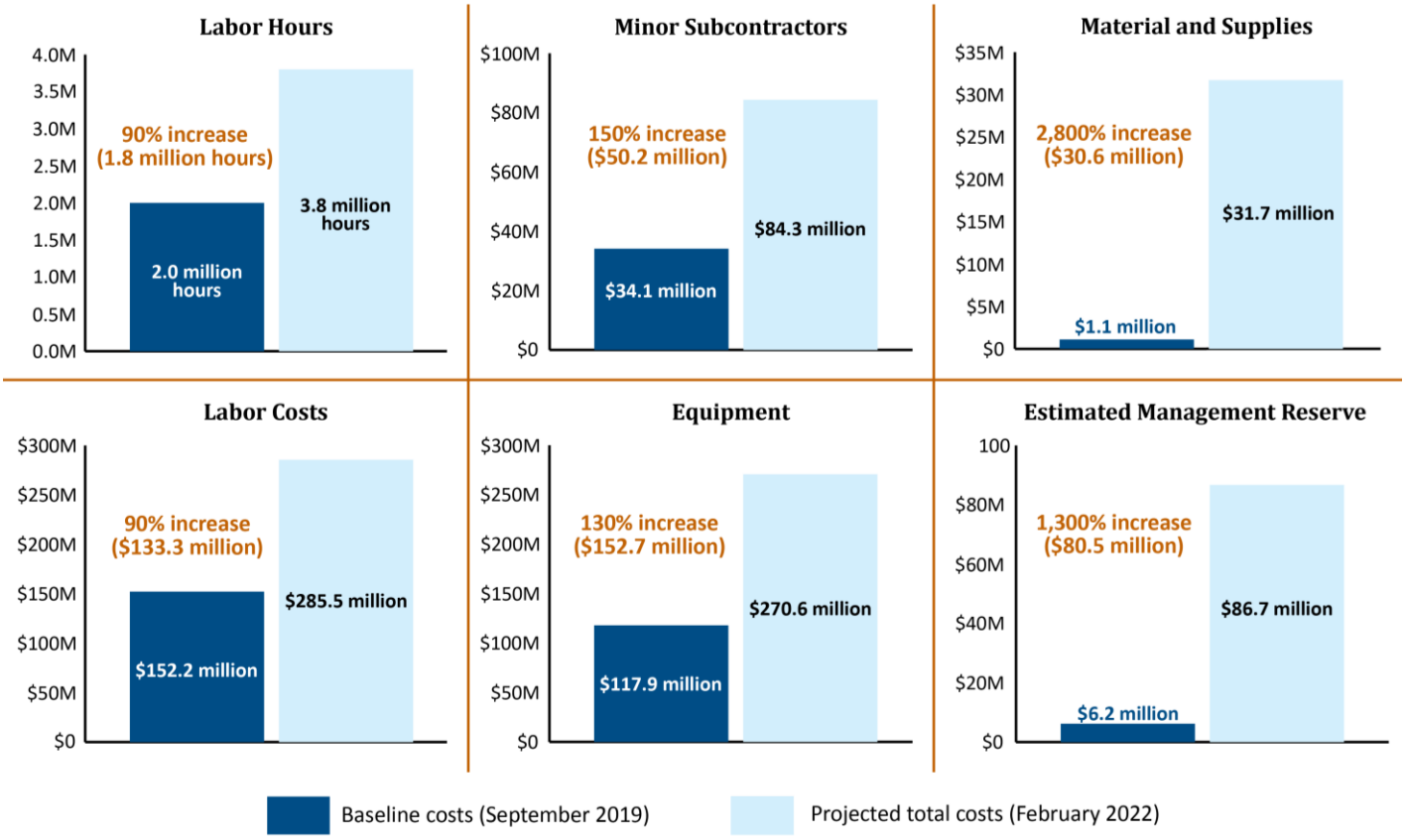
[35] A subcontractor works directly under a prime contractor, while a vendor sells and supplies products to a wide range of customers.

another $30 million or more may be required. Further, acquiring tubing and piping materials have also proved challenging for the contractor.

- *Material and supplies*. Bechtel originally estimated $1.1 million in material and supplies costs to complete the ML-2. As of February 2022, estimated material and supplies costs had increased by $30.6 million, a nearly 2,800 percent increase from the original estimate, to approximately $31.7 million. Under the material and supplies category, Bechtel includes other direct costs associated with the construction such as trailer and truck rentals, generators, and portable toilets. ML-2 project officials were not clear why these costs were projected to increase so significantly over the course of the remaining period of performance because Bechtel had not provided adequate details behind the new estimates.
- *Estimated Management Reserve*. Bechtel's original contract value included management reserve costs of $6.2 million to cover any potentially unforeseeable situations as the project progressed through construction. According to NASA officials, this management reserve value was "woefully inadequate for a project of this scope, complexity, and magnitude." As of February 2022, Bechtel increased their estimated management reserve costs by $80.5 million to approximately $86.7 million, an approximately 1,300 percent increase over initial estimates. According to NASA officials, Bechtel shifted management reserves to cover other costs without prior NASA approval as required by the contract. If Bechtel continues shifting management reserves at the current rate, we estimate the reserves will be depleted by February 2023. Further delays could potentially result in construction beginning without any management reserves.

Figure 8 depicts the rising hours or costs in selected categories.

Figure 8: Selected ML-2 Contract Rising Hours and Cost Categories (as of February 2022)



Source: NASA OIG presentation of NASA and Bechtel cost information.

Note: All labor hours, dollar amounts, and percentages are rounded.

By December 2021, NASA had issued Bechtel two Letters of Concern noting the contractor's poor performance and inability to control rising costs and schedule delays, along with other areas such as the contractor's Earned Value Management System (EVMS), which is discussed in further detail below. In its first letter from March 2021, NASA noted that Bechtel's response to NASA's concerns in these areas had been lacking in timely and effective approaches to mitigate the contractor's myriad of problems. In its second letter from December 2021, the Agency explained that despite ongoing action by Bechtel, project metrics continued to indicate negative trends and it was unclear when those actions would produce improved project performance. As of March 2022, according to NASA officials, Bechtel's multiple responses to NASA have been inadequate. Specifically, in its December 2021 letter NASA requested that Bechtel provide updated cost and schedule recovery efforts by the beginning of February 2022. While Bechtel plans to provide interim updates by the end of May 2022, full cost and schedule updates will not be provided by the contractor until September 2022. NASA and Bechtel continue to review potential options, such as increasing labor hours and reducing contract scope. For example, to lessen the contract's scope and better focus Bechtel on the remaining tasks, in early 2022, NASA and Bechtel agreed to remove the development of the umbilicals from the contract—an action that has not affected the contract value as of April 2022. NASA will utilize a different contractor for the umbilicals and provide them to Bechtel for ML-2 integration as government furnished equipment.

Additional Management Issues Contribute to Bechtel's Poor Performance and Will Likely Continue to Negatively Affect the ML-2 Project

Several other interrelated issues contributed to Bechtel's poor performance on the ML-2 project—many of which will likely continue to affect the contract in the future—including Bechtel's reluctance to utilize NASA's expertise in subsystem development, weight management and mitigation challenges, lack of risk management, and staffing turnover and retention. Additionally, Bechtel's lack of a certified EVMS since inception of the ML-2 contract has limited the Agency's insight into project cost and schedule issues.

Reluctance to Utilize NASA's Expertise in Subsystem Development

After NASA decided in March 2018 to build a second mobile launcher for the more powerful versions of the SLS, the ML-1 project went through an extensive lessons learned process to capture the experience gained from that effort. The ML-1 and ML-2 rely on many of the same types of subsystems, such as cryogenics, emergency egress, platforms, ground support, and communications.[36] Moreover, many of the ML-2's subsystems—27 out of 44—are derived from ML-1 designs, with the remaining 17 subsystems being new designs.[37] However, despite its experience with the ML-1, NASA officials have described reluctance from Bechtel to utilize and incorporate the Agency's expertise.

NASA has expressed concern over Bechtel's practice of relying on vendors to produce ML-2 designs given the issues experienced with ML-1 project vendors and their inexperience with conducting design analyses. Contrary to recommendations from NASA, Bechtel continued with this approach, resulting in cost increases and schedule delays as numerous designs needed to be redone (see Appendix C for examples of vendor designed subsystems that have experienced significant cost increases). For example, the Heating, Ventilation, and Air Conditioning subsystem design for ML-2 is now nearly 1.5 years behind schedule.[38] According to the ML-2 project, these delays can be attributed to issues with Bechtel's vendors having to rework designs.

Further, Bechtel has struggled to produce detailed drawings for steel fabrication.[39] Fabrication drawings are plans developed in much greater detail and translate how all the components of a design need to be manufactured, fabricated, assembled, and installed. While NASA expected Bechtel to produce the ML-2 designs in-house, Agency officials suggested Bechtel outsource the fabrication drawings to its prime fabricator, a common practice within NASA and industry. According to ML-2 project officials, Bechtel did not have the requisite expertise in this area; however, the company insisted on utilizing in-house resources to produce the drawings, claiming that this approach would save cost and schedule. When the fabricators attempted to utilize the Bechtel-generated drawings, they experienced numerous issues such as missing data, lack of clarity, and illogical directions requiring extensive rework. Moreover, the prime fabricator had to supplement Bechtel's drawings, which effectively duplicated effort and

[36] A subsystem is a self-contained system, but one that normally will not provide a useful function without being integrated with other subsystems or systems.

[37] Fifteen subsystems, including five that also feature new designs or designs derived from ML-1, feature government furnished designs or equipment.

