NASA

National Aeronautics and Space Administration

2020 REPORT ON NASA's TOP MANAGEMENT AND PERFORMANCE CHALLENGES

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Office of Inspector General

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INTRODUCTION

As required by the Reports Consolidation Act of 2000, this report presents the Office of Inspector General's (OIG) independent assessment of the top management and performance challenges facing NASA. For 2020, we identified seven challenges and linked each challenge to one of NASA's strategic objectives (see figure 1).[1] We also considered the initial effects of the coronavirus pandemic (COVID-19) on the Agency's operations and missions.

Figure 1: 2020 Top Management and Performance Challenges Linked to NASA Strategic Objectives

Challenge 1: Landing the First Woman and the Next Man on the Moon by 2024

Strategic Objective 2.2: Conduct human exploration in deep space, including to the surface of the Moon

Challenge 2: Improving Management of Major Projects

Strategic Objective 1: Expand human knowledge through new scientific discoveries
Strategic Objective 2: Extend human presence deeper into space and to the Moon for sustainable long-term exploration and utilization
Strategic Objective 4.3: Assure safety and mission success

Challenge 3: Sustaining a Human Presence in Low Earth Orbit

Strategic Objective 2.1: Lay the foundation for America to maintain a constant human presence in low Earth orbit enabled by a commercial market

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Challenge 5: Improving Oversight of Contracts, Grants, and Cooperative Agreements

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Challenge 6: Managing and Mitigating Cybersecurity Risk

Strategic Objective 4.5: Ensure enterprise protection

Challenge 7: Addressing Outdated Infrastructure and Facilities

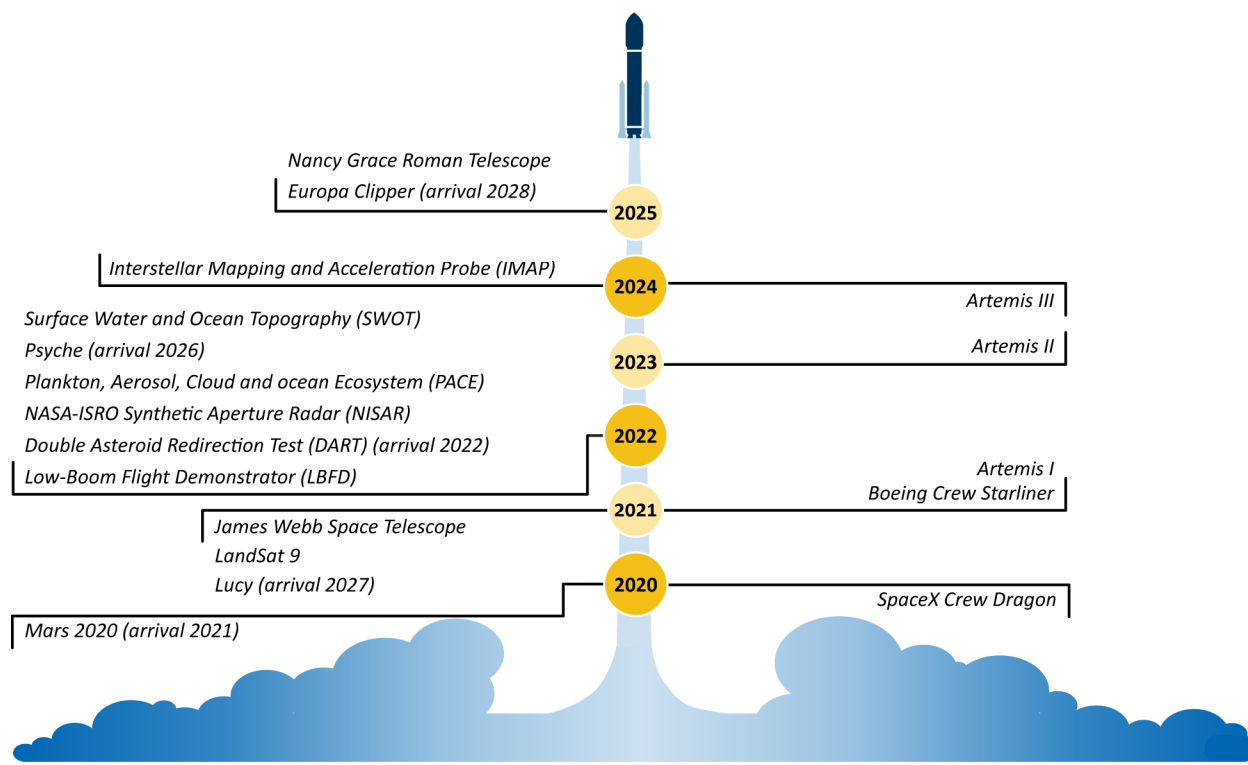*Strategic Objective 4.6:* Sustain infrastructure capabilities and operations

Source: NASA OIG analysis.

NASA stands at the forefront of aeronautics, science, and space exploration, and is responsible for numerous scientific discoveries and technological innovations. In NASA's first half century, long-term human space flight missions such as Apollo, the Space Shuttle Program, and the International Space Station (ISS or Station) progressed through formulation, development, and operation across multiple Administrations and congresses. However, in the past 10 years the Agency's space exploration priorities

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[1] NASA, *NASA Strategic Plan 2018* (February 12, 2018; last accessed September 1, 2020).

have shifted multiple times from the Constellation Program's lunar ambitions to an asteroid retrieval effort focused on developing technologies to enable a human mission to Mars and then back to an expedited crewed return to the Moon. Additionally, the Agency has been challenged to temper its culture of optimism and require more realistic cost and schedule estimates for major projects by establishing well-defined and stable requirements and maturing technologies early in development. Despite all of this, NASA has continued to develop and manage some of the world's most complex systems and projects while juggling the annual appropriations process and shifting timetables. As the Agency moves forward with key decisions on several of its major projects, addressing the challenges discussed in this report will be paramount to success (see figure 2).

Figure 2: Timeline of Major Projects and Missions

Nancy Grace Roman Telescope
Europa Clipper (arrival 2028)

2025

Interstellar Mapping and Acceleration Probe (IMAP)

2024

Artemis III

Surface Water and Ocean Topography (SWOT)
Psyche (arrival 2026)
Plankton, Aerosol, Cloud and ocean Ecosystem (PACE)
NASA-ISRO Synthetic Aperture Radar (NISAR)
Double Asteroid Redirection Test (DART) (arrival 2022)
Low-Boom Flight Demonstrator (LBFD)

2023

Artemis II

2022

James Webb Space Telescope
LandSat 9
Lucy (arrival 2027)

2021

Artemis I
Boeing Crew Starliner

2020

Mars 2020 (arrival 2021)

SpaceX Crew Dragon

Source: NASA OIG presentation of NASA information.

In deciding whether to identify an issue as a "top challenge," we considered its significance in relation to NASA's mission; whether its underlying causes are systemic in nature; and its susceptibility to fraud, waste, and abuse. Identification of an issue as a top challenge does not necessarily denote significant deficiencies or lack of attention on NASA's part. Rather, these issues are long-standing and inherently difficult challenges central to the Agency's core missions and, as such, will likely remain challenges for many years. Consequently, they require consistent, focused attention from NASA management and ongoing engagement on the part of Congress, the public, and other stakeholders.

Given the importance and scope of the issues, this year's list includes many of the same challenges discussed in previous reports. However, because it has permeated every aspect of NASA's operations, the effects of COVID-19 is a theme repeated in many of the top challenges. In March 2020, in accordance with Centers for Disease Control guidance, the President directed federal agencies to modify

their operations including closing facilities and mandatory telework of nonessential federal and contractor employees. In NASA's case, while maintaining vital operations such as the ISS and efforts to launch the first commercial flight of astronauts into space, the Agency altered—essentially overnight—how it does business in an effort to protect employees. By mid-April 2020, 12 of the Agency's 18 major facilities were closed and the rest had transitioned to "mission critical" operations that could not be accomplished remotely. Additionally, 90 percent of the Agency's workforce was working from home since mid-March and all nonessential travel was canceled. Given this unprecedented telework situation, the Agency was faced with the challenge of managing and securing its numerous information technology (IT) systems. NASA has been proactive in expanding telework readiness and disseminating information to staff through email, establishing dedicated internal websites, and routinely communicating with its workforce through virtual town hall meetings. The OIG continues to monitor the Agency's response to the pandemic as well as implementation of its plans for returning to on-site work.

Beyond protecting its workforce and property, NASA has had to prioritize which missions would continue and which would be delayed. For example, the Agency slipped the launch date for the already years-delayed James Webb Space Telescope—the planned successor to the Hubble Space Telescope—due to the pandemic while the Mars 2020 mission remained on track and launched successfully in July.

NASA is actively supporting the federal government's response to the pandemic. In recent months, the Agency announced an employee crowdsourcing initiative to solicit new ideas focused on developing personal protective equipment; developed new ventilation devices; and used NASA data, analytics, high performance computing, and artificial intelligence to predict the spread of COVID-19 and help address its environmental, economic, and societal impacts. NASA engineers also designed a new ventilator and oxygen helmet specifically for coronavirus patients with milder symptoms.

As NASA continues to work under the "new normal" for the foreseeable future, the Agency has developed a science and common sense-based Return to On-Site Work Framework consistent with guidance from the White House, Office of Personnel Management, Office of Management and Budget, and Centers for Disease Control and Prevention. The plan utilizes a four-stage, risk-based approach and emphasizes the Agency's commitment to the health and safety of its workforce. NASA is also establishing protocols for face covering requirements, reconfiguring office space to ensure social distancing, ensuring personal protective equipment is on-site and available for situations when social distancing cannot be maintained, and

Time-lapse of the ISS passing over Jupiter and Saturn on October 8, 2020, viewed from Nokesville, Virginia

Source: Ray Tolomeo

implementing enhanced cleaning techniques. For example, the Agency formed a Clean Team Task Force that includes industrial hygiene professionals from multiple locations who are exploring various options for cleaning NASA facilities and workspaces as well as ensuring HVAC systems are providing optimal air filtration.
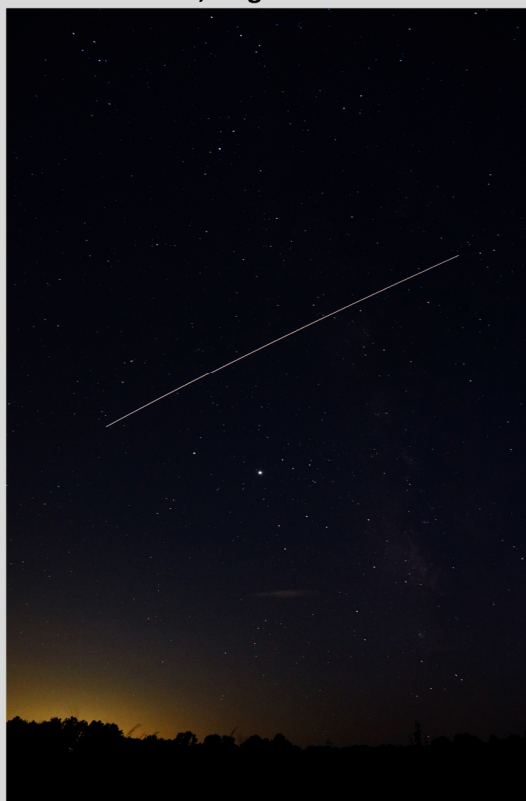
The Coronavirus Aid, Relief, and Economic Security Act (CARES Act) enacted in March 2020 provided funding for federal agencies to respond to the pandemic along with loans, grants, and other forms of assistance for individuals, businesses, and state and local governments. NASA received $60 million in CARES Act funding to prevent, prepare for, and respond to COVID-19 domestically or internationally. As of October 2020, NASA had committed approximately $42 million for contractor impact claims, information technology services, cleaning supplies, and personal protective equipment.[2] Utilizing these funds appropriately is a challenging task and one the OIG will continue to monitor.

In this report and all related work, the OIG is committed to providing independent, aggressive, and objective oversight of NASA programs and projects with the singular goal of improving the Agency. To that end, we plan to conduct audits and investigations in the coming year that focus on NASA's continuing efforts to meet these and other top challenges.

Paul K. Martin
Inspector General

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[2] Contractor impact claims may be made pursuant to the Denied Access and Stop Work Order provisions in a contract but also may fall under Section 3610 of the CARES Act, which allows agencies to reimburse contractors—using CARES Act funding or regular appropriations—for paid leave caused by the pandemic.

Challenge 1: Landing the First Woman and the Next Man on the Moon by 2024

Why This Is a Challenge

NASA is working toward landing the first woman and next man on the Moon by the end of 2024, with the eventual goal of landing humans on Mars. In March 2019, the White House directed NASA to accelerate its plans for a lunar landing, and NASA subsequently renamed this effort the Artemis program. The Agency requested an additional $1.6 billion in its fiscal year (FY) 2020 budget as initial funding to help meet the program's new timetable. To support the initial lunar landing capability, NASA requested over $7 billion for Artemis in FY 2021; in order to realize its lunar ambitions on the expedited timetable, the Agency has estimated it will cost approximately $28 billion between 2021 and 2025.[3]

The development of a deep-space human exploration capability to reach the Moon and then Mars is NASA's most ambitious and costliest ongoing activity. The Agency is currently developing the Space Launch System (SLS)—a two-stage, heavy-lift rocket—that will launch the Orion Multi-Purpose Crew Vehicle (Orion) to carry crew and cargo into space. Launch infrastructure under development by the Agency's Exploration Ground Systems (EGS) Program includes two mobile launchers (ML-1 and ML-2) that will serve as the ground structure to assemble, process, transport, and launch the SLS. Additionally, the Agency is updating its spacesuits, developing a robotic lunar rover for long duration operations, and using commercial partnerships to provide end-to-end payload delivery services to the Moon. Within the next few years, the Agency plans to develop new systems, including the Human Landing System that will provide crew transportation from lunar orbit to the Moon and back, and the Lunar Gateway (Gateway), a small spacecraft similar in design to the ISS yet only about the size of a studio apartment that would orbit the Moon and act as a waypoint for crews traveling to the lunar surface or deep space destinations. See Figure 3 for the systems in development for the Artemis missions.

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[3] This amount is for Phase I of the Artemis missions including costs for Artemis I, II, and III but does not include Gateway.