[38] The Heating, Ventilation, and Air Conditioning subsystem provides temperature and humidity control and ventilation within enclosed areas on the ML-2.

[39] Fabrication is the process of transforming raw steel into a product or item that can be used in construction or assembly.

severely impacted the project's cost and schedule. During this period, NASA requested a cost comparison of internal versus outsourced fabrication drawings, but Bechtel stated that it would not generate cost or schedule savings. ML-2 project officials stated that errors in these fabrication drawings are the root cause for many of the scheduling issues experienced by the contractor in the latter half of 2021. In December 2021, Bechtel leadership agreed that the in-house approach was flawed and began transitioning all remaining drawing development to the prime fabricator.

ML-2 Weight Management and Mitigation Challenges

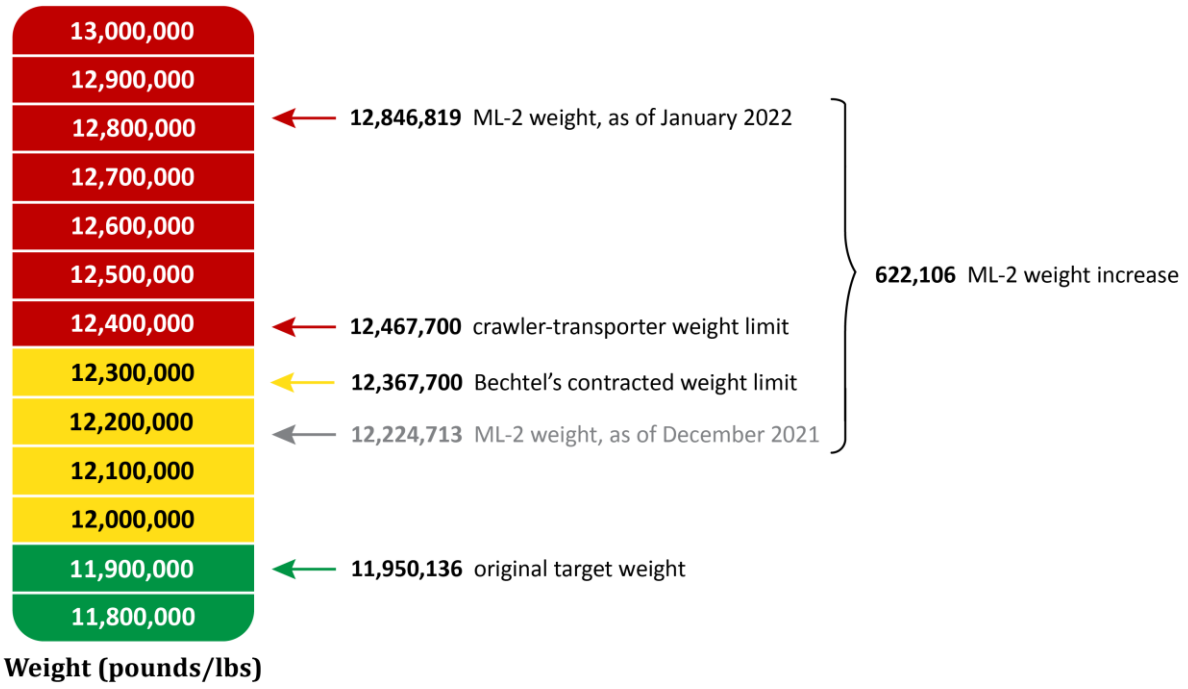
The ML-2's weight continues to be a challenge for Bechtel and has resulted in ongoing schedule delays for the project. The crawler-transporter—a large, tracked vehicle and platform that will pick up and move the ML-2 to and from the VAB and launch pad—can carry a maximum of 18 million pounds, which needs to include both the mobile launcher and integrated SLS/Orion system.[40] As such, weight management is a critical component of the ML-2 project. At the beginning of the ML-2 contract, NASA established a firm weight limit for an empty ML-2—that is, the weight of the launcher without the integrated SLS/Orion system—to be no greater than roughly 12.37 million pounds. According to ML-2 project officials, to provide a margin for unexpected weight increases due to the lengthy design and construction processes, NASA and Bechtel agreed to a target empty weight of 11.9 million pounds. This resulted in an approximately 417,000-pound weight margin between the contracted weight limit and the launcher's target weight.

In February 2021, Bechtel reported its first significant weight increase for the ML-2—almost 1 million pounds—but was unable to explain why the weight had increased. Bechtel's new weight estimates exceeded the maximum allowable empty weight limit. Bechtel commissioned an independent team of experts to assess the weight challenges and identify corrective actions, implementation of which resulted in approximately 143,000 pounds of weight margin, bringing the empty weight of the ML-2 to 12.22 million pounds as of December 2021 (see Figure 9).

In January 2022, Bechtel informed NASA that they had experienced another significant weight increase of approximately 620,000 pounds. As a result, the total projected weight of the ML-2 design increased to nearly 12.9 million pounds—approximately 500,000 pounds over the 12.37-million-pound empty weight limit and nearly 1 million pounds over the 11.9-million-pound target weight (see Figure 9). NASA officials explained the weight increase can be attributed to Bechtel not understanding how their structural modeling tool calculated weight thereby underestimating the projected design weight. In addition, despite prior recommendations from NASA to utilize welded connections in certain locations, Bechtel prioritized construction efficiencies over conserving weight by incorporating many bolted connections, which are easier to implement in the field yet inherently heavier. Upon realizing the projected ML-2 design was overweight, Bechtel took several redesign actions, including strategically incorporating more welded connections.

[40] During preparations for launch, the crawler-transporter will pick up and move the ML-2 into the VAB. The SLS and Orion will be integrated onto the launcher before the crawler-transporter leaves the VAB and makes its 8-hour, 4-mile trek to return the integrated system to the launch pad. Once at the launch pad, the ML-2 will be lowered onto the pad and the crawler-transporter removed prior to launch.

Figure 9: ML-2 Weight Scale



Source: NASA OIG presentation of NASA and Bechtel ML-2 weight information.

Given the significance of this issue, in January 2022 Bechtel paused structural design efforts to focus on weight mitigation actions and engaged with experts from both industry and NASA to develop ideas to address the ML-2's weight challenges. As a result, approximately 639,000 pounds of weight reduction to the ML-2 design were identified. In addition, Bechtel indefinitely halted all steel fabrication. In February 2022, NASA officials reexamined the crawler-transporter's weight capacity and identified an additional 500,000 pounds in weight margin, helping Bechtel's projected weight exceedances and mitigating some cost and schedule impacts to the project. In doing so, NASA raised the ML-2 weight limit from 12.37 million pounds to approximately 12.87 million pounds. While these efforts will help the project's weight challenges, understanding the full impact on ML-2's cost and schedule is ongoing as incorporating these effects will require significant redesign. As of March 2022, Bechtel was incorporating these weight saving measures into their designs, potentially resulting in a several month impact to the project's schedule.

Lack of Risk Management

During 2021 Bechtel stopped identifying and tracking technical risks to the project.[41] According to ML-2 project officials, Bechtel project management was focused instead on developing new cost and schedule estimates rather than identifying risks that could impact cost, schedule, and performance later in the project. Although NASA requested updated cost and schedule estimates in December 2020 to better inform its ABC-development efforts, the Agency did not direct Bechtel to pause other efforts such as risk

[41] NASA guidance defines a risk as the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly stated performance requirements. The performance shortfalls may be related to institutional support for mission execution or related to the safety, technical, cost, or schedule domains. NASA/SP-2016-6105 Rev 2, *NASA Systems Engineering Handbook* (December 2007).

management. Specifically, the ML-2 contract requires and the project relies upon Bechtel to identify, assess, and track the cost, schedule, and performance impacts of technical risks. Bechtel is currently addressing this issue after a recent change in its management and began holding risk meetings with NASA again in January 2022. However, neither Bechtel nor NASA was fully engaged in the risk management process between December 2020 and January 2022, resulting in a lack of confidence in cost and schedule estimates as the impact of design and construction risks were not properly accounted.

As a result of the IRT's efforts in early 2022 to conduct a thorough review of the project's cost, schedule, and risks, the team noted that the lapse of Bechtel's risk management process had impacted NASA's ability to assess risk and NASA did not take full advantage of the risk management process. The IRT identified 11 project-specific risks and recommended the ML-2 project office break down its high-level risks into smaller, more focused risks. As of March 2022, the project has identified approximately 20 project-specific risks that will assist NASA in developing better cost and schedule estimates.

Contractor Staffing Turnover and Retention

Staffing has continued to be a challenge for Bechtel, with the company on its third leadership team for the ML-2 project within roughly the first 2 years of the contract. According to Bechtel officials, in 2020 the contractor experienced 10 key personnel losses, resulting in a second leadership team taking over the project. During this turnover, Bechtel was without a Chief Engineer for a year, the same time period when NASA realized the scope of Bechtel's cost and schedule problems. Since that second leadership change, Bechtel brought on a number of new personnel, including a Deputy Project Manager in spring 2021, a Project Manager and Construction Manager in summer 2021, and an Engineering Manager in fall 2021, resulting in the third leadership change.

Beyond its leadership challenges, Bechtel has also struggled with staffing across the project. For example, Bechtel noted that the September 2021 COVID-19 vaccine mandate for NASA contractors resulted in a greater rate of attrition and retirements among its staff than normal.[42] Furthermore, the contractor has been challenged to find and keep workers local to Kennedy, a challenge the contractor had not anticipated. As a result, Bechtel has had to relocate staff from around the country, resulting in increased travel expenses to NASA. As the project transitions from the design to the construction phase, whether the contractor continues to experience increases in travel expenses will depend on Bechtel's ability to staff the project with local workforce.

Lack of Certified Earned Value Management System

Since the start of the ML-2 contract in July 2019, Bechtel has lacked a certified EVMS—a required tool for measuring and assessing project performance. While Bechtel currently has an EVMS, it may not be fully certified until October 2022 at the earliest, more than 3 years into a contract that was originally

[42] In September 2021, the Administration announced a COVID-19 vaccine mandate for federal workers and contractors; however, in January 2022, a federal district court granted a preliminary injunction that blocked implementation of this mandate. The injunction remains in place as of April 2022.

supposed to be completed in about 3.5 years.[43] During the acquisition process in 2019, NASA officials inferred Bechtel's EVMS was essentially a "plug-and-play" application, easily utilized for the ML-2 contract and considered Bechtel's proposed EVMS as a strength.[44] However, shortly after awarding the ML-2 contract, NASA learned that the contractor did not have a compliant EVMS specific to the ML-2 contract.[45] Instead, Bechtel establishes a new EVMS for each contract and the supporting documentation included as part of its contract proposal was not applicable to the ML-2 contract.[46]

Bechtel Delayed Defense Contract Management Agency Review Twice. NASA requested assistance from the Defense Contract Management Agency (DCMA) to leverage their expertise and determine the adequacy of the contract's EVMS.[47] As noted in Figure 10, NASA contracted with DCMA in August 2019 to review Bechtel's EVMS plans, provide an assessment of their adequacy, and verify initial and continuing contractor compliance with EVMS guidelines. While DCMA conducted its integrated baseline review and initial visit in 2020, due to scheduling constraints, DCMA was not able to schedule Bechtel's compliance review until January 2021.[48] However, two requests from Bechtel, which NASA approved, further delayed DCMA's review until June 2021. For both delay requests, Bechtel cited its need to focus on the rebaseline effort for the ML-2 contract—the updated cost and schedule estimates. Although NASA agreed to the delay requests, DCMA officials stated a delay was not necessary and an EVMS can be evaluated at any stage of a project to show that it is functioning.

[43] Earned value management is a process for measuring and assessing project performance through the integration of cost and schedule objectives during the execution of a project. NPR 7120.5F requires projects with estimated life-cycle costs greater than $250 million to perform earned value management for all contracted portions of the project as soon as the contract begins. To meet this requirement, the Agency and its contractors rely on an integrated set of policies, processes, systems, and practices known as an EVMS. A certified EVMS ensures that the performance measurement data provided to NASA is valid, accurate, and timely to support informed decision-making. This also allows NASA to plan contract scope to completion; integrate the cost, schedule, and technical aspects of the contract into a detailed baseline plan; objectively measure progress; and forecast achievement of milestones.

[44] The acquisition process for the ML-2 contract was a two-phase approach. Bechtel's EVMS was evaluated during the first phase of this process under the areas of technical and specialized experience.

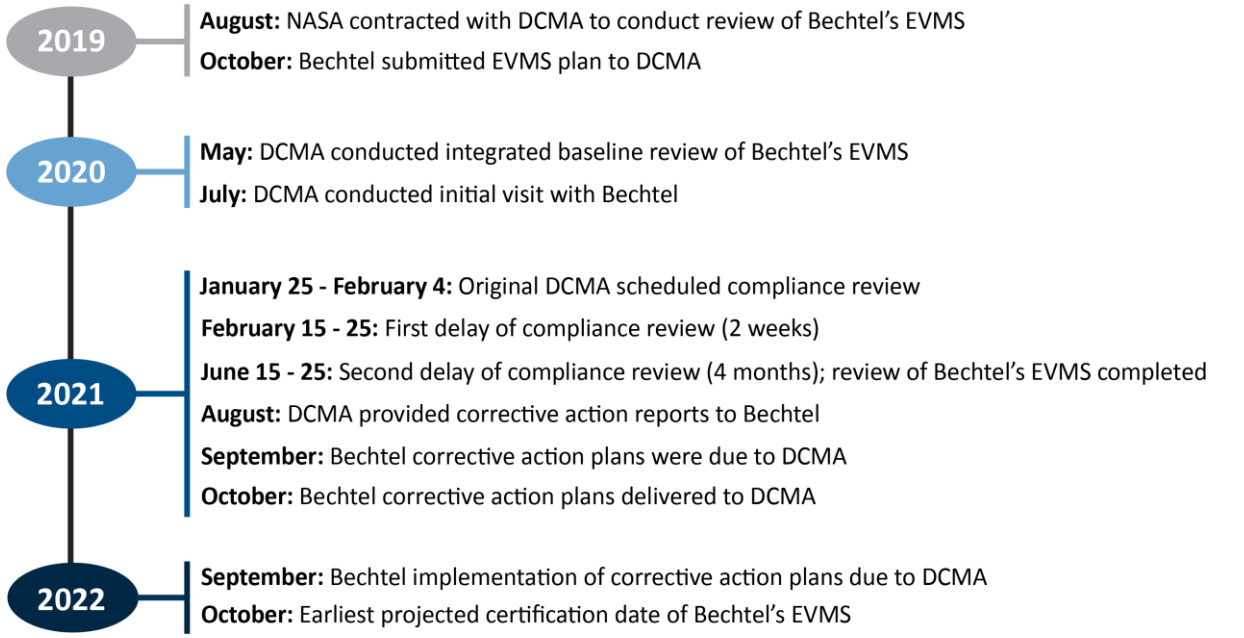
[45] EVMS guidelines are outlined in Electronic Industries Alliance–Standard 748, *Earned Value Management Systems* (1998).

[46] Since awarding the ML-2 contract in June 2019, and as the result of a NASA OIG recommendation, NASA has updated its approach to verifying a contractor's EVMS status. In May 2020, the OIG issued a report examining the Agency's management of the Low-Boom Flight Demonstrator Project, finding issues with the contractor's EVMS similar to the certification issues experienced by the ML-2 project. NASA OIG, *Management of the Low-Boom Flight Demonstrator Project* (IG-20-015, May 6, 2020).

[47] A part of the U.S. Department of Defense, DCMA is responsible for determining EVMS compliance. NASA has a Memorandum of Understanding with DCMA for EVMS acceptance and surveillance. Under this agreement, DCMA is expected to provide NASA with evidence supporting its acceptance of a contractor's EVMS.

[48] According to FAR 34.202, *Integrated Baseline Review* (2022), the purpose of the integrated baseline review is to verify the technical content and realism of related performance budgets, resources, and schedules. The review should provide a mutual understanding of the inherent risks in contractors' performance plans and the underlying management control systems, as well as formulate a plan to handle these risks.

Figure 10: Timeline of Bechtel's EVMS Review



Source: NASA OIG presentation of NASA and DCMA information.

Defense Contract Management Agency Identified Numerous Shortcomings with Bechtel's EVMS. DCMA provided Bechtel with the results of its review in August 2021, and as of March 2022, Bechtel was still working to address the compliance issues identified. DCMA identified 39 noncompliance issues with the Bechtel ML-2 EVMS, 15 of which were considered material weaknesses that affect the ability of government officials to rely upon information produced by the system.[49] DCMA's review team evaluated how the contractor's EVMS is structured, how it is used in the management of contracts, and whether it meets the intent of industry guideline criteria. Among the issues identified were reports of criteria not being defined; requirements not being met; incorrect, incomplete, or inaccurate data; process or procedural issues; missing Work Breakdown Structure (WBS) elements; and budgetary concerns related to management reserve.[50] Some of these issues had previously been identified and reported to Bechtel during DCMA's initial visit in July 2020 (see Figure 10). DCMA identified these issues as opportunities for Bechtel to improve its EVMS prior to DCMA's compliance review; however, in the year that followed between the two reviews none of the issues had been corrected. After DCMA provided Bechtel the results of the compliance review, Bechtel submitted to DCMA corrective action plans to address the noncompliance issues. Bechtel's schedule had shown the contractor concluding implementation of the corrective actions in September 2022; however, as of March 2022, the contractor anticipates missing this date. See Appendix D for a full list of noncompliance issues and respective corrective action plans.

[49] DCMA identified 37 noncompliance issues during the initial August 2021 review. DCMA later identified two additional noncompliance issues in February and March 2022, respectively.

[50] WBS is a product-oriented family tree that identifies the hardware, software, services, and all other deliverables required to achieve an end project objective. The purpose of a WBS is to subdivide the project's work content into manageable segments to facilitate planning and control of cost, schedule, and technical content. It identifies the total project work to be performed, which includes not only all NASA in-house work but also all work to be performed by contractors, international partners, universities, or any other performing entities.

DCMA officials explained that Bechtel was unmotivated to correct deficiencies sooner and did not appear to have personnel knowledgeable in EVMS management. In its letter to NASA confirming that it had completed the compliance review of Bechtel's EVMS, DCMA noted U.S. Department of Defense guidance that allows the department to withhold 5 percent of payments due to a contractor whose business systems, including EVMS, have material noncompliances that are not resolved in a timely manner, ultimately providing additional motivation to ensure deficiencies are corrected.[51] While current NASA guidance does not specifically address business system noncompliance, the NASA FAR Supplement does address EVMS noncompliance and advises the contracting officer to take remedial action, that may include, but is not limited to, a reduction in fee.[52] Therefore, even though the ML-2 project does have the option to withhold payment for EVMS noncompliance, they have not utilized this option to deter Bechtel from postponing implementation of the corrective actions.