Figure 3: Artemis Systems in Development

Exploration Ground Systems
All the structures on the ground required to support launch

Space Launch System
The most powerful rocket in the world

Orion
Spacecraft for lunar missions

Gateway
Lunar outpost around the Moon

Lunar Landers
Modern human landing systems

Artemis Generation Spacesuits
Modern spacesuits for deep space

Source: NASA.

The Artemis mission's first launch will be Artemis I, an uncrewed test flight lasting approximately 22 to 25 days that will orbit the Moon before returning to Earth. Originally scheduled for 2020, the Artemis I launch has been delayed to late 2021. Artemis II, a crewed test flight currently scheduled to launch in 2023, will follow a similar trajectory to Artemis I, while Artemis III plans to land crew on the Moon by late 2024.

The Artemis mission has experienced a series of challenges exacerbated more recently by COVID-19's impact on Agency facilities and operations. Beginning in April 2020, 12 of the Agency's 18 major facilities were closed except to protect life and critical infrastructure. As a result, key development activities for SLS and Orion had to be delayed or suspended. The Green Run test—a hot fire testing and analysis of the integrated SLS rocket core stage—originally scheduled for August 2020 was delayed until the fall. Michoud Assembly Facility (where the SLS Core Stage was manufactured) and Stennis Space Center (where the

Green Run test will be run) were both shut down for almost 2 months due to the pandemic. This could further delay the Artemis I launch date currently set for late 2021. In addition, development of hardware for SLS and Orion was temporarily halted during this period, with NASA still working to assess the cost and schedule impact of those delays.

Progress in Addressing the Challenge

While the SLS, Orion, and EGS programs are making progress, each has experienced significant cost increases and schedule delays. Specifically, the SLS Program exceeded its Agency Baseline Commitment (ABC) by at least 33 percent at the end of FY 2019, a figure that could reach 43 percent or higher if Artemis I experiences additional delays.[4] By the end of FY 2020, NASA will have spent more than $17 billion on SLS—including almost $6 billion not tracked or reported as part of the ABC.[5] Further, each of the major contracts for building the SLS for Artemis I have experienced technical challenges, performance issues, and requirement changes that have resulted in $2 billion of overall cost increases and at least 2 years of schedule delay.[6]

Orion has also experienced significant issues with cost and schedule. The Orion Program excluded $17.5 billion in its ABC costs from FY 2006 to FY 2030, significantly limiting visibility into how the program spends its money. Since Orion's cost and schedule ABC was set in 2015, the Program has experienced over $900 million in cost growth through 2019, a figure expected to rise to at least $1.4 billion through 2023. In the same timeframe, the Program's schedule for Artemis I slipped 3 years while the schedule for Artemis II slipped 2 years, and additional delays are likely as Orion completes development efforts for these missions. Moreover, Orion is proceeding with production of crew capsules for later Artemis missions before completing key development activities, increasing the risk of additional cost growth and schedule delays as technical issues are discovered late in the development effort, potentially requiring costly rework. While the Orion Program has undertaken a series of development, production, and infrastructure initiatives aimed at controlling costs which we view as positive steps, most are in the early stages and their actual impact remains unclear.

For its part, the EGS Program is working to complete launch control software while also managing late requirements changes and cost overruns. As of January 2020, modification of the first mobile launcher (ML-1) to accommodate the SLS has cost $693 million—$308 million over budget—and is running more than 3 years behind schedule. Looking ahead, the project faces a risk of further cost increases and schedule slippage as ML-1 completes testing for Artemis I and undergoes modifications for Artemis II. While the Agency has taken positive steps to address lessons learned from ML-1, NASA is missing opportunities to improve project management and oversight of the $486 million ML-2 project. First, the ML-2 schedule is risky due to requirements changes for Orion and later variations of SLS. Second, the contract structure established for ML-2 may limit the Agency's ability to motivate contractor

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[4] The ABC is the cost and schedule baselines committed to Congress against which a program is measured.

[5] The $6 billion not tracked or reported as part of the ABC is a result of the SLS Program deviating from program requirements and federal law for cost reporting, both of which require a life-cycle cost estimate of the entire program and the setting of an ABC based on all formulation and development costs. As a result of the deviation, NASA has not established a cost commitment for Artemis II activities and beyond and is not tracking these costs as part of the SLS ABC, meaning cost increases for those activities are not reported through the ABC process.

[6] NASA contracted with The Boeing Company to provide the launch systems' Core Stage and Upper Stage (known as the Interim Cryogenic Propulsion Stage); Aerojet-Rocketdyne to provide the RS-25 Engines; and Northrop Grumman the Solid Rocket Boosters that help power the SLS.

performance and control costs. Finally, the Agency's approach to managing the ML-2 project lacks key project management requirements that would provide greater levels of oversight and transparency.

In August 2020, NASA alerted Congress of development cost increases of 30 percent for both SLS and EGS.[7] Specifically, NASA aligned the development costs for SLS and EGS through Artemis I and established revised cost commitments placing the new development baseline cost for SLS at $9.1 billion, and the commitment for the initial ground systems capability to support the mission at $2.4 billion.

While NASA is fast tracking the development or purchase of additional capabilities needed to meet its lunar goals, the Agency has yet to make final decisions on key aspects, including the Gateway—the initial elements of which are currently set to launch in January 2024, several months later than originally planned—and the Human Landing System. Although the Agency has not determined whether the Human Landing System will dock with the Gateway in lunar orbit for the planned 2024 Artemis III mission, the lander will dock with Gateway for future missions. While the Agency requested over $3 billion in its FY 2021 budget to accelerate development of the Human Landing System, the House of Representatives appropriation provided less than half that amount for all exploration research and development efforts, and it remains uncertain how much will be approved by Congress.[8] For the Gateway, NASA awarded a contract to Maxar Technologies in 2019 to develop power, propulsion, and communications with a planned launch date of 2022. The Agency has also announced a sole-source award for the Habitation and Logistics Outpost—the first step in an anticipated larger pressurized habitation module for cargo and astronauts—to Northrop Grumman. To reduce costs and mitigate the risks associated with a rendezvous in orbit, NASA decided to launch the power and propulsion element and Habitation and Logistics Outpost together in 2024. This will be the Agency's first attempt at integrating and launching a system of this magnitude. Due to these challenges, we anticipate further schedule delays and cost increases, making the Gateway unlikely to be available for the planned 2024 lunar landing.

Key Implemented Recommendations

Develop a corrective action plan for completing the two Core Stages and EUS and brief that plan to Boeing and senior NASA officials to gain their approval (IG-19-001).

Complete a review of the Boeing Stages contract that includes an independent federal government cost estimate to confirm the funding amounts needed to complete all deliverables (IG-19-001).

Work That Needs to Be Done

Although NASA has made significant progress to further its human exploration efforts, many questions remain about the total cost, schedule, and scope of the Agency's lunar ambitions. In the near term for the SLS, production and certification for flight, and engine and core stage testing need to be completed; Orion needs to finalize assembly and test for Artemis I and continue hardware production for Artemis II; and EGS needs to continue to prepare launch infrastructure. Additionally, as mandatory telework orders

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[7]   NASA is required to submit a report to relevant congressional committees when development costs increase by 30 percent or more.

[8]   The House of Representatives FY 2021 appropriation bill provides a top line funding amount for exploration, research, and development but does not break out funding for the various efforts such as the Human Landing System.

remain in place for most NASA employees and contractors, ongoing impacts to these missions will need to be continuously evaluated. For later lunar missions, NASA will need to complete development of the SLS Exploration Upper Stage, which would be used in post-Artemis III missions, and complete the second Mobile Launcher. Concurrently, plans for the Gateway and lunar lander need to be finalized to meet NASA's goal of landing on the Moon by 2024.

Given the multiple challenges outlined above, we believe the Agency will be hard-pressed to land astronauts on the Moon by the end of 2024. At the very least, achieving any date close to this ambitious goal—and reaching Mars in the 2030s—will require strong, consistent, sustained leadership from the President, Congress, and NASA, as well as stable and timely funding. For its part, NASA must determine the true long-term costs of its human exploration programs, set realistic schedules, define system requirements and mission planning, form or firm up international partnerships, and leverage commercial space capabilities. Over the past decade, our oversight work has found NASA consistently struggling to address each of these significant issues and the Artemis mission's accelerated timetable will likely further exacerbate these challenges.

Key Unimplemented Recommendations

Review HEOMD and NASA program management policies, procedures, and ABC reporting processes to provide greater visibility into current, future, and overall cost and schedule estimates for the SLS Program and other human space flight programs (IG-20-012).

Establish methodologies and processes to track and set cost commitments for Artemis II (IG-20-012).

Require the ML-2 project to develop an ABC separate from the EGS Program (IG-20-013).

Ongoing and Planned Audit Work

Audit of NASA's Management of Astronaut Space Suit Development
This audit is assessing NASA's management and development of space suits for upcoming Artemis missions and future deep space applications.

NASA's Challenges to Ensure Safe Return of Humans to the Moon
NASA's goal is to return humans to the Moon by 2024. This audit is identifying the top safety issues in that pursuit and the Agency's plans for mitigating those issues.

COVID-19 Impact on NASA's Programs and Projects
This review is identifying impacts of COVID-19 on NASA's programs and projects, including any cost and schedule performance challenges and technical issues.

Why This Is a Challenge

NASA is planning to invest at least $65 billion over the life cycle of its current portfolio of 25 major Earth science, human exploration, planetary science, astrophysics, aeronautics, and technology demonstration projects in development.[9] NASA's major projects have historically cost significantly more and taken much longer to complete than planned. Cost increases and schedule slippage with major ongoing projects such as Mars 2020, the Stratospheric Observatory for Infrared Astronomy (SOFIA), the Europa Clipper, the James Webb Space Telescope (JWST), and the Nancy Grace Roman Space Telescope (Roman Space Telescope) can affect project schedules and funding for other NASA projects.[10]

- *Mars 2020.* As of January 2020, the Mars 2020 program reported cost growth of $310.9 million due to multiple development difficulties, delayed deliveries, and higher-than-anticipated procurement costs. That said, the Perseverance Rover successfully launched on July 30, 2020, with an anticipated Mars landing on February 18, 2021.

Stratospheric Observatory for Infrared Astronomy (SOFIA)

Source: NASA

- *SOFIA.* Originally estimated to cost $265 million and take 4 years to complete, SOFIA has actually cost $1.1 billion and taken more than 17 years to reach full operational capability. These cost overruns and schedule delays resulted in a replan, a rebaseline, and a major program

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[9] The Government Accountability Office (GAO) categorizes "major projects" as those with life-cycle costs over $250 million; GAO-20-405, *NASA: Assessments of Major Projects* (April 2020).

[10] Mars 2020/Perseverance rover is designed to better understand the geology of Mars and seek evidence of ancient life. The mission will collect and store a set of rock and soil samples that could be returned to Earth in the future. It will also test new technology to benefit future robotic and human exploration of Mars. SOFIA is a Boeing aircraft modified to carry a telescope. SOFIA is designed to observe the infrared universe and allows astronomers to study the solar system in ways that are not possible with ground-based telescopes. The Europa Clipper will conduct detailed reconnaissance of Jupiter's moon Europa and investigate whether the moon could harbor conditions suitable for life. The JWST is an orbiting infrared observatory that will be able to search for the unobserved formation of the first galaxies, as well as look inside dust clouds where stars and planetary systems are forming today. The Wide Field Infrared Survey Telescope (WFIRST) was renamed the Nancy Grace Roman Space Telescope (Roman Space Telescope) in May 2020. The Roman Space Telescope will conduct large surveys of the infrared universe to explore everything from our solar system to the edge of the observable universe, including planets throughout our galaxy and the nature of dark energy.

reorganization.[11] Moreover, NASA spends $80 million a year to operate SOFIA, with questionable returns on its investment. While the President's Budget Request has attempted to cancel the program several times, Congress has required the Agency to maintain the program and continues to provide appropriations for SOFIA.

- *Europa Clipper.* In August 2019, the Europa Clipper project established its cost and schedule baselines at $4.25 billion with a launch date of September 2025—$250 million more and 2 years later than the project's preliminary cost and schedule estimates. These cost increases and schedule delays are due in part to a congressional mandate that SLS be used as the launch vehicle, even though an SLS will not be available until 2025 at the earliest. In addition, in August 2020 the Europa Clipper mission announced a series of hardware compatibility issues if the Clipper is required to fly on the SLS. As a result, the Clipper team is developing the spacecraft to accommodate the differing launch and flight capabilities of the SLS and a commercial launch vehicle. However, the Agency has recently asked for relief from the SLS requirement. In its FY 2021 budget request, NASA proposed to launch Europa as early as 2024 on a commercial launch vehicle, which would save over $1.5 billion compared to using SLS. The House of Representatives version of the FY 2021 funding passed in July 2020 directs the Agency to launch Clipper by 2025 and the Europa lander by 2027 and states SLS should be used for both missions "if available," permitting use of a commercial launch alternative. As of September 2020, a decision on a launch vehicle had not been made.

- *JWST.* In June 2018, NASA established a revised life-cycle cost commitment of $9.7 billion and launch readiness date of March 2021—$828 million more and 2 years later than the baselines established by the project in 2011. Technical challenges since the program's last replan have further strained the schedule, while delays related to COVID-19 forced the Agency to delay the planned launch from March to October 2021.

- *Roman Space Telescope.* The Roman Space Telescope was envisioned to cost $2 billion; however, current cost estimates range from $3.3 to $3.9 billion. Due to its significant cost and higher priorities within NASA such as JWST, for three consecutive years the President's Budget Request has proposed canceling the Roman Space Telescope. To date, Congress has refused NASA's request and continues to fund the telescope.

Over its storied history, NASA has developed and managed some of the world's most complex systems and projects. Yet, along with that scientific success, the Agency has also experienced significant cost overruns and schedule delays. GAO has designated NASA's management of acquisitions as a high-risk area for almost 3 decades. In its 2020 assessment of NASA's major projects, GAO found the cost performance of NASA's portfolio of major projects had worsened for the third consecutive year, while the average schedule delay had decreased. Additionally, GAO reported that cost growth had increased from 27.6 percent to approximately 31 percent, while the average launch delay decreased from 13 months to approximately 12 months.