NASA's Management Practices Have Contributed to the ML-2 Contract's Increased Costs and Schedule Delays

NASA decisions prior to awarding the ML-2 contract in June 2019 have contributed to the project's cost increases and schedule delays. Specifically, due to schedule pressures, NASA decided to award the ML-2 contract while the Exploration Upper Stage (EUS)—the main driver requiring a second mobile launcher—was early in its design cycle and lacked finalized requirements, impacting the contract approach and independent government cost estimate (IGCE). Moreover, despite withholding all award fees in spring 2021 due to Bechtel's poor performance, 6 months later during the following performance evaluation period, the Agency awarded Bechtel with over $2.9 million in award fees even though cost, schedule, and technical performance continued to decline.

Lack of Finalized EUS Requirements Impacted Bechtel's Performance

To better ensure that ML-2 met the Artemis IV timeline, NASA officials said the Agency had no choice but to move forward with awarding the ML-2 contract while its primary dependent program—the SLS EUS—was still in design, resulting in concurrent changes to ML-2 design and development requirements. As of March 2022, NASA had added approximately $77.2 million and 10 months of additional schedule to the contract due to government-driven changes.[53] At that time, NASA further anticipated government-driven changes to add an additional $19 million in costs. According to NASA officials, areas such as refinement of detailed design requirements, flight vehicle interface changes, and obsolete parts will contribute to these estimated cost increases.

[51] Defense FAR Supplement 252.242-7005, *Contractor business systems* (2012). This clause applies to contracts that are subject to the Cost Accounting Standards as implemented in 48 C.F.R. § 9903.201-1, *CAS applicability* (2018), meaning those contractor business systems that comply with the terms and conditions of the applicable business system clauses listed in the definition of "contractor business systems." Contractor business systems include accounting systems, EVMS, estimating systems, material management and accounting systems, property management systems, and purchasing systems. Specifically, the clause states that a contractor shall establish and maintain acceptable business systems in accordance with the terms and conditions of the contract, and if the contracting officer determines that the contractor's business system contains significant deficiencies, the final determination will include a notice to withhold 5 percent of amounts due from progress payments and performance-based payments.

[52] NASA FAR Supplement 1852.234-2(b), *Earned Value Management System* (2015).

[53] The $77.2 million in contract value increase and 10 months extension in period of performance is through contract modification 51.

In May 2020, NASA increased the contract value by $17.6 million and extended the period of performance by 3 months to accommodate updates to NASA's coupled loads analysis—a critical process to ensure events such as liftoff, wind gusts, and engine startup and shutdown do not compromise the structural integrity of the SLS vehicle and launcher. While this is the responsibility of the SLS Program, they require an analytical model of the ML-2 to interact with their software to produce the analysis. As part of the design process, Bechtel then uses the results of the analysis to determine whether their ML-2 model can handle the loads of the SLS vehicle. However, due to maturing EUS and ML-2 requirements, the coupled vehicle and launcher loads analysis provided by the SLS Program was delayed, ultimately delaying Bechtel's design work and steel purchases by 3 months.

More than half of the $77.2 million increase, or $49 million, and 7 months of additional schedule was added in March 2022 to incorporate several changes in requirements and alignment with the SLS schedule. Specifically, the ML-2 tower and vehicle stabilizer stiffness requirements—needed to keep the SLS more stable during movement—were revised, which required an update to Bechtel's tower design. Additional changes included but were not limited to the following: reassessing structural configuration to include revising the wind load requirements for the crew access arm, updating the VAB mount mechanism to provide additional relief on weight limitations, and adding crew emergency egress platforms.

Design-Build Contracting Approach Not Well Suited for ML-2 Procurement

NASA's use of a design-build contracting approach for ML-2—utilizing a single contract and contractor—deviates from the traditional design-bid-build approach under which separate contractors are hired for design and construction. When implemented correctly, the design-build approach can save time and money by encouraging innovation and collaboration. As such, NASA selected this method for the ML-2 contract due to contractor cost and schedule issues experienced with the ML-1 project and Artemis IV mission time constraints. Because this was the first design-build construction contract of this magnitude awarded at Kennedy, NASA officials responsible for the contract award were not experienced in this approach. According to federal guidance, one of the factors to consider when determining if the design-build approach is appropriate is the extent to which project requirements have been adequately defined.[54] At the time the ML-2 contract was awarded to Bechtel, numerous EUS requirements remained unknown such as umbilical connections between the EUS and the ML-2.

Further, according to industry best practices, to ensure success using this approach NASA should have focused on the following issues: (1) develop realistic project budgets, (2) identify project-specific risks, and (3) ensure project staff are well educated and experienced with design-build best practices.[55] We found that NASA struggled in each of these areas, which contributed to the significant cost increases and schedule delays on the project.

[54] FAR 36.301, *Use of two-phase design-build selection procedures* (2019).

[55] The Design-Build Institute of America is an organization that defines, teaches, and promotes best practices in design-build and in 2014 released their 10 design-build best practices known as "Design-Build Done Right, Universally Applicable, Best Design-Build Practices." These best practices were written to be applicable to both the public and private sectors.

NASA's Cost Assessments of Contractors Based on Inadequate Independent Government Cost Estimates

The ML-2's IGCE was inadequate due to incomplete cost data related to the EUS's unknown requirements. The IGCE is an estimate of the resources needed and projected costs that a contractor will incur in the performance of a contract. These costs include direct costs such as labor, supplies, equipment, or transportation; indirect costs such as labor overhead; material overhead; general and administrative expenses; and profits or fees. Federal guidance requires this detailed independent cost estimate be prepared for construction costs to assess contract proposals prior to awarding the contract.[56] However, the ML-2's IGCE was based on the ML-1 project—originally constructed for the Ares I launch vehicle and subsequently modified for the SLS Program—and did not provide an accurate representation of the costs associated with building a new mobile launcher specifically for the SLS. Further, due to incomplete EUS requirements, NASA acknowledged the IGCE was underestimated, which made it difficult for NASA to rely on the estimate when evaluating contractor proposals.

Contract Award Fees Do Not Consistently Reflect Bechtel's Performance

While contract award fees are intended to incentivize positive contractor performance, NASA has struggled to motivate and improve Bechtel's performance using the award fee structure. As of February 2022, NASA had awarded Bechtel nearly 50 percent of the total available award fees—$8.2 million out of an available $16.8 million—over the span of five award fee periods (see Table 2). For the first three award fee periods, NASA assessed Bechtel's performance as "very good." While NASA expressed concerns about Bechtel's performance during the third award fee period, the Agency decided these concerns did not warrant a lower rating. However, during the fourth award fee period, NASA assigned Bechtel a score of 45, which resulted in an "unsatisfactory" rating and no award fees—a rare outcome in NASA's dealings with its contractors.

Table 2: Bechtel Interim Award Fee Evaluation Ratings

Award Fee Period	Maximum Available Fee	Earned Fee	Score	Adjective Rating
Period 1 (July 2019 to September 2019)	$987,907	$790,325	90	Very Good
Period 2 (October 2019 to March 2020)	1,275,347	1,020,277	88	Very Good
Period 3 (April 2020 to September 2020)	4,320,765	3,456,612	90	Very Good
Period 4 (October 2020 to March 2021)	4,691,450	0	45	Unsatisfactory
Period 5 (April 2021 to September 2021)	5,546,542	2,939,667	53	Good
Total	**$16,822,011**	**$8,206,881**	**73 (average)**	**Good (average)**

Source: NASA award fee evaluations for Bechtel contract performance.

[56] FAR 36.203, *Government estimate of construction costs* (2019), states an independent government estimate of construction costs shall be prepared and furnished to the contracting officer at the earliest practicable time for each proposed contract and for each contract modification anticipated to exceed the simplified acquisition threshold. FAR 2.101, *Definitions* (2022), states the simplified acquisition threshold is $250,000.

Despite Period 4 resulting in no award fee, according to NASA, Bechtel was initially slow to respond and implement changes that would improve the contractor's performance. Ultimately, towards the end of the fifth award fee period Bechtel implemented leadership changes—the third such change in leadership since contract award—but cost management, schedule, and technical performance did not improve. Nevertheless, NASA assigned a score of 53, which aligned with a "good" rating, for the fifth award fee period and awarded them $2.9 million, indicating the contractor had met cost, schedule, and technical goals—a rating inconsistent with the contract's criteria (see Figure 5). Even though there had not yet been any noticeable performance improvements, NASA ML-2 project officials explained that they wanted to recognize Bechtel's difficult decisions and commitments for the leadership changes it made. Moreover, Agency officials explained that although a score of 53 is technically considered a "good" rating, such a score is not a positive accomplishment and does not send the message that the Agency is pleased with the contractor's performance. Applying NASA guidance to Bechtel's performance during the fifth award fee period, the significant cost overruns within the contractor's control and schedule slippage should have resulted in no award fee.[57] Therefore, we question the $2.9 million in award fees NASA awarded to Bechtel for the fifth period. See Appendix E for details on this questioned cost.

At the conclusion of the fourth award fee period in March 2021, NASA began including performance assessments for Bechtel in the Contractor Performance Assessment Reporting System (CPARS) in an effort to properly align recurring contractor performance evaluations.[58] This is an uncommon practice, as typically a CPARS assessment is provided annually through the life of the contract.[59] As of February 2022, NASA had completed three CPARS evaluations for Bechtel. While the first assessment was positive, the next two identified poor performance rating indicators—"unsatisfactory" for schedule, cost control, and management categories and "marginal" for quality. According to NASA, because CPARS evaluations are used by other entities to assess the contractor's performance before awarding a contract, including these "unsatisfactory" and "marginal" ratings have led to increased interest in the state of the project by Bechtel's senior leadership.