In our *2019 Report on NASA's Top Management and Performance Challenges*, we discussed several factors affecting NASA's ability to complete major projects within their planned costs and schedules,

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[11] A rebaseline is a process initiated when the NASA Administrator determines the development cost growth for a project is more than 30 percent of the estimate provided in the project's baseline, or if other events make a rebaseline appropriate. When the Administrator determines that development cost growth is likely to exceed 15 percent, or a program milestone is likely to be delayed from the baseline's date by 6 months or more, NASA must submit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate. 51 U.S.C § 30104(e)(2)(reporting requirement).

including a culture of optimism, underestimating technical complexity, and funding instability. Other factors driving schedule delays and cost overruns include flawed estimating assumptions, congressional directives, and poor project management. In addition to these historic challenges, in the short term the Agency will face cost and schedule concerns attributable to COVID-19 closures.

Progress in Addressing the Challenge

To its credit, NASA has taken steps in the last few years aimed at curbing cost growth and schedule delays which have shown early indications of improved performance for several projects including the Surface Water and Ocean Topography (SWOT), NASA-Indian Space Research Organisation (ISRO) Synthetic Aperture Radar (NISAR), and Plankton, Aerosol, Cloud and ocean Ecosystem (PACE).[12] For example, in part to address concerns highlighted on GAO's High Risk list, in December 2018 the Agency established a corrective action plan to strengthen its project management efforts and improve transparency to stakeholders and monitoring of contractors.[13] In addition, NASA plans to broaden its use of a project management process known as Earned Value Management, a tool that integrates information on a project's cost, schedule, and technical efforts for management and decision makers.[14] The Agency plans to add one additional full-time employee to focus on this initiative and has established the NASA Earned Value Management Working Group to ensure agency-wide representation in developing implementation procedures and addressing review issues.

NASA also plans to assess and update its project cost and schedule estimates at additional points in the acquisition process. The Agency originally implemented a Joint Cost and Schedule Confidence Level (JCL) analysis policy to help reduce cost and schedule growth in its portfolio, improve transparency, and increase the likelihood of meeting project expectations. A May 2019 update to the Agency's JCL policy requires projects with life-cycle costs over $1 billion to conduct JCLs at key decision points (KDP) B and C, Critical Design Review, and potentially at KDP-D if current development costs have exceeded their development agency baseline commitment cost by 5 percent.[15]

Moreover, NASA is establishing an updated training curriculum for its programmatic analysts to strengthen the Agency's programmatic capabilities and promote consistency of the agency's best

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[12] SWOT is a satellite mission to make the first global survey of Earth's surface water, observe the fine details of the ocean's surface topography, and measure how water bodies change over time. The NISAR mission is a joint project between NASA and ISRO to develop and launch a dual-frequency synthetic aperture radar on an Earth observation satellite. PACE is a NASA Earth-observing satellite mission that will advance observations of global ocean color, biogeochemistry, and ecology, as well as carbon cycle, aerosols, and clouds.

[13] GAO first cited the Agency's acquisition management as a high risk in 1990. GAO, *High-Risk Series: Substantial Efforts Needed to Achieve Greater Progress on High-Risk Areas* (GAO-19-157SP, March 6, 2019), is the most recent in which NASA's acquisition management is cited as a high risk. NASA's corrective action plan is located at https://www.nasa.gov/sites/default/files/atoms/files/nasa_high_risk_corrective_action_plan_2020.pdf (last accessed May 20, 2020).

[14] Earned value management measures the value of work accomplished in a given period and compares it with the planned value of work scheduled for that period and the actual cost of work accomplished.

[15] A JCL produces a point-in-time estimate that includes all cost and schedule elements in project life-cycle phases A through D, incorporates and quantifies known risks, assesses the impacts of cost and schedule to date, and addresses available annual resources, among other things.

practices. Courses will cover NASA programmatic policy, JCL implementation, independent assessments, scheduling, cost estimating, and project integration and communication.

Key Implemented Recommendations

Require all Standing Review Boards to explicitly monitor and document variances from NASA's JCL policy, specifically regarding international partners and launch vehicle risks, and their potential cost and schedule impacts (IG-18-011).

Require that all JCL analyses include all discrete development risks managed outside of the project; such as a project's launch vehicle with potential cost and/or schedule impacts (IG-19-018).

Rebaseline Artemis I costs to appropriately and transparently track costs that include SLS development costs and activities tied to the first SLS launch (IG-20-012).

Work That Needs to Be Done

We have consistently reported on NASA's culture of optimism and the positive and negative effects this has had on project management. NASA's ability to overcome technological and scientific obstacles to accomplish its objectives has become part of the Agency's culture and helped foster a belief that NASA can accomplish anything. Many of the Agency's planned missions are ambitious endeavors that need to be grounded in more realistic cost and schedule commitments. NASA should carefully consider its commitment to congressional and other stakeholders and seek to undertake missions on sustainable budgets and realistic timelines that take into account the Agency's overall goals and priorities. Complicating matters this year will be the Agency's evaluation of the impact of COVID-19 on its projects, costs, and schedules. Without transparent and accurate accounting of cost and schedule commitments, it will be difficult for NASA, Congress, and external stakeholders to make informed decisions about future projects and programs.

Key Unimplemented Recommendations

Document and provide the JCL analysis approach used by LBFD to the NASA Chief Knowledge Officer to serve as a reference for future large-scale-X-plane development projects (IG-20-015).

Establish a process to be used during source evaluation boards and source selections that includes direct contact with the Center EVM Working Group Representative and cognizant Defense Contract Management Agency (DCMA) office to verify all contractor proposed information related to EVM (IG-20-015).

Reassess SOFIA's strategy and mission to identify and consider implementing alternative operational approaches and models to maximize SOFIA's capabilities within the Astrophysics portfolio and return on investment (IG-20-022).

Ongoing and Planned Audit Work

COVID-19 Impact on NASA's Programs and Projects
This review is identifying impacts of COVID-19 on NASA's programs and projects, including cost and schedule performance challenges and technical issues.

NASA's Astrophysics Portfolio
This audit will evaluate the current state of the portfolio and identify and assess risks to future astrophysics missions.

Audit of NASA's Multi-Mission Program Estimates
This audit will examine the effectiveness of NASA's project definition and estimating processes for large multi-mission programs.

Challenge 3: Sustaining a Human Presence in Low Earth Orbit

Why This Is a Challenge

Orbiting roughly 200 miles above the Earth's surface, the International Space Station (ISS or Station) is a unique platform that has allowed humans to live and work in space for more than 20 years. However, the $3 to $4 billion annual cost of operating the ISS and transporting astronauts to and from the Station consumes about half of NASA's human space flight budget. With the proposed extension of the Station's operations from its current planned retirement in 2024 to a retirement date in 2030, combined with the Artemis mission's goal of returning humans to the Moon by 2024, the Agency will be challenged to obtain the funds to sustain ISS operations while simultaneously achieving its lunar goals.[16]

In recent years, and under the direction of Congress, NASA has sought opportunities to commercialize low Earth orbit by transitioning from being the sole operator of the ISS to serving as one of many customers for a privately owned and operated platform.[17] The Agency has relied on commercial partners to successfully transport cargo to and from the ISS since 2012 and had a recent first success in the long road to development of a commercial crew transportation capability.[18] In May 2020, the Space Exploration Technologies Corporation (SpaceX) launched two American astronauts to the ISS and safely returned them 64 days later in the first successful test of a commercial crew mission. However, leading up to this point, SpaceX and The Boeing Company (Boeing)—the Agency's second commercial crew partner—experienced years-long delays. As a result, in 2020 the U.S. segment of the ISS has twice operated with a single crew member.[19] Typically, the U.S. segment of the Station operates with three to four astronauts, and a reduction in crew decreases the time available to conduct on-board scientific research. Presently, the ISS is the only platform available to NASA for critical on-orbit research into human health risks and demonstration of technologies required for Artemis missions to the Moon and future missions to Mars.

NASA's broader plans for increasing commercialization of low Earth orbit are contingent on the Agency's ability to increase and sustain commercial activity on the ISS. Similar to findings in prior NASA OIG reports, in February 2020 a NASA-initiated independent review found significant issues with the effectiveness of the Center for the Advancement of Science in Space, Inc. (CASIS), which manages commercial, non-NASA

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[16] 51 U.S.C. § 70907(b)(3). ISS operations are currently authorized through September 2024, but several legislative proposals propose extending Station operations through 2030.

[17] National Aeronautics and Space Administration Transition Act of 2017, Pub. L. No. 115-10 § 303 (2017).

[18] Russia and Japan have spacecraft that deliver cargo to the ISS that NASA has used when needed.

[19] The ISS is comprised of two connecting segments: the Russian segment is operated by the Roscosmos State Corporation for Space Activities and the United States On-Orbit Segment is operated by NASA and its international partners at the Canadian Space Agency, European Space Agency, and Japan Aerospace Exploration Agency. Beginning on April 17, 2020, one astronaut served aboard the ISS until the two-member SpaceX demonstration mission crew arrived on May 31, 2020. When the SpaceX crew departed the ISS on August 1, 2020, the U.S. segment once again operated with a single astronaut until October 14, 2020 when a second U.S. astronaut arrived via a seat purchased on the Russian Soyuz.

research activities on the U.S. segment of the ISS. Specifically, the review team found that (1) CASIS's business structure does not reflect the typical structure or function of other non-profit organizations; (2) CASIS's model for selecting projects to conduct research on the National Laboratory is outdated; (3) NASA has poorly managed its oversight of CASIS, and (4) CASIS's procedures for partner access to the National Laboratory are poorly defined.[20] Given the important role CASIS plays in increasing commercialization of the ISS and low Earth orbit, proper management and oversight of the organization is key to creating and sustaining a commercial market for low Earth orbit.

Progress in Addressing the Challenge

After numerous delays by both commercial crew partners, on August 2, 2020, SpaceX became the first private company to successfully launch astronauts into low Earth orbit and return them after a 2-month stay on the ISS. As the final test flight for SpaceX's Dragon 2 capsule and Falcon 9 rocket before the company begins regular transportation to the ISS, this mission validated key components of the company's crew transportation system, including the launch pad infrastructure; rocket; spacecraft; operational capabilities, including docking with the ISS; and reentry capabilities, including parachutes and splashdown. However, NASA's other commercial partner—Boeing—has experienced significant additional delays related to an aborted uncrewed test flight in December 2019. Given the need to re-fly that test mission, Boeing will not be ready to launch a crewed mission to the ISS until summer 2021 at the earliest. To ensure a continued U.S. presence on the ISS, in May 2020 NASA agreed to pay Roscosmos, the Russian state space corporation, more than $90 million to purchase a seat on a Soyuz spacecraft that launched to the ISS in mid-October 2020.

Spacewalk to Upgrade ISS Battery

Source: NASA

NASA has accomplished many of the goals originally set for the ISS Program, including mitigating the majority of the health concerns associated with space travel. The program has also sponsored research in life and physical sciences, human health, astrophysics, Earth sciences, space science, and commercial research and development for pharmaceuticals, materials, manufacturing, and consumer products. Additionally, in response to the above mentioned February 2020 independent assessment of CASIS, NASA and CASIS are reexamining the organization's board of directors and creating a User Advisory Committee to provide input on how the National Laboratory's resources should be managed. NASA also appointed the Agency's Chief Economist as the Program Executive of the National Laboratory.

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[20] ISS Cooperative Agreement Independent Review Team, *Final Report to NASA* (February 4, 2020). The National Laboratory is the U.S. portion of the ISS research facilities.

To spur interest in commercial activity in low Earth orbit, NASA announced several initiatives in recent years. Most recently, in June 2020 the Agency created the Suborbital Crew office within the Commercial Crew Program to enable astronauts, principal investigators, and other Agency personnel to fly on commercial suborbital space transportation systems, which are expected to be more accessible and affordable alternatives to the ISS. This announcement builds on the Agency's June 2019 Plan for Commercial Low Earth Orbit Development, which established five goals: (1) establish ISS commercial use and pricing policies, (2) enable private astronaut missions to the ISS, (3) initiate process for commercial development of LEO destinations, (4) seek out and pursue opportunities to stimulate demand for low Earth orbit, and (5) quantify the Agency's long-term needs for activities in low Earth orbit.[21] Furthermore, in July 2019 the Agency issued the Next Space Technologies for Exploration Partnerships Broad Agency Announcement, which will allow commercial entities to enter into public-private partnerships to develop commercial destination technologies—including habitable modules, external platforms, and deployable structures—for low Earth orbit.[22] Although these initiatives are a positive step, the Agency's new commercialization policy does not include performance metrics for evaluating NASA's development of commercial markets, even though the Agency agreed with a suggestion we submitted during our review of the interim directive to add language establishing future metrics. Further, NASA may need to clarify how to manage commercial missions and private astronaut requests with respect to their impact on the Agency's commercial crew missions and ISS crew capacity.

Key Implemented Recommendations

Initiate internal processes and coordinate with congressional and other stakeholders to obtain an extension of INKSNA (Iran, North Korea, and Syria Nonproliferation Act) exemptions (IG-20-005).

Ensure there is a contingency plan for each human health risk not scheduled to be mitigated prior to 2024 (IG-18-021).

Establish goals for CASIS raising non-NASA funds to offset ISS operating expenses (IG-18-010).

Work That Needs to Be Done

Commercial crew transportation is fundamental to full utilization of the ISS. SpaceX's successful crewed demonstration flight in August 2020 was a critical achievement; however, in order to conduct regular crewed missions to the ISS, the company has a number of elevated risks that must be addressed, including those related to both the Falcon 9 rocket and the Dragon 2 spacecraft's propulsion systems. Moreover, risks that NASA accepted for the demonstration mission may not be accepted for regular crewed missions. For its part, Boeing must overcome multiple technical issues before it can conduct a manned test flight. The company's December 2019 uncrewed test flight of its Starliner capsule and Atlas V rocket encountered significant software glitches that prevented the capsule from reaching the ISS. As a result, Boeing is repeating its uncrewed test flight no earlier than December 2020, which pushes the contractor's first crewed test flight back to summer 2021 at the earliest. Until both SpaceX and Boeing are operating regular crew transportation flights to the ISS, the Station will be challenged to

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[21] NASA, *NASA Plan for Commercial LEO Development* (June 7, 2019).

[22] NASA, *Next Space Technologies for Exploration Partnerships-2: Broad Agency Announcement NNH16ZCQ001K* (September 23, 2019). NASA released the initial Next Space Technologies for Exploration Partnerships Broad Agency Announcement in 2014 and made selections in 2015.

operate at full utilization, impacting the amount of on-board research and Station maintenance that can be accomplished.

NASA's plan for the ISS, as detailed in the President's FY 2021 budget request, envisions new commercial facilities and platforms in low Earth orbit. This plan includes a request for $150 million for commercialization of low Earth orbit. The effectiveness of this plan while continuing to provide substantial funding to maintain and operate the ISS remains to be seen, particularly with regard to the feasibility of fostering increased commercial activity in low Earth orbit. It is clear that the ISS will require significant federal funding beyond 2025, given the current limited commercial market interest in assuming the Station's operational costs. To the point, an independent review conducted in 2017 concluded that the profitability of a commercial platform like the ISS in low Earth orbit is questionable and will be highly dependent upon generating sufficient revenue from commercial activities and keeping operation costs low.[23]

Moving forward, NASA will need to continue to support opportunities for private operators to sustain private platforms in low Earth orbit. This includes working with other federal agencies to ensure that the adoption of regulations for the commercial use of space promote economic growth while minimizing uncertainty for taxpayers, investors, and private industry.[24] More broadly, whether NASA decides to extend, increase commercialization of, or retire the ISS, the timing of each of these decisions has a cascading effect on the funding available to support space flight operations in low Earth orbit, ambitions for establishing a permanent presence on the Moon, and ultimately sending humans to Mars. The sooner NASA, the Administration, and Congress agree on a definitive path forward for the ISS, the better NASA will be able to plan for that future.

Key Unimplemented Recommendations

Correct identified safety-critical technical issues before the crewed test flights, including parachute, propulsion, and launch abort systems, to ensure sufficient safety margins exist (IG-20-005).

Ensure there is a contingency plan for each exploration-enabling technology demonstration not scheduled to be fully tested by 2024 (IG-18-021).

Complete all end-of-mission critical systems and open work related to nominal and contingency deorbit operations (IG-18-021).

Ongoing and Planned Audit Work

NASA's Management and Utilization of Low Earth Orbit
This audit will examine NASA's utilization and management of the ISS and its plans and progress toward developing a commercial market in low Earth orbit.

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[23] Science and Technology Policy Institute, "Market Analysis of a Privately Owned and Operated Space Station," March 2017.

[24] 83 Fed. Reg. 24901, Space Policy Directive 2: Streamlining Regulations on Commercial Use of Space (May 30, 2018).

Why This Is a Challenge

The success of NASA's projects and missions relies on the Agency attracting and retaining a highly skilled workforce with diverse technical and management skills. Although 2019 marked the 8th year in a row that NASA was voted the top large agency in the *Best Places to Work in the Federal Government* rankings, workforce challenges remain a concern.[25]

The OIG and GAO have reported on multiple NASA projects—Europa Clipper, Low-Boom Flight Demonstrator, and Mars 2020 to name a few—that have experienced workforce challenges, including not having enough staff or not having staff with the right skills. Our September 2020 report on the Planetary Science Division noted that 16 of NASA's 19 engineering technical disciplines experienced a medium- to high-risk of their workforce being unable to meet current and future mission needs.[26]

Several of the Agency's workforce challenges can be traced to factors external to NASA. In July 2017, the National Academy of Public Administration concluded that "the Federal Government's human capital system is fundamentally broken."[27] The Academy identified issues such as: comparative decline in Federal employment to the U.S. population but increasing expectations for government to solve major issues; challenges in recruiting and retaining millennials into the aging Federal workforce; gaps in data driven governance; governance sprawl across sectors including higher contractor to civil service ratios; and the evolving nature of government occupations. In addition, NASA must compete for talent within the limited national supply of Science Technology Engineering and Math (STEM) workers. The Executive Director of the American Institute of Aeronautics and Astronautics testified to Congress in June 2018 about a nationwide shortage of STEM workers across the aerospace community that will require significant investments to overcome.[28]

A series of internal factors also contribute to NASA's workforce challenges. Primary among these is the growing risk from an impending retirement wave. Roughly 11,000 of NASA's 17,000 employees (65 percent) fall under the occupation category "science and engineering"—the portion of the workforce that provides technical capabilities to enable space flight and science missions. Within this category, 6,000 of the 11,000 are more than 50 years old, and of those approximately 3,200 employees

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[25] The Partnership for Public Service is a nonprofit, nonpartisan organization that strives for a more effective government for the American people.

[26] The 19 technical discipline capabilities are Aerosciences; Avionics; Cryogenics; Electrical Power; Flight Mechanics; Guidance, Navigation, and Control; Human Factors; Life Support/Active Thermal; Loads and Dynamics; Materials; Mechanical Systems; Non-Destructive Evaluation; Passive Thermal; Propulsion; Sensors and Instruments; Software; Space Environments; Structures; and Systems Engineering.

[27] National Academy of Public Administration, *No Time to Wait: Building a Public Service for the 21st Century* (July 2017).

[28] Testimony of Daniel L. Dumbacher before the Subcommittee on Space Committee on Science, Space, and Technology, United States House of Representatives (June 14, 2018). The American Institute of Aeronautics and Astronautics' membership includes nearly 30,000 engineers and scientists from 88 countries dedicated to the global aerospace profession.

are eligible to retire in 2020, with an additional 2,000 employees becoming eligible within the next 5 years. This wave of impeding retirements, shown in Figure 4, could result in a significant loss of institutional knowledge and skills at a critical time for NASA. The Agency's ability to monitor and mitigate this risk is hampered by a lack of retirement and staffing data applicable to the key technical disciplines, gaps in the transfer of knowledge (e.g., ad hoc or lack of formal mentoring), challenges in ensuring a robust employment pipeline, and ineffective use of available hiring flexibilities. NASA's workforce capacity is being further challenged as the Agency's ambitious Artemis mission ramps up to meet its goal of returning humans to the Moon in 2024.

Figure 4: Science and Engineering Workforce Trend
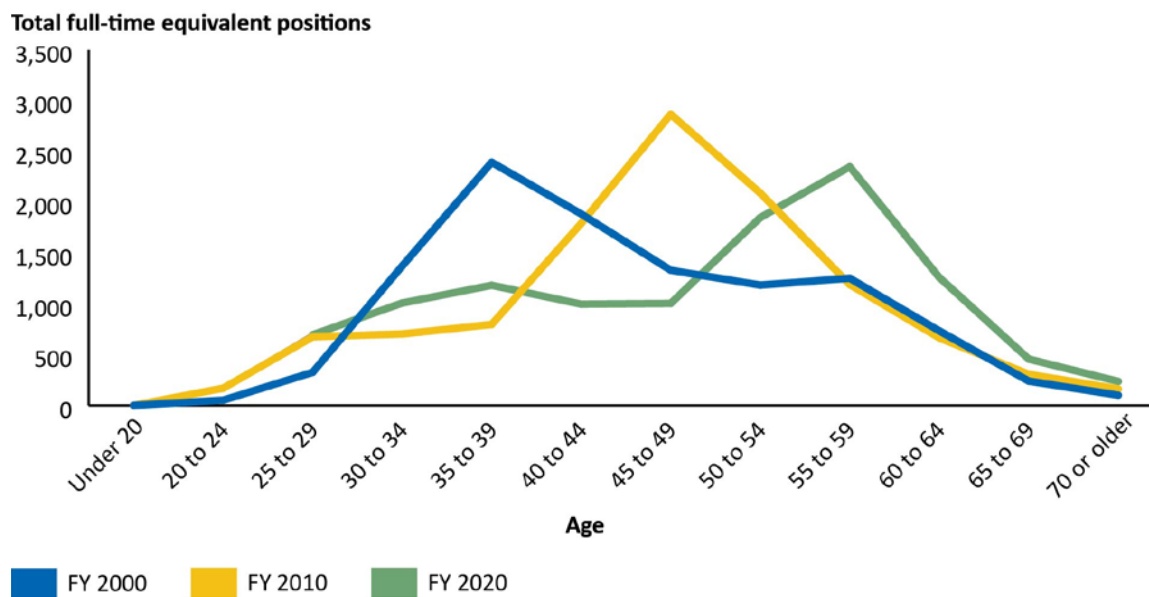
Source: NASA OIG presentation of Agency workforce data.

Progress in Addressing the Challenge

NASA has made several attempts to "right-size" its workforce over last decade.[29] In 2012, the Agency studied a new agency operating model through its Technical Capabilities Assessment Team (TCAT). TCAT's goal was to identify and assess the technical capabilities the Agency needs to meet current and future missions and make recommendations on investing in, consolidating, or eliminating unneeded capabilities. Subsequent related efforts included the Business Service Assessment which focused on evaluating mission support functions such as information technology, procurement, human capital, and facilities and the Capability Leadership Model which evaluated technical capabilities such as Astrophysics or Aircraft Operations. Additionally, the Mission Support Future Architecture Program (MAP), begun in 2017, is a phased plan to evaluate and realign each mission support organization to more efficiently utilize employee skills across the Agency, creating enterprise workforce structures to meet evolving mission needs.

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[29] "Right-size" refers to the processes of restructuring NASA's infrastructure and workforce to align with current and future organizational goals.

Critical to maintaining a sufficiently talented aerospace workforce supply is improved engagement with the education community and young professionals. To encourage the next generation of employees to join aerospace and STEM professions, NASA is partnering with nonprofit organizations and educational institutions. For example, the CubeSat Launch Initiative (CSLI) provides rideshare opportunities for small satellite payloads—built by universities, high schools, or non-profit organizations—to fly on launches when space is available. Since its inception in 2010, CSLI has flown 108 CubeSats. Additionally, the Agency's NASA's Robotics Alliance Project inspires youth in STEM fields through robotics competitions that reach thousands of students. Missions such as the Lucy Student Pipeline Accelerator and Competency Enabler (L'SPACE) provide undergraduates the opportunity to support NASA's Lucy Mission.[30]

NASA has also increased utilization of several special hiring authorities to address workforce gaps in highly specialized, critical skill areas. For example, the National Aeronautics and Space Act authorizes the Administrator to hire up to 425 scientific, engineering, or administrative employees (NASA Excepted, or "NEX") without regard to the Classification Act of 1949 rules for classifying positions and assigning pay rates.[31] Further, NASA obtained direct hire authority in 2019 and 2020 for STEM, professional, administrative, and technical occupations to support the Artemis mission. Additionally, in July 2020 the Office of the Chief Human Capital Officer issued the *NASA FY20-21 Human Capital Operating Plan* that details how NASA plans to execute the human capital elements in the Agency's Strategic Plan.

Key Implemented Recommendations

Issue an Implementation Plan that aligns and remains current with NASA's Strategic Plan and accurately reflects the Office of Education's strategic direction and management of the education portfolio (IG-16-001).

Create standardized guidance for performing annual capability assessments that considers, at a minimum, the appropriate time and resources for performing the assessments and the required data, analyses, and expected goals or results (IG-17-015).

Evaluate current and future critical technical staffing requirements by project over the next 5 years (IG-19-019).

Work That Needs to Be Done

To maintain a world-class workforce, NASA must fill current critical workforce gaps and prepare for those yet to emerge. Meeting this challenge will require planning about how to mitigate the Agency's looming retirement wave. Furthermore, the ability to successfully address that risk will require the Agency to have detailed visibility into workforce skill types—data that the Agency currently does not collect. Ideally, NASA would use that data, in combination with national STEM priorities, to support the Agency's technical needs. NASA will also need funded, formal mentoring and knowledge-sharing programs to enable the transfer of institutional knowledge before it is lost.

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[30] Lucy is a satellite spacecraft mission expected to launch in October 2021 with a primary mission to visit "Trojan" asteroids of Jupiter that are grouped ahead and behind the giant planet.

[31] National Aeronautics and Space Act, codified at 51 U.S.C. § 20113(b), and Classification Act of 1949, codified at Title 5 U.S.C. Chapter 51.

Over the past four years, NASA has unsuccessfully proposed eliminating its traditional education programs, which include funds for internships provided by Space Grants, minority engagement in K-12 education in the New Minority University Research and Education Project, university participation in the Established Program to Stimulate Competitive Research, and general STEM engagement in STEM Education and Accountability Projects.[32] These NASA programs, together with those mentioned above, seek to produce increased numbers of graduates prepared for STEM occupations. Moreover, NASA should focus sustained efforts toward areas of critical workforce need.

As noted above, NASA has made efforts to "right-size" its workforce through the TCAT, Business Services Assessments, Capability Leadership Model, and now MAP. Our audits have shown that despite establishing frameworks for change, NASA has had limited success implementing these efforts to reorganize Agency-wide operations.

Key Unimplemented Recommendations

Finalize and fully implement the performance metrics dashboard to measure acquisition performance (IG-21-002).

Engage relevant Centers and technical capability leaders to identify and implement budgetary and accounting system options to support the health of critical discipline capabilities (IG-20-023).

Institute additional opportunities based on existing NASA leading practices to foster and track mentoring to ensure a robust pipeline for Planetary Science Division related disciplines (IG-20-023).

Ongoing and Planned Audit Work

We will continue to monitor progress on the Agency's workforce master plan and may initiate an audit to assess NASA's workforce challenges. We will also continue to examine specific workforce issues as part of broader audits and reviews.

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[32] In fiscal year 2020, Congress appropriated the Office of STEM Engagement $120 million that was not requested by NASA.

Why This Is a Challenge

In FY 2019, NASA spent approximately $19.5 billion of its $24 billion in total obligations on contracts, grants, and cooperative agreements awarded primarily to businesses, educational and nonprofit institutions. Given NASA's continued reliance on contractors to provide essential goods and services, the Agency must ensure it receives fair value for these investments and that funds are spent appropriately. However, the Agency continues to face challenges in managing contracts, grants, and cooperative agreements for research and development activities, services, supplies, and equipment. Additionally, under Section 3610 of the pandemic relief legislation known as the CARES Act, agencies are permitted to reimburse contractors for work stoppages caused by the pandemic to keep employees and subcontractors in a ready state given the closure of NASA Centers. This provision is particularly relevant to an agency like NASA that relies so heavily on private contractors for its science and space exploration projects. It is imperative that NASA ensure these Section 3610 funds are appropriately identified, recorded, and segregated, since the reimbursement may be paid not only from NASA's $60 million in CARES Act funding, but also from its annual appropriations. Furthermore, it will be incumbent upon NASA contracting officers to oversee contractor activity and obtain appropriate documentation to identify contractors that qualify for this relief.