NASA has consistently assigned areas of emphasis as part of the award fee evaluation plan. For Period 6, in October 2021 NASA updated Bechtel's award fee evaluation plan with new areas of emphasis—that is, performance elements NASA has deemed require the highest priority attention during the evaluation period. Specifically, NASA emphasized that Bechtel begin construction by January 2022 and complete the Interim Critical Design Review by the end of March 2022. However, as of March 2022, these milestones have gone unmet, which should impact Bechtel's sixth award fee score.

[57] *NASA Award Fee Contracting Guide*, Section 3.6.3, "Scoring of Cost Control" (May 14, 2019) states whenever there is a significant cost overrun that was within its control, a contractor should be given a score of zero. If the overrun is insignificant, a higher score may be given. The reasons for the overrun and the contractor's efforts to control or mitigate the overrun should be considered in the evaluation.

[58] CPARS is a web-based system that allows government agencies to report and rate contractor performance.

[59] FAR 42.1502(a), *Policy* (2019).

NASA Evaluating a Path Forward on Managing the ML-2 Contract

During the course of our audit, we urged NASA to take immediate corrective action to address the significant performance and management issues related to the ML-2 contract to potentially include partially or fully terminating the contract, negotiating a fixed-price contract for the construction phase, and reevaluating the current award fee structure. In response to our concerns, NASA issued a Letter of Concern to Bechtel in December 2021 requesting an assessment of project risks and impediments; a corrective action plan; and identification of opportunities to reduce cost, mitigate schedule, and improve efficiency in the project implementation.

In February 2022, Bechtel provided NASA with a two-phased recovery plan. In addition, an internal assessment of the project by NASA's Office of Procurement provided 10 recommendations to improve the contract.[60] The procurement management team's analysis identified many of the same issues that this report discusses, such as use of a design-build contract, continued issues with the EVMS, and evaluation of contractor performance and related award fees. To analyze the recovery plan and recommendations, NASA established an ML-2 Recovery Evaluation and Implementation Team, the results of which were due in April 2022. The team is also identifying areas of the ML-2 contract that can be converted to a firm-fixed-price structure.[61] At this stage, it is too early to tell what impact these efforts will have on the ML-2 project's cost and schedule. In particular, while converting portions of the ML-2 contract to a fixed-price would reduce NASA's risk and increase transparency, it is unclear whether Bechtel would agree to this approach nor is it clear if NASA could afford the high costs associated with this contract structure.

Addendum

Subsequent to the completion of our audit work, NASA rated Bechtel's performance as "unsatisfactory" (with a score of 28 out of 100) for the sixth award fee period from October 1, 2021, through March 31, 2022. As a result of this rating, Bechtel will receive no award fee for this 6-month period. Additionally, on May 31, 2022, the Agency received from Bechtel an interim updated cost and schedule estimate to complete the project that shows even higher contract costs and delivery of the ML-2 to NASA late in 2026—more than 3.5 years later than the original contracted delivery date of March 2023. As of June 2022, NASA is evaluating the revised interim cost and schedule estimate while continuing to work with Bechtel to address their performance issues on the ML-2 contract. As noted earlier in the report, Bechtel is expected to provide a fully updated cost and schedule estimate in September 2022. We did not evaluate the most recent award fee rating or Bechtel's revised cost and schedule estimate as part of this audit but will do so as we continue to monitor NASA's management of the ML-2 contract.

[60] The NASA Office of General Counsel also participated in the assessment of the ML-2 project.

[61] A firm-fixed-price contract type places maximum risk on the contractor and full responsibility for all costs and resulting profit or loss.

CONCLUSION

The ML-2 is key to achieving NASA's goals of sustaining a human presence on the Moon and future Mars exploration. When complete, the ML-2 will serve as the ground structure to assemble, process, transport, and launch larger variants of the integrated SLS/Orion space flight system. In the nearly 3 years since NASA awarded the ML-2 contract, Bechtel has experienced numerous challenges, resulting in projected costs more than doubling to $960.1 million and the delivery schedule slipping at least 2.5 years to October 2025. NASA finds itself in this precarious position because the contractor severely underestimated the scope and complexity of the project, from labor hours to material and equipment costs to subcontracting. Moreover, the contractor's reluctance to utilize NASA expertise, failure to track risks, challenges with managing the launcher's weight, and lack of certified EVMS will likely continue to impact the contractor's cost, schedule, and performance.

While the majority of the problems experienced by the ML-2 project can be attributed to Bechtel's poor performance, NASA is not without fault. A lack of final requirements for the EUS—the major contributing factor for the need to design and build a second mobile launcher—at the onset of awarding the ML-2 contract hindered the design-build contracting approach and resulted in incomplete IGCE data. Furthermore, although NASA took the unprecedented step of rating Bechtel's performance as "unsatisfactory" and awarding the contractor $0 in award fees during the fourth award fee period, the Agency did not continue this practice despite Bechtel's poor performance during the subsequent fifth period. As a result, we are questioning the nearly $3 million in award fees that NASA awarded to Bechtel for this performance period.

During the course of the audit, we urged NASA to take immediate corrective action to address the significant challenges facing the ML-2 contract given the substantial concerns surrounding Bechtel's performance. Our suggestions included, among other options, partially or fully terminating the contract, negotiating a fixed-price contract for the construction phase, and reevaluating the current award fee structure. Bechtel and NASA developed a recovery plan and procurement-focused recommendations, respectively. While Bechtel's recovery plan focused on addressing weight concerns and updating the cost and schedule, NASA's assessment recommended the ML-2 project immediately begin planning the strategy to transition the construction phase to a fixed-price contract. However, it is too early to tell what impact, if any, these efforts will have on improving the project's cost and schedule.

RECOMMENDATIONS, MANAGEMENT'S RESPONSE, AND OUR EVALUATION

To improve NASA's management of the ML-2 contract and Bechtel's performance, we recommended the Associate Administrator for Exploration Systems Development Mission Directorate:

1. Evaluate Bechtel's support for the updated estimate of cost and schedule at project completion and finalize negotiations for Bechtel's currently proposed cost increases and NASA's government-driven changes.
2. Before completing and finalizing the ML-2 project-level ABC, update the JCL analysis to reflect realistic life-cycle cost and schedule estimates to ensure effective budgeting and management of the project.
3. To the extent that some or all of the Bechtel contract is converted to a fixed-price contract, ensure that
    a. the Critical Design Review has been completed in accordance with NASA's life-cycle policies prior to conversion and
    b. an IGCE is established before entering into any new contractual agreements.
4. Ensure acquisition officials minimize the availability of award fees when contract modifications and value increases are the result of shortcomings in contractor performance and require documentation of the rationale for any award fees granted.

To increase accountability and improve future selection and management of contracts, we recommended the Assistant Administrator for Procurement:

5. Issue policy guidance to reinforce current FAR and NASA FAR Supplement regulatory guidance for stopping or withholding payments to a contractor for significant deficiencies in business systems, such as the EVMS.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions. We consider the proposed actions responsive and will close the recommendations upon completion and verification.

Management's comments are reproduced in Appendix F. Technical comments provided by management and revisions to address them have been incorporated as appropriate.

Major contributors to this report include Ridge Bowman, Human Exploration Audits Director; Susan Bachle, Project Manager; Thomas Dodd; Areeba Hasan; and Sarah McGrath. Additionally, Lauren Suls provided editorial and graphics support, Rachel Pierre provided EVMS support, and Theresa Thompson provided legal support.

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.

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Paul K. Martin
Inspector General

APPENDIX A: SCOPE AND METHODOLOGY

We performed this audit from August 2021 through May 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

In this report, we assessed the cost, schedule, and performance goals for the ML-2 contract and what best practices NASA could use to better control costs and increase performance. Our review was conducted with officials from Kennedy Space Center and Bechtel National, Inc. 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 the ML-2 project's cost performance, we examined EGS Program budget documentation, base and conformed ML-2 contract file, all contract modifications, rebaseline documentation, EVMS data and DCMA corrective action reports, and Bechtel's monthly financial reports (known as NASA Form 533M) for fiscal years 2019 through 2022. We further analyzed NASA's obligations and costs on the contract for fiscal years 2019 through 2022 through NASA's financial accounting system. We conducted interviews with NASA and Bechtel officials, including, but not limited to, the EGS Program Manager, ML-2 Project Manager, ML-2 Deputy Project Manager, contracting officers, contracting officer's representatives, members of the source evaluation board, and Bechtel project officials and engineering managers. We also spoke with DCMA officials to better understand the EVMS review process and identify potential best practices available to NASA.

To assess the ML-2 project's schedule, we examined NASA's acquisition planning data, ML-2 contract modifications affecting schedule, Preliminary Design Review (PDR) documents, NASA's integrated master schedule, and Bechtel's monthly forecast schedules. We analyzed schedule forecasts and quarterly program status reports to identify schedule slippages. We also conducted interviews with the EGS Program Manager, ML-2 Project Manager, ML-2 Deputy Project Manager, contracting officers, and contracting officer's representatives to better understand NASA's schedule concerns.

To assess Bechtel's performance and award fees, we examined the ML-2 contract's award fee evaluation plan, award fee performance evaluation reports, CPARS entries, EGS Program risk management presentations, and ML-2 weight sensitivity reports. We also reviewed the EGS Risk Management Plan and NASA Award Fee Guide for information on managing risks and award fees. We conducted interviews with the ML-2 Project Manager, ML-2 Deputy Project Manager, contracting officers, and contracting officer's representatives to better understand the tracking and management of project-level risks. We also spoke with Bechtel personnel to identify what steps the company was taking to manage ML-2 risks.

Assessment of Data Reliability

Our audit used limited computer-processed data that we assessed as reliable. Primarily, we reviewed and analyzed NASA cost and obligation data from fiscal years 2019 through 2022 in NASA's financial accounting system. We corroborated information with other sources where possible and performed

audit steps to validate the accuracy of a limited amount of data contained in the database. We determined that the data was sufficiently reliable for the purposes of this report.

Review of Internal Controls

We reviewed and evaluated the internal controls associated with the cost, schedule, and performance of the ML-2 contract. We also reviewed appropriate policies, procedures, and regulations, and conducted interviews with responsible personnel. While we concluded that the internal controls were adequate, because our review was limited to these internal control components and underlying principles, it may not have disclosed all internal control deficiencies that may have existed at the time of this audit.

Prior Coverage

During the last 5 years, NASA OIG and the Government Accountability Office have issued 10 reports of significant relevance to the subject of this report. Unrestricted reports can be accessed at https://oig.nasa.gov/audits/auditReports.html and https://www.gao.gov, respectively.

NASA Office of Inspector General

Artemis Status Update (IG-21-018, April 19, 2021)

NASA's Management of the Orion Multi-Purpose Crew Vehicle Program (IG-20-018, July 16, 2020)

Management of the Low-Boom Flight Demonstrator Project (IG-20-015, May 6, 2020)

Audit of NASA's Development of Its Mobile Launchers (IG-20-013, March 17, 2020)

NASA's Management of the Space Launch System Stages Contract (IG-19-001, October 10, 2018)

Government Accountability Office

NASA: Assessments of Major Projects (GAO-21-306, May 20, 2021)

NASA: Assessments of Major Projects (GAO-20-405, April 29, 2020)

NASA: Assessments of Major Projects (GAO-19-262SP, May 30, 2019)

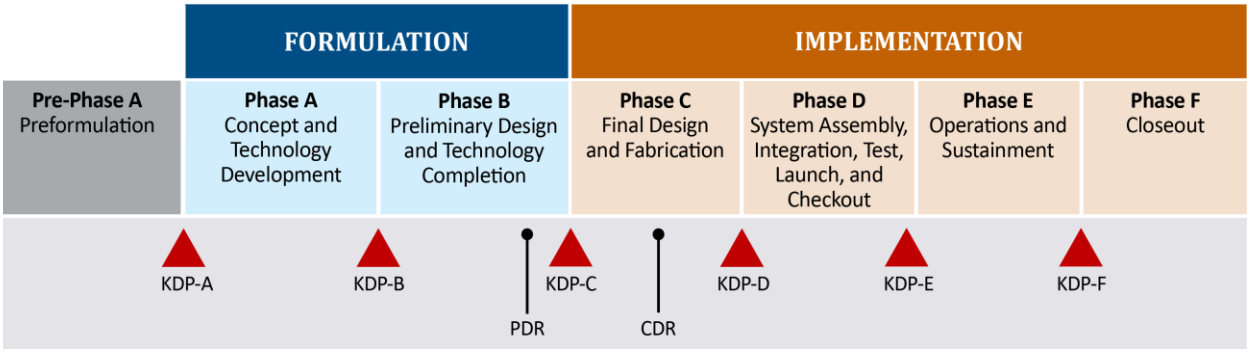
NASA: Assessments of Major Projects (GAO-18-280SP, May 1, 2018)

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

APPENDIX B: NASA PROJECT LIFE CYCLE

NASA's project life cycle is divided into two phases—Formulation and Implementation—that are further divided into Phases A through F. The project life cycle also consists of numerous activities, including Key Decision Points (KDP) that determine the readiness of a project to progress to the next phase of the life cycle (see Figure 11).[62]

Figure 11: NASA Project Life Cycle



Source: NASA OIG presentation of NPR 7120.5F information.

Note: Critical Design Review (CDR).

During the Formulation Phase project personnel conduct a PDR to (1) evaluate the completeness and consistency of the planning, technical, cost, and schedule baselines developed during Formulation; (2) assess compliance of the preliminary design with applicable requirements; and (3) determine if the project is sufficiently mature to begin the Implementation Phase. The ML-2 project deviated from the traditional project life-cycle process by splitting the PDR into two phases: programmatic and technical. A project is approved for implementation at KDP-C, which occurs between Phases B and C. As part of the KDP-C review process, cost and schedule baselines are established against which the project is thereafter measured. To establish these baselines, NASA policy requires projects to produce a joint cost and schedule confidence level (JCL).[63] This analysis measures the likelihood of completing all remaining work at or below the budgeted levels and on or before the planned completion of Phase D. A new JCL is required during the Implementation Phase if a project is rebaselined or upon request from the Decision Authority.[64]

[62] NPR 7120.5F.

[63] The JCL process uses software tools and models that combine cost, schedule, risk, and uncertainty estimates to evaluate and illustrate how expected threats and unexpected events affect a project's cost and schedule. To generate this data, project managers develop comprehensive project plans, inputs, and priorities that integrate costs, schedules, risks, and uncertainties.

[64] NASA may rebaseline a project when significant changes are required or under the terms of National Aeronautics and Space Administration Authorization Act of 2005, Pub. L. No. 109-155, Section 16613 (b)(f)(4) (2005), which requires congressional authorization to continue any project that will exceed the development cost estimate provided in the baseline report by 30 percent or more, or if launch is delayed by 6 months or more.

Once approval is received to move from KDP-C to the next phase, the project prepares its final design, fabricates test units that resemble the actual hardware, and tests those components during the first half of Phase C. A second design review, the Critical Design Review, occurs later in Phase C. The purpose of that review is to demonstrate the design is sufficiently mature to proceed to full-scale fabrication, assembly, integration, and testing, and that the technical effort is on track to meet performance requirements within identified cost and schedule constraints. After the Critical Design Review, a System Integration Review takes place during which the readiness of the project to start flight system assembly, test, and launch operations is assessed. Once all necessary requirements are met, the project may continue into Phase D, which includes system assembly, integration, test, and launch activities. Phase E consists of operations and sustainment, while Phase F is project closeout.

APPENDIX C: COST OVERRUNS ON SELECT ML-2 SUBSYSTEMS

A number of subsystems have experienced significant cost increases for which Bechtel has been unable to provide solutions on how to get the costs under control. As shown in Table 3, the Ignition Overpressure and Sound Suppression, Emergency Egress System, Weather Instrumentation, and Handling and Access subsystems all experienced cost increases that more than doubled the planned budget. In most cases, Bechtel conducted contractor bid analyses for subsystems without NASA's input. One of the exceptions to this experience was the Weather Instrumentation subsystem. For this subsystem, Bechtel chose the same vendor as ML-1, but the bid was extremely high. In this case, the ML-2 project brought in a NASA official to analyze the bid. However, as noted in Table 3, even with NASA's help, costs for this subsystem increased 163 percent. According to ML-2 project officials, Bechtel did not appropriately scope or bid the work needed for ML-2. During the source selection process for the ML-2 contract, ML-2 project officials explained that they tried to tell Bechtel that based on NASA's experience with the ML-1, the contractor's cost projections were low, but the Agency had limited success in increasing Bechtel's proposal.

Table 3: Cost Overruns Experienced by Selected ML-2 Subsystems (as of May 2021)

Subsystem	Description	Planned Cost	Actual Cost	Dollar Increase	Percent Overrun
Ignition Overpressure and Sound Suppression	Minimizes the effects of the launch-induced environment on the launch vehicle.	$554,887	$1,824,488	$1,269,601	229%
Emergency Egress System	Provides personnel with an emergency egress pathway from the Orion hatch through the Crew Access Arm to the baskets/loading platform. From there transit is possible to the launch pad.	25,402	67,917	42,515	167
Weather Instrumentation	Provides NASA with the capability to continuously monitor meteorological conditions and remotely monitor, retrieve, process, and report meteorological data.	163,038	428,884	265,846	163
Handling and Access	Provides safe access to various areas around the boosters, main engines, tail service masts, and miscellaneous hardware such as cameras and temporary core aft restraint struts.	94,142	225,007	130,865	139

Source: NASA OIG presentation of Agency information.

APPENDIX D: BECHTEL EARNED VALUE MANAGEMENT SYSTEM CORRECTIVE ACTION REPORTS AND PLANS

DCMA's review of Bechtel's EVMS identified 39 issues of noncompliance, 15 of which were identified as material weaknesses. Table 4 lists these issues along with Bechtel's proposed corrective action plans.