Throughout its history, NASA has faced long-standing challenges with oversight of its contracts and grants. GAO first designated the Agency's acquisition management as high risk in 1990, and it has remained a high-risk area for almost 3 decades due to persistent cost growth and schedule delays in many of NASA's major projects. Similarly, the OIG has highlighted acquisition as a management challenge for the past 14 years. In recent years, we have expressed concerns related to contract management practices on several of NASA's acquisition efforts:

- NASA lacked visibility into its contract with Boeing to produce the SLS Core Stage because the contractor's key development activities were co-mingled into one contract line item, making it difficult for the Agency to separate and track individual expenditures. Additionally, flaws in NASA's evaluation of Boeing's performance resulted in the Agency inflating the contractor's scores and leading to overly generous award fees in an environment of substantial cost overages and schedule delays—of which we questioned $64 million. Finally, contracting officers approved contract modifications and issued task orders to several contracts without proper authority, exposing NASA to $321.7 million in unauthorized commitments, most of which required follow-up contract ratification.[33]

- The Agency also experienced challenges with its commercial crew contract with Boeing. NASA agreed to pay an additional $287.2 million above Boeing's fixed prices to mitigate a perceived 18-month gap in ISS flights anticipated in 2019 for the company's third through sixth crewed missions (which, to date, have yet to begin), and to ensure the company continued as a second

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[33] According to the FAR, "ratification" is the act of approving an unauthorized commitment by an official who has the authority to do so.

commercial crew provider. In our judgment, the additional compensation was unnecessary and any gap could have been addressed through the purchase of additional Soyuz seats – seats that the Agency ultimately purchased. In total, we questioned $187 million of the NASA's additional payment to Boeing as unnecessary costs.

- Similarly, NASA has also been overly generous with award fees for Lockheed Martin, the prime contractor for the Orion Program. The program used subjective award fee evaluations, as well as nebulous and outdated criteria, resulting in the contractor receiving 91.4 percent of its available award fee—$863 million between 2006 and March 2020—despite significant performance shortfalls and substantial cost and schedule growth. In addition, the "look-back" clause" for end-item contracts like the one used for Orion serve as a disincentive to contractor performance because they give the contractor a second opportunity to collect unearned fees once the end-item (in this case the Orion capsule) is delivered.[34]

NASA's grants and cooperative agreements are also at risk of mismanagement and fraud. Key areas of concern include ensuring grant investments achieve intended results, overseeing the use of grant funds, and obtaining timely and accurate financial and performance information from grantees. We find repeated cases where NASA and award recipients lacked an adequate system of controls to ensure proper administration and management of awards, and as a result funds were not used for their intended purposes. For example, we identified instances of inappropriate use of grants for the construction of telescopes and operation and maintenance of an observatory where a contract would have been more appropriate and would provide NASA greater oversight and the ability to minimize risks of improper spending by the grantee.

Prior NASA financial statement audits have also identified oversight and internal control issues related to the grant management process. Specifically, in recent financial statement audits we found no controls to ensure grantee expenditures were managed and administered appropriately, thereby ensuring that federal funding is expended and associated programs are implemented in full accordance with statutory and public policy requirements. For active grants reviewed during our annual financial statement audits since FY 2015, NASA was unable to provide documentation indicating whether the grantee expenses were reviewed for reasonableness.

Our Office of Investigations conducts criminal investigations involving grant fraud and abuse. Over the past 3 years, we have conducted 8 grant fraud investigations resulting in 4 indictments, 1 prosecution, $740,000 in direct recoveries to NASA, $2.6 million in civil settlements, and 5 debarments.

Collectively, our audit and investigative work has shown that NASA's inadequate management and oversight of contracts, grants, and cooperative agreements has resulted in inappropriate expenditures and wasted taxpayer dollars that negatively impacted the Agency's mission. In 2015, we launched a data analytics initiative to help identify indicators of contract, grant, and procurement fraud, and since that time, our Advanced Data Analytics Program has provided numerous analytic products to our investigative and audit teams to help identify potential fraud. For example, our auditors now review grant recipient's general ledger data, which has successfully uncovered unallowable costs. Additionally, our investigators utilize data sets based on similar fraud indicators from previously successful prosecutions, thereby better focusing their oversight efforts. We continue to use a variety of statistical

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[34] For contracts with this clause, NASA evaluates contractor performance and makes interim award-fee payments throughout the course of the contract, but the amount of award fee the contractor ultimately receives is based upon demonstrated performance of the end-item deliverable.

and mathematical techniques to gather, analyze, and interpret Agency and open-source data to identify fraud indicators and help target OIG audit and investigations resources.

Progress in Addressing the Challenge

While NASA has made several enterprise-wide changes to address challenges related to its procurement oversight and acquisition management, progress remains slow. In what we view as a positive trend, NASA's use of award-fee contracts has diminished as a percentage of procurement dollars paid to businesses from 56 percent in FY 2014 to 47 percent in FY 2019. In addition, the Agency revised the NASA Federal Acquisition Regulation Supplement in 2016 to address a number of questionable practices we identified in a 2013 report, including award fees not justified by contractor performance and high ratings not supported by technical,

Illustration of the Low-Boom Flight Demonstrator

Source: NASA

cost, and/or schedule performance. Similarly, in a May 2020 audit of NASA's Low-Boom Flight Demonstrator (LBFD) Project, we found that management instituted a sound acquisition strategy when Lockheed Martin was issued a task order under an existing contract for the preliminary design of the aircraft and was then selected as the contractor for LBFD's subsequent phases after a full and open competition. The LBFD Project also implemented an innovative project management structure that leveraged geographically dispersed aeronautics expertise across multiple NASA Centers rather than designating a single Center as the lead for LBFD development. In addition, the LBFD Project provided the contractor more-than-expected amounts of government furnished equipment, which reduced procurement costs. Additionally, several OIG recommendations have been implemented within the SLS Program that will establish greater controls within the program, enhance government oversight into contract costs, and address excessive payments of award fee. While we recognize these are positive trends in NASA's contract management, we believe sustained leadership commitment and attention is needed to make meaningful progress in addressing this long-standing challenge.

NASA has also made efforts to increase its efficiency in closing expired grants. Over the past 5 years, the Agency has revised its Grants and Cooperative Agreement Manual—including updating procedures regarding pre-award risk reviews and closeout of awards—in response to OIG recommendations and its own initiatives, which has strengthened the Agency's grants management and oversight.[35] Furthermore, in October 2019 NASA entered into a new contract with its grant closeout service provider under which payments to the provider are based on the volume of grants closed. We believe that this new contract should provide further incentive for closing grants in a timely manner.

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[35] The *NASA Grant and Cooperative Agreement Manual* and associated information can be found at https://prod.nais.nasa.gov/pub/pub_library/srba/index.html (last accessed May 19, 2020).

Key Implemented Recommendations

Renegotiate the Boeing Stages contract based on both Boeing and federal government cost estimates (IG-19-001).

Separate each deliverable (Core Stage 1, Core Stage 2, and EUS) into its own CLIN for tracking costs, performance, and award fees (IG-19-001).

For large award fee contracts where NASA has on-site personnel, ensure they are appointed in writing and clearly assigned the task of monitoring and reporting on the performance of the contractor (IG-20-012).

Work That Needs to Be Done

In 2017, NASA initiated MAP to optimize all mission support functions with a more interdependent enterprise model that enables the sharing of capabilities across Centers, realign budget structures, and improve collaboration. The Headquarters Office of Procurement began operating under the new model in October 2019. Also, in 2018 the Headquarters Office of Procurement developed an Acquisition Portfolio Assessment Team to address inefficient procurement operations across NASA, including redundant and duplicative contracts, duplicative services and workforce capabilities across multiple Centers, and limited procurement workload capacity.

Successful implementation of these initiatives could provide more consistency in oversight and management of contracts, grants, and cooperative agreements, as well as sharing of lessons learned. However, as we have seen in past NASA enterprise-wide initiatives, progress can be slow and halting due largely to the Agency's decentralized management structure, lack of insight into Agency-wide operations, and the limited authority of Headquarters officials to control budgets and implement change at the Center level. We have similar concerns with the Agency's ability to reorganize procurement management authority, operations, and oversight into a Headquarters-based, enterprise-level function. Finally, NASA needs to improve its oversight of the grants process to include documentation requirements and developing a process for tracking questioned costs. Moving forward, ensuring proper use of NASA's resources remains a top priority and Agency contracting personnel need to be proactive in their efforts to prevent fraud and mismanagement before it occurs.

Key Unimplemented Recommendations

Develop policies and procedures for how desk reviews and on-site visits will be conducted and documented, including the frequency with which such grantee monitoring will occur to cover programmatic and financial requirements (IG-20-009).

In coordination with the NASA Shared Services Center, comply with the Federal Grant and Cooperative Agreements Act of 1977 on the proper use of grants and contracts to allow Center and Program personnel greater visibility into partner operations and to ensure that funding levels and performance are commensurate with requirements (IG-20-023).

Establish science metrics, such as publications and citations per year, as criteria for the performance evaluation of the USRA contract award fee (IG-20-022).

Ongoing and Planned Audit Work

The OIG's Offices of Audits and Investigations, in conjunction with our Advanced Data Analytics Program, will continue to assist NASA in its acquisition oversight efforts by examining Agency-wide procurement and grant-making processes. These efforts will include actions NASA is taking to identify and mitigate grant fraud risks; auditing individual contracts, grants, and cooperative agreements; and investigating potential misuse of contract and grant funds. Additionally, in fall 2020 we contracted with several external entities to perform incurred cost audits of four NASA subcontractors.

NASA's Management of the Universities Space Research Association
This audit is evaluating NASA's partnership with the Universities Space Research Association relative to proper use of and accounting for Agency resources while meeting program requirements.

Oversight of CARES Act Funding
This audit will evaluate NASA's expenditure of its $60 million in CARES Act pandemic relief funds.

Challenge 6: Managing and Mitigating Cybersecurity Risk

Why This Is a Challenge

NASA spends more than $2.2 billion annually on a portfolio of information technology (IT) assets, and protection of its data and IT systems is central to the success of the Agency's aeronautics, space exploration, science, and overall operations. To accomplish its wide-ranging and complex operations, NASA depends on institutional and mission networks, software, and IT products and services to control spacecraft, collect and process scientific data, and provide security for critical Agency programs and infrastructure.[36] For FY 2020, the Office of the Chief Information Officer (OCIO) allocated approximately $74 million on cybersecurity. Given the unrelenting threats to its IT infrastructure, we remain concerned about gaps between NASA's threat exposure and its ability to effectively manage and mitigate cyber risk.

While there are various ways to measure cybersecurity risk, one key indicator of cyber vulnerability is how much of an agency's data is available on the darknet (also known as the dark web) that can be misused by hackers or criminals. NASA's darknet risk score ranks 7th highest in the federal government, just behind branches of the military.[37] Another measure of NASA's cybersecurity posture is its annual ratings judged against federal IT criteria: the Federal Information Security Modernization Act (FISMA) and the Federal Information Technology Acquisition Reform Act (FITARA).[38] During the 2020 FISMA evaluation, NASA's information security program remained at a Level 2 out of 5—meaning the Agency has issued, but has not consistently implemented, policy and procedures defining its security program. Additionally, in July 2020 NASA received an overall FITARA grade of C+ given its challenges in managing major IT investment risk and cyber threats.

This year, our emphasis on managing and mitigating cybersecurity risk is heightened because, like other federal agencies, NASA's IT infrastructure has seen an uptick of cyber threats, with phishing attempts doubled and malware attacks exponentially increasing during the COVID-19 pandemic. To address the complexity and uncertainty of its cybersecurity challenges, NASA must address three critical areas: lax IT security plans, numerous corrective action plans to remedy security deficiencies, and an extensive web footprint. Until these vulnerabilities are addressed by the OCIO, NASA's IT systems will remain susceptible to a multitude of existing and emerging cyber-related threats.

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[36] NASA's IT assets generally fall into two broad categories: institutional and mission. Institutional (corporate) systems support the day-to-day work of NASA employees and include networks, data centers, web services, desktop and laptop computers, enterprise business applications, and other end-user tools such as email and calendaring. Mission systems support the Agency's aeronautics, science, and space exploration programs and host hundreds of IT systems distributed throughout the United States.

[37] The Darknet Index US Government Edition: Ranking US Government Agencies Using Darknet Intelligence. By comparison, the Federal Bureau of Investigation, Nuclear Regulatory Commission, Central Intelligence Agency, and U.S. Cyber Command rank 11, 31, 48, and 57, respectively.

[38] FISMA, as amended in 2014 (Pub. L. No. 113-283), requires agencies to develop, implement, and document an agency-wide information security program. FITARA puts federal agency Chief Information Officers in control of their agency's IT investments.

Recent OIG audits have found NASA's ability to detect and recover from cyberattacks are hampered by incomplete and inaccurate system security plans that categorize systems and data; prescribe formal techniques for protecting information systems from unauthorized users, viruses, and other events; and specify the actions needed to respond to these threats.[39] For example, in recent reports we found numerous instances of the Agency's system security plans lacking the required measures and information such as system categorization, contingency plans, risk assessments, and system boundary descriptions—elements that are essential in identifying and managing cyber risk.[40] Importantly, an imprecise system security plan directly impacts the requirements and controls needed to address specific cyber risks within the IT environment. The continuing laxness of NASA's security plans raises concerns about the Agency's overall level of cybersecurity preparedness.
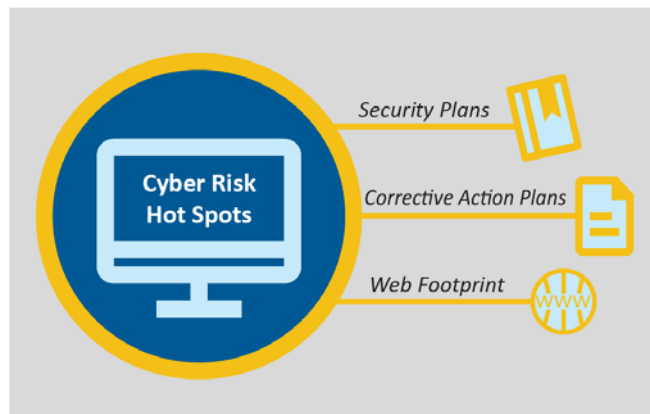
Although NASA developed a remedial action process and maintains a database to track the status of corrective actions for security vulnerabilities, as of May 2020 more than 1,800 actions remain open. Agency officials attribute these corrective action delays to operational priorities and resource constraints. However, delays in addressing these weaknesses pose a threat to the Agency's overall security posture since the delays could allow intruders to exploit these deficiencies. For example, as we recently reported, NASA needs to fully implement security controls that help protect its networks from unauthorized access by personal mobile IT devices (smartphones, tablets, and laptop computers).