Table 4: Bechtel EVMS Noncompliance Issues and Corrective Action Plans

	Noncompliance Issue	Corrective Action Plan
1	EVMS description does not sufficiently define criteria for a compliant Work Breakdown Structure (WBS) with respect to product orientation, ability to measure progress toward completions, and framework for defining technical criteria for completion	• Review and revise system to ensure compliance • Update system checklist • Update training to emphasize need for product orientation in WBS • Conduct refresher training
2	WBS and dictionary not actively maintained, including not accurately reflecting currently planned scope	9 corrective actions, including: • Prepare and issue WBS dictionary • Review WBS text for all incomplete WBS elements to verify they accurately reflect planned scope as supported by the schedule and budget
3	WBS structure is not product-oriented with a hierarchical breakdown of program requirements impeding the ability to roll-up and evaluate the total contract performance from the subsystem level up through the ML-2 level	• Analyze existing WBS and determine least disruptive method to implement a product-oriented WBS hierarchy • Prepare and approve baseline change approvals to implement selected WBS change and verify results
4	For 29 work packages, the baseline does not align between the ML-2 cost tool data and the integrated master schedule (IMS)	5 corrective actions, including: • Revise budget/work authorization procedures to ensure integrity between schedule and cost databases • Conduct training on responsibilities to maintain data integrity and take timely corrective action • Develop database tools to detect inconsistencies and notification
5	Out of 7,543 IMS tasks/milestones, 2,048 (27 percent) did not have baseline dates	• Complete detailed planning needed to incorporate the revised baseline in accordance with NASA instructions • Reiterate expectations for acceptable levels of transient (short-term) non-baselined activities
6	IMS contained inappropriate use of lags	• Develop desktop guide/work instructions to clarify expectations on use of lags in the IMS • Conduct targeted reviews of the use of lags in the schedule in line with new desktop guide and update IMS accordingly
7	IMS schedule contains activities with incorrect logic	• Review and document work instructions/desk guide • Develop appropriate test metrics to identify nonconforming conditions • Conduct training

	Noncompliance Issue	Corrective Action Plan
8	Tasks and milestones within IMS coded as "delete" or "TB removed" lacked defined process	• Review and document work instructions/desk guide for the use of "delete" and "TB removed" activities • Develop appropriate simple test metrics to identify nonconforming conditions
9	Work packages in the IMS are not in the EVMS cost data	• Develop, test, and deploy a simple metric to validate alignment of work package information between IMS and EVMS • Correct disconnects between IMS and cost data identified • Develop and implement desktop guide defining process for creating WBS elements in the IMS and cost processor • Conduct staff training on how to create WBS elements in IMS and cost processor
10	Use of schedule margin is not consistently identifiable in the IMS and lacks traceability to the risk management process	5 corrective actions, including: • Develop and issue guidance on mandatory identification and coding for schedule margin activities • Update risk definitions, mitigations, and impact ranges necessary to provide input on the current forecast schedule
11	EVMS description does not require formal work authorization prior to baseline start or actual start	• Review revised EVMS description • Update EVMS overview training and conduct refresher training
12	Initial work authorization documentation was not issued prior to actual or baseline start of work	9 corrective actions, including: • Review and revise procedures to define a more streamlined and compliant work authorization process • Review existing IMS and cost databases to identify work authorization documentation that is not compliant with streamlined process
13	EVMS description has conflicting verbiage for planning packages in the IMS	• Revise EVMS description and budgeting procedures to resolve ambiguous language • Conduct training • Review and revise IMS
14	EVMS description does not identify minimum requirement for assigning an earned value technique to a work package	• Revise EVMS procedures to resolve ambiguous language • Conduct training • Review and revise IMS
15	Improper work package planning that does not correspond with the proper use and definition of work packages and does not meet established criteria	• Revise EVMS procedures to clarify that all authorized work must have a budget value assigned • Conduct training • Review and revise IMS
16	Lack of discrete earned value techniques and defined measurable technical objectives for discrete work packages	• Revise EVMS procedures to resolve ambiguous language • Conduct training • Review and revise IMS and cost databases to ensure appropriate assignment of earned value techniques to the work packages
17	Identified work packages that have zero budget	7 corrective actions, including: • Review work packages with zero budget and close all charge codes that might be open • Implement monthly data anomaly checks • Prepare desk instructions for the removal or exclusion of work packages with zero budget

Noncompliance Issue		Corrective Action Plan
18	EVMS description does not address all requirements of management reserve, including that major subcontractor reserves be incorporated and traceable to the contractor's EVMS or that reserves be required to be reported as a positive value or zero	• Review and revise EVMS description on management reserve to ensure compliance with standards • Update overview training to emphasize need for proper traceability to subcontractor reserves and that no negative reserve value is allowed • Conduct refresher training
19	EVMS description does not address Cost Accounting Standards Board Disclosure Statement for treatment of direct costs	• Review and revise EVMS description to ensure responsiveness regarding disclosure statement addressing direct costs
20	Instances of completed work packages with reported actuals accrued 2 to 13 months after 100 percent of the performance was earned	• Disseminate proper charging guidelines to project team on regular basis • Assign appropriate project control resources to validate actuals and do timely checks • Create desktop guide describing process to close charge codes • Conduct training
21	Bechtel does not perform data integrity checks and was unable to provide rationale or documentation justifying data anomalies observed	• Conduct training on responsibilities to maintain the data integrity and take timely corrective action • Develop database tools to detect inconsistencies • Prepare desktop guide that assigns responsibilities to review data anomaly listings and log actions for correcting integration anomalies each month • Conduct training
22	EVMS description and lower-level process does not meet the requirements for material transfers and progress assessment	• Review and modify EVMS procedures to correctly incorporate material transfer and loans and guidance
23	Cost and schedule variances are not effectively analyzed	• Prepare and conduct variance analysis report workshops
24	EVMS description does not describe or address indirect variance analysis at a function level or describe how root causes of direct allocation base variances from plan are identified and explained	• Revise EVMS procedures to include requirement to perform variance/impact analysis when indirect rates change • Train staff to perform variance/impact analysis when indirect rates change and document results
25	Variance corrective actions are not properly managed and tracked through closure	• Revise variance analysis procedures to add project control responsibilities for reviewing variances and verifying corrective actions • Train project staff to review variances and verify corrective actions
26	EVMS does not require variances be calculated and analyzed with corrective actions on summary level planning packages	• Update procedures • Conduct training on revised procedures and responsibilities
27	Bechtel program level Estimate at Complete (EAC) process does not require substantiation	• Update procedures to include a more complete and risk informed process • Conduct training on revised procedures and responsibilities • Update EVMS and EAC procedures to eliminate consistencies

Noncompliance Issue		Corrective Action Plan
28	EVMS does not address a process to ensure that the latest direct rates are used for EAC	• Update EVMS and EAC procedures to include the requirement to apply current direct and indirect rates in the EAC calculation • Conduct training on revised EVMS and EAC procedures and responsibilities • Review and update project EAC based on current direct and indirect rates
29	ML-2 EAC was not substantiated in accordance with the EVMS, including $60.2 million associated with active and emerging risks that may not have been accounted for	• Update EVMS and EAC procedures to include a more complete and informed process for developing an EAC • Conduct training on revised EVMS and EAC procedures and responsibilities
30	Estimate at Completes are not regularly adjusted based on Earned Value Management performance metrics, variances analyzed, and an assessment of remaining work	• Update EVMS and EAC procedures to describe a clear, repeatable process for identifying work packages that have EAC values inconsistent with performance statistics to date • Prepare database queries that provide a listing of in-process corrective actions • Develop and conduct training to communicated expectations, responsibilities, and timing of EAC process
31	Undistributed budget was distributed to management reserves prior to negotiation of the authorized unpriced work	• Develop and deliver appropriate training • Validate current authorized unpriced work, undistributed budget, and management reserve
32	EVMS and supporting procedures do not establish a freeze period suitable for forward planning and the integrity of the performance measurement baseline	• Modify EVMS procedures to incorporate a formal freeze requirement and establish expectations • Conduct training on the freeze period requirements
33	Changes to the performance measurement baseline are processed in the current period without a compelling reason and Program Manager approval	• Modify procedures to remove the “compelling business reason” doctrine and replace it with formal freeze period requirement • Modify procedures to incorporate formal freeze period requirement
34	Management reserve was distributed for work outside the scope of the contract totaling nearly $5 million	• Review and revise EVMS procedures to clarify authorized unpriced work process and rules • Conduct training on authorized unpriced work process
35	Authorized changes to the performance measurement baseline are not incorporated before the commencement of work	• Modify EVMS procedures to clarify requirements for logging changes in the same reporting period in which they are approved • Provide training on new processes
36	Documentation does not substantiate and support changes to the performance measurement baseline	• Provide refresher training on required documentation • Provide process/tool training to ensure adequate skills are developed to support the project • Provide IMS training and appropriate requirements for approval to implement any changes to the baseline schedule

Noncompliance Issue		Corrective Action Plan
37	Authorized unpriced work was incorporated directly to management reserve instead of undistributed budget	• Review and revise EVMS procedures to clarify authorized unpriced work process and rules • Conduct training on the authorized unpriced work process and the proper recording and tracking of authorized unpriced work
38	Performance management baseline and integrated program management report do not accurately reflect authorized unpriced work and an over target baseline	• Review and automate software • Conduct training
39	Interim Critical Design Review integrated master schedule baseline does not align with contractual need date	• To be determined[a]

Source: NASA OIG presentation of DCMA and Bechtel information.

[a] Bechtel has not yet provided corrective action plans for this issue.

APPENDIX E: ML-2 AWARD FEE QUESTIONED COST

Table 5 summarizes the questioned cost identified during our audit and discussed in this report. The questioned cost is the result of the improper award fee NASA gave to Bechtel for the fifth award fee period in 2021. Based on our audit work, Bechtel should not have received any award fee as they were experiencing significant cost, schedule, and management performance challenges.

Table 5: Questioned Cost and Associated Recommendation

Issue	Recommendation Number	Questioned Cost
Unsupported award fee given to Bechtel during award fee period five	4	$2,939,667
	Total	**$2,939,667**

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 F: MANAGEMENT'S COMMENTS

National Aeronautics and
Space Administration

Mary W. Jackson NASA Headquarters
Washington, DC 20546-0001

May 31, 2022

Reply to Attn of: Exploration Systems Development Mission Directorate and Office of Procurement

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Exploration Systems Development Mission Directorate
Assistant Administrator for Procurement

SUBJECT: Agency Response to OIG Draft Report, "NASA's Management of the Mobile Launcher 2 Contract" (A-21-015-00)

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 Mobile Launcher 2 Contract" (A-21-015-00), dated May 6, 2022.