Additionally, NASA's inventory of nearly 3,000 web domains, including more than 42,000 publicly-accessible datasets, presents a significant cyber risk.[41] In May 2019, the NASA Administrator requested "a full review of NASA's Web footprint and digital presence" and an assessment team led by the NASA Office of the Chief Scientist was tasked with recommending ways to reduce cyber vulnerabilities by strengthening digital security.[42] Until the Agency obtains a comprehensive accounting of all its websites and reduces the number, security vulnerabilities remain. For example, in November 2019 we issued a Management Referral regarding the compromise of a NASA system hosting more than 40,000 records containing personally identifiable information such as social security numbers and dates of birth. These records were improperly accessed when an Internet-facing server at a NASA Center was compromised and the attackers remained undetected for nearly a month after the intrusion. Believed to have originated from a Chinese IP address, this attack occurred because of inadequate monitoring and NASA's failure to apply a software patch to the server in a timely fashion. If not for notification by NASA

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[39] System and data categorization is designed to provide a foundation for determining the security controls that should be applied to an information system commensurate to its criticality in an effort to ensure appropriate confidentiality, integrity, and availability risk is addressed.

[40] The system and authorization boundary establish the scope of protection for an IT system, which includes people, processes, and technologies.

[41] NASA's clearinghouse for data provided to the public encompassing a variety of datasets such as earth science, geospatial data, and atmospheric chemistry is data.nasa.gov.

[42] A "digital presence" refers to how NASA appears online and is what people find when searching for NASA on the Internet. For example, digital presence includes content that the Agency controls, like its websites and social media profiles, but also content that it cannot control, such as online reviews or comments. Web Site Modernization and Enhanced Security Protocols Memorandum, May 15, 2019.

counterintelligence officials, it is unclear when the intruders would have been detected through existing NASA cybersecurity processes and capabilities. As a result of this incident, NASA paid approximately $150,000 to a credit monitoring company for identity theft monitoring services for the affected employees.

Progress in Addressing the Challenge

Over the past several years, the OCIO has taken positive steps to improve NASA's overall information security program and posture, including implementing Department of Homeland Security directives and legislative requirements. For example, NASA began using cyber risk software and established the use of Risk Information Security Compliance System (RISCS) across the Agency. Although RISCS allows IT system owners to administer and track cybersecurity compliance, additional functionality and quality-checking data entered into the system needs to be implemented.

Likewise, the Agency made progress in the areas of identity management and authentication which provides visibility into who and what is connected to the institutional network. NASA requires 100 percent of privileged users to sign in before using its IT assets with Personal Identity Verification (PIV) credentials with privileged users having more IT system authority than ordinary (non-privileged) user. For example, privileged users might be able to install or remove software, upgrade the operating system, or modify application configurations. Also, they might have access to files not normally accessible to non-privileged users. Importantly, in 2019 NASA met the 90 percent FISMA Risk Management Assessment target of unprivileged users required to utilize PIV. With that said, implementing similar PIV capabilities for their unique mission systems requires continued focused attention.

Lastly, having organization-wide governance and appropriate resources is essential to mitigating cybersecurity risk. In September 2019, NASA updated its IT Strategic Plan that identifies critical activities, milestones, and resources needed to manage IT as a strategic resource. For example, consistent with the plan and past OIG recommendations, NASA streamlined its previously fragmented IT governance model by integrating its mission processes across organizational boundaries. To further improve its IT operating model, the OCIO is participating in MAP, which is intended to improve NASA's mission support services by moving toward an enterprise computing model to centralize and consolidate IT capabilities while ensuring unique local requirements are met.[43] As a result, the OCIO expects to complete its MAP assessment by March 2021 with implementation in 2021. Ultimately, MAP's success depends in large part on the OCIO efforts to be agile, transformational, and forward thinking. Subsequently, as MAP progresses, we will continue to assess to what extent the planned IT realignment has centralized and strengthened cybersecurity throughout the Agency, as well as overcoming long-standing agency resistance to consolidating management of budgets at Headquarters versus the Centers.

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[43] Enterprise computing is the use of IT systems in a centralized structure, where the IT department manages technology, and everyone works with standardized products and systems.

Key Implemented Recommendations

Ensure OCIO and OSI representatives are included in functional reviews of NASA's critical infrastructure assets and facility security assessments so that cyber and facility interdependencies are addressed appropriately (IG-17-011).

Identify and reduce unnecessary duplication of the incident monitoring, detection, and response capabilities, including toolsets and competencies available Agency-wide to enhance the capabilities and resources of the SOC and realize efficiencies in the management of these capabilities (IG-18-020).

Require the JPL CITO to complete its validation and updates of open waivers, perform annual reviews to ensure system representatives are validating the need for the waiver, and provide NASA documentation of these waivers (IG-19-022).

Work That Needs to Be Done

Managing and mitigating cybersecurity risk is critical to protecting NASA's vast network of information technology systems from malicious attacks or other breaches that may inhibit the Agency's ability to carry out its mission. While NASA has taken steps to address cybersecurity risks, it continues to face challenges in strengthening its internal controls and insight across Agency systems. Specifically, the OCIO needs to (1) address information security deficiencies within security plans, (2) ensure that corrective action plans for security deficiencies are resolved in a timely manner, and (3) reduce the Agency's vast web footprint. Concurrently, Agency leadership needs to demonstrate its commitment to timely implementation of MAP to centralize and consolidate cybersecurity activities and reduce gaps in vulnerability management. Without sustained improvement, NASA will be challenged to reduce the risk of cyberattacks that may expose sensitive information or jeopardize intellectual property and compromise the Agency's mission.

Key Unimplemented Recommendations

Perform an assessment to evaluate the feasibility of modifying RISCS to ensure that required data fields, system inventory sections, and other supporting documentation required for the creation or modification of a system security plan are completed before a system can be authorized to operate (IG 20-017).

Issue clarifying policy guidance to ensure that information security controls for all active NASA information systems that are categorized as "other than satisfied" are properly supported by either a Plan of Action and Milestones or Risk-Based Decision document and track exceptions in Agency-wide monitoring tools (IG 20-017).

Ongoing and Planned Audit Work

Cybersecurity Readiness
This audit is examining NASA's ability to identify and respond to current and future cybersecurity threats.

Evaluation of NASA's Information Security Program under the Federal Information Security Modernization Act for Fiscal Year 2020
This annual review is evaluating NASA's information security program.

Challenge 7: Addressing Outdated Infrastructure and Facilities

Why This Is a Challenge

NASA and its partners rely on the Agency's infrastructure to prepare for missions to the Moon and Mars, facilitate a commercial space industry, conduct aeronautics research, and study Earth and space science. With installations in 14 states, NASA manages $40 billion in assets with an inventory of more than 5,000 buildings and structures, making the Agency one of the largest property holders in the federal government. Over the past 60 years, NASA has used its unique facilities to develop new and innovative technologies for space exploration, scientific research, and aeronautics. To achieve its current exploration and research goals, the Agency needs to maintain these facilities in a safe and sustainable condition.

Primary among NASA's challenges in this area is the fact that over 75 percent of its facilities are beyond their original design life. While it strives to keep these facilities operational, the Agency faced a deferred maintenance backlog of $2.66 billion as of 2020. This has resulted in unscheduled maintenance costing up to three times more to repair or replace equipment after it has failed rather than if scheduled maintenance had occurred. The Agency is also responsible for 155 abandoned properties worth $307 million that present a safety and maintenance liability as many have structural or interior deficiencies.

As NASA updates its ground support infrastructure for lunar missions, many of its facilities are undergoing modifications to accommodate modern launch capabilities. For example, the EGS Program at Kennedy Space Center is upgrading infrastructure and facilities required for the Artemis program, including modernization of Pad 39B and modification of the Vehicle Assembly Building to accommodate the SLS rocket and Orion capsule. In March 2020, we reported that NASA greatly surpassed its cost and schedule targets on a project to develop the Agency's first mobile launcher. We also found that the Agency is missing opportunities to improve project management and oversight as it begins development of a second mobile launcher.

Vehicle Assembly Building for the SLS, Kennedy Space Center

Source: NASA

NASA's construction projects faced additional challenges in 2020 due to the COVID-19 pandemic. As the Agency implemented its emergency response plan, installations across the country were closed except to protect life and critical infrastructure. Consequently, NASA was forced to scale back work on construction projects that will, in turn, face challenges from increased costs and schedule delays. Additionally, as facilities were re-opened for mission critical work, the Agency has obligated $3.8 million on cleaning expenses to ensure the buildings are properly sanitized for the workforce.

NASA is also managing several significant environmental cleanup efforts including the Santa Susana Field Laboratory (SSFL), a project that accounts for 40 percent of the Agency's overall environmental cleanup liability. In March 2019, we questioned $377 million in unfunded liability costs associated with NASA's current soil cleanup plans for the SSFL. We questioned these costs because the Agency's current approach is not based on risks to human health and the environment or the expected future use of the land, the standard practice for environmental remediation at similar sites. Spending the more than $500 million required to clean the soil to the current exacting standards would preclude the Agency's ability to address other environmental cleanup priorities such as a project to remove contaminants from drinking water used by communities surrounding the Jet Propulsion Laboratory in Pasadena, California.

Progress in Addressing the Challenge

NASA's Construction of Facilities program focuses on modernizing the Agency's infrastructure into fewer, more sustainable facilities and repairing failing infrastructure to reduce overall maintenance costs. This has resulted in an increasing number of construction projects to eliminate or repurpose old or unused facilities. For example, in April 2019 Marshall Space Flight Center completed Building 4221, part of the refurbishment of the "4200 Complex" that included the demolition and replacement of old buildings with new, more sustainable facilities. Additionally, as we reported in October 2018, the Agency is utilizing $18 million in historic property lease proceeds at Ames Research Center to maintain facilities including the Unitary Planned Wind Tunnel, Arc Jet Complex, and Vertical Motion Simulator.

Furthermore, NASA has initiated a number of significant infrastructure projects to support its Artemis program, such as refurbishing Kennedy Space Center's Vehicle Assembly Building and Launch Complex 39B; activating Stennis Space Center's B-2 Test Stand in preparation for the SLS rocket's Green Run test; and constructing the new Modular Supercomputing Facility at Ames Research Center to run complex simulations in support of the Artemis program.

Key Implemented Recommendation

Decide whether to preserve or demolish the remaining six test stands and related structures before soil remediation begins and take action on that decision (IG-19-013).

Work That Needs to Be Done

Over the past few years, we have assessed a variety of infrastructure issues including the Agency's environmental remediation efforts; management of NASA's historic real and personal property; efforts to "rightsize" the NASA workforce, facilities, and other supporting assets; construction of new assets such as test stands; and NASA's efforts to reduce unneeded infrastructure and facilities. Common themes from these reviews are NASA's slow implementation of corrective actions, inconsistent

implementation of Agency policies, and the need for stronger life-cycle cost considerations in facility construction decisions.

NASA will need to continue to make difficult decisions to invest, divest, or consolidate unneeded infrastructure; effectively communicate those decisions to stakeholders; and withstand the inevitable political pressure to retain unnecessary capabilities and facilities at Centers throughout the country. These decisions will become even more essential following the COVID-19 pandemic, which has resulted in widespread telework and reignited questions about the number and size of facilities the Agency will need in the future. Additionally, despite some progress, the Agency needs to address its substantial deferred maintenance backlog and significant environmental cleanups at multiple sites.

Key Unimplemented Recommendation

Ensure life-cycle and milestone reviews incorporate programmatic and technical risks and are conducted with the Associate Administrator for Human Exploration and Operations Mission Directorate and other senior Agency officials (IG-20-013).

Ongoing and Planned Audit Work

NASA's Construction of Facilities
This audit is assessing the extent to which the Agency is effectively managing its Construction of Facilities process.

NASA's Management of Hazardous Materials
This audit is examining the Agency's management of hazardous materials.

NASA Management of Ames Research Center's Lease Management Practices
This audit will examine Ames Research Center's implementation and management of its lease agreements.

APPENDIX A: RELEVANT OIG REPORTS

Landing Humans on the Moon by 2024

NASA's Management of the Gateway Program for Artemis Missions (IG-21-004, November 10, 2020)

Orion Multi-Purpose Crew Vehicle (IG-20-018, July 16, 2020)

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

NASA's Management of Space Launch Systems Program Costs and Contracts (IG-20-012, March 10, 2020)

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

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

Improving Management of Major Projects

NASA's Management of the Gateway Program for Artemis Missions (IG-21-004, November 10, 2020)

NASA's Management of the Stratospheric Observatory for Infrared Astronomy Program (IG-20-022, September 14, 2020)

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

NASA's Surface Water and Ocean Topography Mission (IG-18-011, January 17, 2018)

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

NASA's Mars 2020 Project (IG-17-009, January 30, 2017)

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

Attracting and Retaining a Highly Skilled Workforce

NASA's Management of Its Acquisition Workforce (IG-21-002, October, 27, 2020)

NASA's Planetary Science Portfolio (IG-20-023, September 16, 2020)

Management of NASA's Europa Mission (IG-19-019, May 29, 2019)

NASA's Surface Water and Ocean Topography Mission (IG-18-011, January 17, 2018)

NASA's Efforts to "Rightsize" its Workforce, Facilities, and Other Supporting Assets (IG-17-015, March 21, 2017)

Sustaining a Human Presence in Low Earth Orbit

NASA's Management of Crew Transportation to the International Space Station
(IG-20-005, November 15, 2020)

NASA's Management and Utilization of the International Space Station (IG-18-021, July 30, 2018)

NASA's Management of the Center for the Advancement of Science in Space
(IG-18-010, January 11, 2018)

NASA's Response to SpaceX's June 2015 Launch Failure: Impacts on Commercial Resupply of the International Space Station (IG-16-025, June 28, 2016)

NASA's Efforts to Maximize Research on the International Space Station (IG-13-019, July 8, 2013)

Improving Oversight of Contracts, Grants, and Cooperative Agreements

NASA's Planetary Science Portfolio (IG-20-023, September 16, 2020)

NASA's Management of the Stratospheric Observatory for Infrared Astronomy Program
(IG-20-022, September 14, 2020)

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

Fiscal Year 2019 Financial Accounting Management Letter, Prepared by CliftonLarsonAllen LLP
(IG-20-009, December 17, 2019)

Cybersecurity Management and Oversight at the Jet Propulsion Laboratory (IG-19-022, June 18, 2019)

Ames Research Center Protective Services Contract (IG-19-017, April 25, 2019)

NASA's Strategic Assessment Contract (IG-19-015, March 28, 2019)

NASA's Engineering and Technical Services Contracts (IG-19-014, March 26, 2019)

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

Audit of the National Space Biomedical Research Institute (IG-18-012, February 1, 2018)

NASA's Management of the Center for the Advancement of Science in Space
(IG-18-010, January 11, 2018)

NASA's Efforts to Improve the Agency's Information Technology Governance
(IG-18-002, October 19, 2017)

Audit of NASA Space Grant Awarded to the University of Texas at Austin (IG-16-013, February 18, 2016)

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

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

NASA's Efforts to Maximize Research on the International Space Station (IG-13-019, July 8, 2013)

Audit of NASA Grant Awarded to HudsonAlpha Institute for Biotechnology (IG-12-019, August 3, 2012)

Audit of NASA Grants Awarded to the Philadelphia College Opportunity Resources for Education (IG-12-018, July 26, 2012)

Audit of NASA Grants Awarded to the Alabama Space Science Exhibit Commission's U.S. Space and Rocket Center (IG-12-016, June 22, 2012)

NASA Should Reconsider the Award Evaluation Process and Contract Type for the Operation of the Jet Propulsion Laboratory (IG-09-022, September 25, 2009)

Managing and Mitigating Cybersecurity Risk

Testimony before the House of Representatives Subcommittee on Space and Aeronautics, Committee on Science, Space, and Technology on *Cybersecurity at NASA: Ongoing Challenges and Emerging Issues for Increased Telework During COVID-19* (September 18, 2020)

Audit of NASA's Policy and Practices Regarding the Use of Non-Agency IT Devices (IG-20-021, August, 27, 2020)

Evaluation of NASA's Information Security Program under the Federal Information Security Modernization Act for Fiscal Year 2019 (IG-20-017, June 25, 2020)

NASA's Management of Distributed Active Archive Centers (IG-20-011, March 3, 2020)

Cybersecurity Management and Oversight at the Jet Propulsion Laboratory (IG-19-022, June 18, 2019)

Audit of NASA's Security Operations Center (IG-18-020, May 23, 2018)

NASA's Efforts to Improve the Agency's Information Technology Governance (IG-18-002, October 19, 2017)

NASA's Information Technology Governance (IG-13-015, June 5, 2013)

Sustaining Infrastructure and Facilities

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

NASA's Progress with Environmental Remediation Activities at the Santa Susana Field Laboratory (IG-19-013, March 19, 2019)

Audit of NASA's Historic Property (IG-19-002, October 22, 2018)

NASA's Efforts to "Rightsize" its Workforce, Facilities, and Other Supporting Assets (IG-17-015, March 21, 2017)

NASA's Efforts to Reduce Unneeded Infrastructure and Facilities (IG-13-008, February 12, 2013)

APPENDIX B: MANAGEMENT'S COMMENTS

National Aeronautics and Space Administration

Office of the Administrator
Washington, DC 20546-0001

November 3, 2020

TO: Inspector General

FROM: Administrator

SUBJECT: Agency Response to Office of Inspector General Report, "2020 Report on
              NASA's Top Management and Performance Challenges"

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to
review and comment on the Office of Inspector General (OIG) report entitled, "2020 Report on
NASA's Top Management and Performance Challenges."

The audits and investigations conducted by your office provide NASA's leadership and
management with valuable contributions to the collective effort to provide oversight and gain
insight into NASA's broad portfolio of programs, projects, and mission support activities with
which it is entrusted. The efforts expended by your office during this past year have furthered
the cause of providing the taxpayer with maximum value for each dollar invested in NASA's
wide-ranging, ambitious, and challenging portfolio. As an Agency, we continue to aggressively
pursue the mitigation and remediation of findings related to the audit recommendations issued by
your office, including those which form the underpinnings of your observations as cited in your
2020 Report on NASA's Top Management and Performance Challenges.

While we fundamentally agree that the seven areas outlined in your 2020 report constitute
significant challenges for the Agency, we would like to highlight the following mitigation and
remediation efforts relative to each challenge outlined in your report that have either been taken
or are currently under way. We believe these efforts substantively demonstrate NASA's
commitment to addressing its most significant management and performance challenges faced by
the Agency:

Challenge 1: Landing the First Woman and the Next Man on the Moon by 2024

NASA agrees that landing the first woman and the next man on the Moon by 2024 is a
significant challenge, and the Agency is working hard to achieve this goal. Despite challenges
associated with the COVID-19 virus, NASA continued to make steady progress towards the
launch of Artemis I, the first test flight of the launch vehicle that will carry astronauts and cargo
into space for the 2024 mission. With the exception of the Core Stage, all major elements of
flight hardware for the first Artemis flight have been delivered to Kennedy Space Center. The
Core Stage is currently undergoing green run testing, and six of eight tests have been completed

as of early October. NASA is well into production for the Artemis II mission, and Artemis III hardware builds are under way.

NASA has selected three U.S. companies to develop preliminary designs for a human landing system (HLS) under the Next Space Technologies for Exploration Partnerships (NextSTEP-2) Appendix H Broad Agency Announcement (BAA). NASA has completed Contractor Certification Baseline Reviews (CBRs) for each of the three HLS contractors as planned and is on schedule in early 2021 to select the contractor(s) who will complete HLS design and development to enable the 2024 crewed mission.

The Gateway Program continues to make significant progress and has selected the first U.S. commercial provider under the Gateway Logistics Services contract to deliver cargo, experiments, and other supplies to the Gateway in lunar orbit. NASA has initiated manufacturing of the Exploration Extravehicular Mobility Unit Development Verification Test (DVT) suit, which will be the space suit astronauts will use on the lunar surface on Artemis III.

NASA has implemented a number of the OIG's key recommendations to improve cost, schedule, and technical performance and is working to complete implementation of the remaining open recommendations. NASA's status on key unimplemented recommendations is shown below:

Key Unimplemented Recommendations:

Review Human Exploration and Operations Mission Directorate and NASA program management policies, procedures, and ABC reporting processes to provide greater visibility into current, future, and overall cost and schedule estimates for the SLS Program and other human space flight programs (IG-20-012).

NASA agrees with this recommendation and has been implementing improvements to better track cost and schedule and to report progress against baselines. In addition, NASA is evaluating changes to NASA Procedural Requirements (NPR) 7120.5, "Space Flight Program and Project Management Requirements," to better enable the necessary insight into program affordability and efficient monitoring of total program costs and execution for multi-year, multi-cadence type programs. NASA estimates completion of this recommendation by spring of 2021.

Challenge 2: Improving Management of Major Projects

NASA is focused on its mission of bold exploration and discovery. In support of this mission, the Agency has developed a rigorous process for program formulation, approval, implementation and evaluation. We see excellence in program management as a core capability and critical for enabling exploration. NASA's program management expertise brings together the people, resources, and processes necessary to execute the most challenging and complex programs as we explore our world and our universe.

As NASA carries out the Nation's exploration plans, the Agency has been making strident progress on improving program planning and control and increasing transparency for external stakeholders. NASA leadership continues to evaluate the considerable progress made to date on

implementation of the initiatives contained in the Agency's High Risk Corrective Action Plan (CAP). In July 2020, NASA leadership determined seven of nine CAP initiatives had been fully completed, including the creation of a technology readiness assessment best practices document, an update to the Agency's probabilistic programmatic policy (i.e., Joint Confidence Level (JCL)), increased transparency by inclusion of original Agency baseline commitments in external reporting for re-baselined projects, among other initiatives. NASA leadership also added an additional four initiatives to a renewed CAP in July 2020. New initiatives under way include a full implementation of a Schedule Repository, a comprehensive HEOMD ESD/AES cost and schedule transparency effort, enhancements to the CADRe data collection for Category 3 Class D projects, and the adoption of a risk assessment and financial evaluation of contractors' activity. The 2020 CAP is accessible via the NASA Reports and Transcripts webpage[1]. NASA leadership's progress on and renewal of the CAP is evidence that the Agency is committed to pursuing the most critical changes to increase transparency, improve cost and schedule estimation, and maintain focus on accountability.

NASA is also making substantial progress in the implementation of the Program Management Improvement and Accountability Act (PMIAA). As part of the PMIAA implementation, NASA appointed a Program Management Improvement Officer (PMIO) within the Office of the NASA Associate Administrator. The PMIO has convened an Agency stakeholder team to lead the implementation of PMIAA and has conducted two rounds of annual NASA portfolio reviews focused on the identification, capture, and improvement of PM practices. Practices that have been addressed include improvements to schedule analyses; improvements to life-cycle reviews; and furthering implementation of tailoring approaches. The NASA PMIO is also implementing a program management integration function on behalf of the NASA AA with support from OCFO and OCE and in partnership with the Mission Directorates and Field Centers. This integration will promote overall synergy and integration of PM practices and capabilities across the Agency to further enhance PM performance and mission success.

We take our responsibilities as stewards of limited Federal resources very seriously, and we will continue to apply all available authorities to accomplish our mission efficiently. At the same time, the Nation expects NASA to embrace big challenges. NASA must continue to accept risk. Our missions will continue to incorporate the leading edge of technology and to pursue the challenging goals that can only be accomplished in the hostile environment of space. NASA missions must do things that have never been done before. NASA is developing one-of-a-kind spacecraft and new technologies. One of the key ways the Agency attempts to manage expectations with our external stakeholders is by specifically waiting until Key Decision Point-C (KDP-C) to make cost and schedule commitments. Only by KDP-C are technical designs and risk assessments mature enough to make these important commitments. Two of the cost growth examples cited by the OIG (Europa Clipper and the Roman Space Telescope) are measured against early estimates of cost instead of cost commitments. The Science Mission Directorate (SMD) has made substantial investment in pre-formulation mission studies and technology development in order to address some of the concerns identified by the OIG and continues to

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[1] https://www.nasa.gov/sites/default/files/atoms/files/nasa_high_risk_corrective_action_plan_2020.pdf

study large missions to identify best practices for future flagships[2]. Moreover, Independent Review Boards are being formed prior to KDP-B to identify cost risks and reduce requirement creep, leading to improved early cost estimation. When cost performance is assessed against KDP-C baselines established since the implementation of the 70 percent JCL requirement, major SMD missions have, on average, cost 2 percent less than the NASA commitment. Due to the nature of NASA's mission, some projects will overrun; however, by adopting the 70 percent JCL methodology, NASA is able to minimize the portfolio disruptions due to large overruns. Our missions will employ technologies that must be developed and tested on Earth, but can only be demonstrated in space. Innovation must remain at the core of everything NASA does, and we cannot encourage innovation and discovery without accepting some risk and some uncertainty.

NASA's challenge is to develop and improve the processes necessary to ensure both efficiency and accountability in what is inevitably a dynamic development environment. We appreciate that, in order to retain the confidence of Congress and the American people, we must execute, delivering missions on cost and on schedule while identifying and characterizing risks as quickly as possible so we can promptly take the appropriate corrective action. NASA's monthly internal Baseline Performance Review chaired by the NASA Associate Administrator has continued to evolve and be refined to better reflect portfolio performance against external commitments, focus discussion on issues requiring leadership awareness, and accelerate the identification of solutions to challenges as they arise. NASA has also recently formed the NASA Acquisition Strategy Council to address acquisition decisions holistically under a single Decision Authority. NASA's renewed emphasis on strategic acquisitions will improve the Agency's efficacy in intelligently moving forward on large acquisitions and making data-driven decisions, ensuring a universal view of the aerospace industrial base, international partners, and NASA in-house performance and capacity.

As we strive to return humans to the surface of the Moon in 2024, NASA will continue to foster a culture where leaders and staff are incentivized to develop realistic cost and schedule estimates, take steps to recognize, mitigate, and communicate those estimates and demonstrate progress in our program management improvement efforts.

Challenge 3: Sustaining a Human Presence in Low Earth Orbit

NASA agrees with this challenge. The International Space Station (ISS) International Partnership and the ISS National Lab continue to mature the safe operations and utilization of this unique on-orbit research platform. Research and utilization for the wide variety of fields, including human health and performance, long-duration life support demonstrations, life and physical sciences, Earth and space science, astrophysics, and multiple technology development fields, continue to expand in the number of experiments and the number of investigators.

This is made possible by the combined ongoing efforts of the ISS Program, the ISS National Lab operator, and the commercial crew and cargo suppliers to utilize and operate the ISS to its utmost

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[2] The SMD Large Mission Study, commenced in October 2019, will recommend ways of improving SMD's cost and schedule performance on very large, multi-billion dollar science missions. The study draws on the collected experiences of a diverse team of experts from the civil, commercial, and defense space communities and is on track to be completed by November 2020. Recommendations are expected to be applied to future large SMD missions such as Mars Sample Return and others.

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capability. The ISS Program operates based on the many years of experience learned in pre-flight integration activities, on-orbit crew planning and execution, logistics planning and management, and other aspects of ISS management and operations; all of which is providing dividends in returning benefits to humanity, enabling the development of a commercial market and enabling deep space long-duration exploration. Research clients are able to get experiments to orbit in as little as four months. In recognizing that different resources are required for different types of research, NASA continues to evaluate the needs of the research community and add resources to alleviate limitations whenever possible.

An Independent Review Team (IRT) completed a review of the ISS National Lab management structure in April 2020. The IRT included significant recommendations which NASA and CASIS have begun to implement, specifically:

1. Work with CASIS on the best roles and composition of the CASIS Board of Directors and leadership.
2. Support CASIS' establishment of a User Advisory Committee to provide input to the organization about how best to manage resources.
3. Create transparent project and program evaluation and prioritization processes.
4. Identify an ISS National Lab program executive at NASA Headquarters as the primary liaison to CASIS.
5. Update strategic priorities for the ISS National Lab on an annual basis.
6. Work with CASIS to optimize the allocation of ISS National Lab resources to meet strategic priorities.

While work to address these recommendations remains ongoing, a majority new-membership Board of Directors is in place at CASIS, a User Advisory Committee charter has been established and a public call for applications to serve has been announced, and an ISS National Lab program executive at NASA Headquarters has been named as the primary liaison to CASIS.