As noted in the testimony of Administrator Bill Nelson to Congress on May 3, 2022, NASA recognizes that large cost and schedule overruns, due to a number of factors, have both delayed launch dates and caused major budget pressures across the Agency. The past several years has presented some of the largest challenges the Agency has dealt with to date, many of which cannot be completely attributed to externalities such as the COVID-19 crisis. In response, the Agency is taking concerted action to improve management at all levels of the organization.

The NASA Deputy Administrator, who is designated the Agency Chief Acquisition Officer, will ensure that all major acquisitions and contract management practices are reviewed at the highest levels of leadership. In addition, an Agency-wide Chief Program Management Officer position has been established to guide programs through the technical and programmatic requirements of each life-cycle milestone as required by NASA policy. Meanwhile, at the program level, the Agency continues to implement OIG and Government Accountability Office (GAO) recommendations to improve transparency with external stakeholders and empower managers to deploy actions swiftly when needed to manage performance. While competition has always served as a cornerstone of NASA's technical development strategy, the future of the Agency will rely on its ability to use competitive acquisitions to further expand on cost, schedule, and performance opportunities.

NASA is taking all actions available within the Federal Acquisitions Regulations (FAR) to address contractor performance to date and ensure improved performance moving forward. The contractor, Bechtel, has committed that they will make the necessary changes to improve performance under NASA's oversight.

In the draft report, the OIG makes five recommendations addressed to NASA to improve its management of the Mobile Launcher 2 (ML-2) contract and provide transparency to existing and future contracts.

Specifically, the OIG recommends the following:

Recommendation 1: Evaluate Bechtel's support for the updated estimate of cost and schedule at project completion and finalize negotiations for Bechtel's currently proposed cost increases and NASA's government-driven changes.

Management's Response: NASA concurs with this recommendation. NASA has been working closely with Bechtel leadership to update cost and schedule projections and establish a forward plan that more evenly distributes risks between the Agency and Bechtel. The vast majority of the Government-driven changes and delays have been negotiated and are already definitized in the current ML-2 contract value. Bechtel committed to provide a new interim cost/schedule baseline to NASA on May 31, 2022, which will be refined and finalized by September 30, 2022. In the meantime, NASA commissioned an independent, cross-program team chaired by Agency technical and procurement leadership to evaluate all Mobile Launcher options, review the current state of the Bechtel contract, and recommend additional courses of action. This team, known as the Recovery Evaluation and Implementation Team (REIT), is finalizing its analysis and will provide a set of concrete recommendations, including contract actions, to the Exploration Ground Systems (EGS) program for implementation with Bechtel. The subsequent response by Bechtel will be carefully evaluated. If the Bechtel responses to these actions are not satisfactory, alternative approaches for this development will be employed. Regardless of the forward plan, Bechtel-attributable impacts to the development of the launcher will be reconciled through REIT recommendations. NASA respectfully requests to provide a status update to the OIG on the ongoing process of negotiation by June 30, 2022.

Estimated Completion Date: December 31, 2022

Recommendation 2: Before completing and finalizing the ML-2 project-level Agency Baseline Commitment (ABC), update the JCL analysis to reflect realistic life-cycle cost and schedule estimates to ensure effective budgeting and management of the project.

Management's Response: NASA concurs with this recommendation. The EGS program is continuing to refine its Joint Cost and Schedule Confidence Level (JCL) analysis in alignment with ongoing negotiations with Bechtel, as well as insight provided by the EGS ML-2 Independent Review Team (IRT). The quantification of known technical risks and broader uncertainty is becoming increasingly more refined as new information is provided by Bechtel; new inputs then increase the fidelity of the model's predictive ability. Ultimately, the implementation of REIT actions will influence the model by changing the factors that need to be considered for input.

The Agency is committed to using probabilistic analyses, like those produced by a JCL analysis, to inform long-term budgeting planning. In this case, the ML-2 is a critical part of the Artemis IV mission; as such, the results of the ML-2 JCL model not only guide EGS program planning, but also that of other interdependent stakeholders that are producing hardware or payloads for the Artemis IV mission (for example, the Space Launch System Block 1B variant, which relies on the ML-2 for launch). While the Agency will not be able to set an ML-2 ABC until negotiations with Bechtel are complete, the preliminary results of the JCL analysis will inform EGS Programming, Planning, Budgeting, and Execution for FY 2024, as well as ongoing manifest discussions with other divisions. In this manner, NASA is already reaping the benefits of preliminary JCL data by integrating realistic cost and schedule milestones across its programs. NASA respectfully requests to provide a status update to the OIG on the ongoing process of updating the JCL and establishing an ML-2 ABC by June 30, 2022.

Estimated Completion Date: December 31, 2022

Recommendation 3a: To the extent that some or all of the Bechtel contract is converted to a fixed-price contract, ensure that the Critical Design Review has been completed in accordance with NASA's life-cycle policies prior to conversion.

Management's Response: NASA concurs with this recommendation. The Agency is still considering several contractual options to ameliorate ML-2 cost and schedule issues, including partial conversion of the Bechtel contract to a firm-fixed price structure. While neither NASA nor Bechtel have committed to conversion at this time (fact-finding is ongoing as of the writing of this response), the Agency will commit to having a fully developed and complete design in place prior to any major contractual conversion that takes place. The IRT currently in place to review the Key Decision Point C has also been commissioned to remain through Critical Design Review (CDR), thereby ensuring continuity in the team reviewing the data previously provided during the 2021 Preliminary Design Review data exchanges. From a technical standpoint, the vast majority of Government-driven changes to initial ML-2 requirements have been negotiated and are already definitized in the current ML-2 contract. Therefore, no Government-driven delays in completing ML-2 design are expected.

Estimated Completion Date: January 31, 2023

Recommendation 3b: To the extent that some or all of the Bechtel contract is converted to a fixed-price contract, ensure that an IGCE is established before entering into any new contractual agreements.

Management's Response: NASA concurs with this recommendation. Independent Government Cost Estimates (IGCEs) are always established prior to commencing a new contractual agreement. The Agency commits to continue following all applicable FAR regulations when establishing new agreements.

Estimated Completion Date: January 31, 2023

Recommendation 4: Take appropriate steps to ensure acquisition officials minimize the availability of award fees when contract modifications and value increases are the result of shortcomings in contractor performance and require documentation of the rationale for any award fees granted.

Management's Response: NASA concurs with this recommendation. NASA continually seeks to improve all aspects of its contracting activities and has issued award fee guidance (NASA FAR Supplement (NFS) 1816.405-727 (d)) to include shorter award fee evaluation periods for design and development programs with a life-cycle cost of $250M or more. This guidance was designed to emphasize the need for greater focus on the timely evaluation of contractor performance. The Office of Procurement will provide further guidance to contracting officers reminding them that they should minimize the availability of award fees when contract cost overrun modifications and associated value increases are the result of shortcomings in contractor performance as well as require documentation of action(s) taken in the contract file. The Office of Procurement in collaboration with the Exploration Systems Development Mission Directorate and Kennedy Space Center (KSC) agreed to elevate the ML-2 Fee Determining Official appointment to the KSC Center Director.

Estimated Completion Date: November 30, 2022

To increase accountability and improve future selection and management of contracts, the OIG recommends the Assistant Administrator for Procurement:

Recommendation 5: Update or issue appropriate policy guidance to reinforce current FAR and NASA FAR Supplement regulatory guidance for stopping or withholding payments to a contractor for significant deficiencies in business systems, such as the EVMS.

Management's Response: NASA concurs with this recommendation. NASA continually seeks to provide clear guidance to enable contracting officers to understand and be aware of potential contract remedies when contractors are not complaint with terms and conditions of contracts. The Office of Procurement will review and issue appropriate guidance to reinforce existing FAR and NFS requirements of contractor's compliance with business systems requirements, such as Earned Value Management System (EVMS). As an example, NFS guidance specifically addresses EVMS Non-Compliance as featured in NFS 1852.234-2(b) and advises the contracting officer to take remedial action, that may include, but is not limited to, a reduction in fee. NASA will update or issue appropriate policy guidance to reinforce current FAR and NASA FAR Supplement regulatory guidance that provide options for remedial action such as stopping or withholding payments to a contractor for significant deficiencies in business systems, such as the EVMS.

Estimated Completion Date: November 30, 2022

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 Ruth Siboni at (202) 358-4555.

James Free Digitally signed by James Free Date: 2022.05.31 16:23:08 -04'00'

James Free

/For Marvin Horne Digitally signed by Marvin Horne Date: 2022.05.31 15:57:45 -04'00'

Karla Smith Jackson

APPENDIX G: REPORT DISTRIBUTION

National Aeronautics and Space Administration

Administrator
Deputy Administrator
Associate Administrator
Chief of Staff
Associate Administrator for Exploration Systems Development Mission Directorate
Assistant Administrator for Procurement
Deputy Associate Administrator for Common Exploration Systems Development Division
Director, Exploration Ground Systems Program
Director, Kennedy Space Center

Non-NASA Organizations and Individuals

Office of Management and Budget
    Deputy Associate Director, Climate, Energy, Environment and Science Division

Government Accountability Office
    Director, Contracting and National Security Acquisitions

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 and Science

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 Reform
    Subcommittee on Government Operations

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

(Assignment No. A-21-015-00)