Through the NASA budget process, the ISS Program has projected the resources necessary to continue with its mission based on actual contract and on-orbit performance data for many aspects of the ISS Program, including transportation, maintenance, and operations. The ISS integration process for utilization continues to become more efficient because of private industry inputs and interactions with the National Lab providers.

Overall, the ISS Program is realizing its full potential in accomplishing NASA's and the Nation's goals in exploration, commercial development, and extending human presence beyond low Earth orbit.

Key Unimplemented Recommendations:

Correct identified safety-critical technical issues before the crewed test flights, including parachute, propulsion, and launch abort systems, to ensure sufficient safety margins exist (IG-20-005).

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NASA agrees with the recommendation. NASA works with its commercial partners to identify all safety-critical technical issues before every flight, including crew test flights, crew operational flights, and cargo resupply missions. NASA would never fly crewed flights with known, unresolved safety-critical technical issues, and there has been no indication to suggest otherwise in NASA's management and execution of CCP. NASA will continue this practice prior to all crewed missions.

Estimated Completion Date: July 31, 2021.

Ensure there is a contingency plan for each exploration-enabling technology demonstration not scheduled to be fully tested by 2024 (IG-18-021).

NASA agrees with the recommendation. NASA is continuing work on ensuring a sufficient plan for enabling critical exploration-research in the event that ISS operations are not extended past 2024. (Note: the OIG approved an extension on this recommendation through April 30, 2021.)

Complete all end-of-mission critical systems and open work related to nominal and contingency deorbit operations (IG-18-021).

NASA agrees with the recommendation. The ISS Program is coordinating with ROSCOSMOS for final approval of SSP 51066, "ISS Deorbit Strategy and Contingency Action Plan," which documents the proposed ISS nominal and contingency deorbit strategy. NASA continues to make progress towards a final end-of-mission plan. A draft operations product and first paper simulation was completed in October 2017, and the ISS Deorbit Plan Operations Interface Procedure (OIP) was baselined in June 2019. A NASA/Russian Joint Flight Rule, "Operations in the Event of ISS and FGB Depressurization" was approved in September 2019. NASA continues to refine analysis to define orbital parameters of the final burn sequence, expected delta velocity (d)V and propellant needs, and footprint targeting. NASA anticipates the current round of analysis will conclude by December 2021, though the analysis refinement process is expected to continue through the remaining ISS lifetime.

Additionally, following the successful Northrop Grumman Detailed Test Objective (DTO) to reboost the ISS using the OA-9 Cygnus cargo vehicle in June 2018, NASA is formally pursuing Cygnus reboost capability starting with the NG-17 vehicle in mid-2022. In addition to providing the necessary acceleration for nominal ISS reboost needs, this capability will provide supplemental deorbit support in emergency ISS deorbit scenarios where it is available.

ROSCOSMOS also continues to proceed with end-of-mission planning. Functional Cargo Block (FGB) depressurization evaluation work is complete, and the software updates installed in the FGB multiplexer-demultiplexers (MDMs) on-orbit as of February 2019 have the capability to quickly reconfigure FGB systems for vacuum conditions to ensure FGB propellant remains useable for ISS deorbit operations in the event of a catastrophic depressurization. Additionally, the Service Module (SM) 8.11 software update in February 2020 introduces an engine firing mode to allow SM main engine firing with an aft-docked Progress vehicle. The remaining ROSCOSMOS open work for nominal ISS deorbit includes a proposed SM software mode to

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allow control of three Progress main engines by the SM for the three-Progress vehicle reentry burn scenario.

Challenge 4: Attracting and Retaining a Highly Skilled Workforce

NASA agrees with the challenges identified in the *Attracting and Retaining a Highly Skilled Workforce* section of the report. As the OIG has called out in their letter, several of NASA's workforce challenges can be traced to factors external to NASA. NASA is sitting on the wrong architecture for its personnel system. The antiquated system neither matches the type of complex and dynamic work NASA is required to perform nor positions the Agency to address workforce challenges to be flexible in the labor market. The current position-based, mid-century personnel system defines work as static, requires lengthy hiring processes, is agnostic to the external labor market, rewards workers for longevity, disincentives' mobility, and is overly complicated and not cost-effective, yet we continue to develop human capital solutions that partially address our workforce challenges as we are confined by the system.

- We continue to be active members of the Chief Human Capital Office Council pushing for real meaningful change to personnel laws.
- We work with the Office of Management and Budget and the Office of Personnel Management to seek out, request, and exploit necessary workforce flexibilities. We are relentless in pursuing and advocating for real change for NASA and the Federal workforce as a whole.

Additionally, as the OIG states, "to maintain a world-class workforce, NASA must fill current critical workforce gaps and prepare for those yet to emerge. Meeting this challenge will require planning to mitigate the Agency's looming retirement wave. Furthermore, the ability to successfully address that risk will require the Agency to have detailed visibility into workforce skill types—data that the Agency currently does not collect. Ideally, NASA would use that data, in combination with national STEM priorities, to support the Agency's technical needs. NASA will also need funded, formal mentoring and knowledge-sharing programs to enable the transfer of institutional knowledge before it is lost." The Office of the Chief Human Capital Officer is looking at ways to better identify the skills needed for the workforce and use the Agency Workforce Master planning process to better plan for the needs of the future. An element of the Master planning process includes projecting loss rates and the extent to which past patterns of employee tenure beyond retirement eligibility might guide the development of mitigating strategies to lessen the impact of a future retirement wave.

Challenge 5: Improving Oversight of Contracts, Grants, and Cooperative Agreements

The NASA Office of Procurement (OP) is committed to making meaningful progress in addressing contract oversight challenges and continues to strengthen its overall procurement processes and policy as a part of our ongoing transformation to an Enterprise after graduating from the Mission Support Future Architecture Program (MAP) in June 2020. Twenty-three designated institutional-related product service lines are in place to identify streamlined acquisition strategies and reduce unnecessary duplication.
NASA continually seeks to improve all aspects of its contracting activities including award fee contract administration and guidance. Recent award fee guidance was designed to ensure

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independence in the award fee determination process and emphasize the need for greater focus on the timely evaluation of contractor performance.

Other key NASA OP initiatives under way include a strategic sourcing Web site to optimize the use of existing contract vehicles, a robust NASA FAR Supplement (NFS) Quality Review Process to continually review and update relevant NFS parts, eliminating outdated and unnecessary policy and templates in use at each Center in favor of enterprise-wide job aids, a dedicated focus on improving the timeliness of contract closeout, and strengthening acquisition planning to ensure that the right contract vehicle is utilized for the requirement.
Lastly, OP partners with the Agency's Office of the General Counsel and the representatives of the NASA Acquisition Integrity Program (NASA AIP) to monitor and coordinate criminal, civil, contractual, and administrative (suspension and debarment) fraud remedies as fraud is identified, investigated, and prosecuted.

Challenge 6: Managing and Mitigating Cybersecurity Risks

NASA's information technology (IT) provides foundational capabilities necessary to accomplish NASA's missions. NASA remains firmly committed to managing IT as a strategic resource to enable mission success, ensure effective communications and collaboration, and safeguard both the IT environment and the resources that support the Agency's priorities. NASA's focus on IT as a strategic resource began in 2014, establishing a basis for the work that continues today. In addition to progress noted by the OIG, NASA has also accomplished the following to manage and mitigate cybersecurity risks.

1. NASA modernized and enhanced its Security Operations Center (SOC) capabilities in FY 2020. The Agency established a new SOC distributed site at Johnson Space Center, integrating with existing SOC capabilities at Ames Research Center, ensuring 24/7 continuity of operations in the event of a service disruption. Furthermore, NASA re-aligned cybersecurity functions, established Operational Level Agreements between the SOC and all Centers and the Jet Propulsion Laboratory, and consolidated cybersecurity resources in order to more effectively identify threats, respond to incidents, and manage core services. These SOC modernization activities allow NASA to see a holistic picture of the Agency's threat landscape and create all-encompassing trend analyses of cybersecurity threats to NASA, which in turn further fortifies NASA's infrastructure.

2. NASA has taken a more proactive and forward-leaning approach by creating a High Value Asset (HVA) Information System Owner (ISO) forum for the Office of the Chief Information Officer (OCIO) to engage with system owners. This forum serves to increase ISOs' awareness and understanding of HVA requirements and provides an opportunity for ISOs to voice challenges and collaborate on solutions, ultimately creating a cohesive and transparent effort for all involved. These efforts allow cybersecurity management to understand and address problem areas and gain better insight into the risk based decisions of HVAs. HVA data calls have also moved from de-centralized data collection to a centralized data collection within NASA's Risk Information Security Compliance System (RISCS). Combined, these efforts are expected to improve the HVA Federal Information Security Modernization Act (FISMA) scores in coming quarters and

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ensure the safety of NASA's most valuable assets. NASA has already improved FISMA scores for HVA metrics such as the ability to dynamically reconfigure and/or automatically disable upon the detection of a security violation or vulnerability, as well as the number of HVA systems that use Personal Identity Verification (PIV) authentication.

3. The NASA OCIO has also established a Cybersecurity Integration Team (CIT), with multiple sub-teams, focusing on efforts that will integrate cybersecurity efforts across NASA, primarily with the Missions. CIT achievements include the following:

   A. CIT 1 "Cyber Policy" has been working to address the current lack of understanding and empowerment of Mission personnel to confidently and effectively implement OCIO cybersecurity requirements. The team has identified several roadblocks in this area, including a lack of understanding about roles and responsibilities, inconsistent policy approaches across different divisions, and poor integration of cybersecurity through an entire NASA project life cycle. The team has worked to help standardize roles and responsibilities and stakeholder groups to engage, to update, and to improve key cybersecurity policies across the Agency. This team will soon present its recommendations to the NASA Information Technology Council (ITC) and hopes to move forward with engaging with those stakeholder groups.

   B. CIT 2 "Critical Assets" has worked to enhance cybersecurity efforts on NASA HVAs. CIT 2 briefed its recommendations to the ITC, where they were accepted. The sub-team worked to clarify criteria NASA should use to identify critical systems and who and how those system lists are managed. The team produced a list of "HVA Identification Guidance Questions;" recommended processes for enhanced management of and sightlines into critical asset lists by NASA's Office of Protective Services (OPS), NASA's OCIO, the Agency's Continuity of Operations (COOP) Team, and the NASA Mission Directorates; created a snapshot of NASA's current critical asset inventory, which highlighted relationships across different types of assets; and submitted a White Paper of its process, findings, and its next steps. Currently, OCIO is working to implement some of the recommendations, including baselining the Agency's HVA list and updating the HVA Standard Operating Procedure (SOP).

   C. CIT 6 "Cybersecurity Workforce" is working to define a cybersecurity workforce deployment model that could be used to ensure that Missions are able to receive appropriate cybersecurity guidance throughout the life-cycle phases of their projects. This sub-team is fairly early in its work, but has engaged with a number of different groups, including the NASA Cyber Task Team (CTT) led by the Science Mission Directorate (SMD), the OCIO Mission Support Future Architect Program (MAP) Workforce Group, Department of Defense (DoD), National Institute for Standards and Technology (NIST), National Initiative for Cybersecurity Education (NICE), and NASA's Aeronautics Research Mission Directorate's (ARMD's) cyber

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workforce lead. The team is continuing to develop its recommendations for the ITC in the coming months.

4. In concert with the Enterprise Protection Program and the Office of Strategic Infrastructure, the NASA OCIO continued to mature its policies and guidance for securing Operational Technology (OT). In FY 2020, NPD 2800.1, Managing Information Technology, was updated to define and explicitly address OT. Additionally, the OCIO published IT Security Handbook (ITS-HBK) 2810.19-01, Operational Technology, in September 2020, which provides guidance for the security assessment and authorization process for OT. Furthermore, NASA is continuing to enhance the management of its OT systems. In FY 2020, the Agency identified all NASA Critical Infrastructure (NCI) OT and collected NCI-OT Compliance Status Reports of those OT systems. These reports will allow the NASA OCIO to identify trends and recommended actions to address common issues in the OT community. Additionally, beginning in June 2020, the Industrial Control Systems Cyber Emergency Response Team (ICS-CERT) and US-CERT alerts have been automatically distributed to all NASA Information System Owners and Information System Security Officers.

While the Agency continued to enhance its cybersecurity policies, processes, and governance in FY 2020, NASA recognizes that there is still progress to be made, specifically in addressing security plans deficiencies in a timely manner and in reducing the Agency's Web footprint. The Agency remains committed to tackling these issues and to building an even stronger, more proactive risk-based cybersecurity program that safeguards NASA's IT assets, data, and its users.

Challenge 7: Addressing Outdated Infrastructure and Facilities

NASA agrees with the challenges identified in the *Addressing Outdated Infrastructure and Facilities* section of the report. To address the challenges with outdated infrastructure and facilities, we have implemented a multi-pronged approach to either remove facilities from our inventory altogether or replace them through our renewal or recapitalization program. Over the past several years, NASA has gradually increased its funding for demolition of facilities and has had great success with a dedicated demolition program manager at HQ and at each Center.

NASA is working to make improvements through implementing an Agency Master Plan to ensure its infrastructure is available and affordable, guide Agency investments to mission critical assets to increase the facility condition, and increase availability and reduce the risk of unplanned failures. To achieve this end, NASA is updating its Mission Dependency Index (MDI) score for all its facilities in an effort to identify the high MDI facilities and correlate them to the Facility Condition Index (FCI). MDI and FCI correlation will guide prioritization for capital repair and renewal projects. The Agency continues to demolish facilities with low MDI and FCI scores.

NASA has also identified investment strategies in backlogged maintenance and reliability centered maintenance efforts, such as condition-based maintenance. These efforts lead to improving the condition of important building systems and facilities across the Agency and improving the reliability of NASA facilities to meet mission needs. Implementation of tiered

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maintenance strategies utilizing these reliability centered maintenance principles ensures the right type of maintenance is done on the most critical assets, at the right time, and for the right reasons. Through investments in maintenance, demolition, repair, and recapitalization, NASA strives to right-size the Agency's infrastructure to more modern and efficient facilities that will continue to meet NASA mission objectives.

In addition, there is continued work in assessing and implementing the OIG's key infrastructure-related recommendations from previous infrastructure-related audits. Below are responses to the two unimplemented key recommendations mentioned in *Challenge 7: Addressing Outdated Infrastructure and Facilities*:

Key Unimplemented Recommendations:

Pursue all available options—administrative, legal, or political—to ensure NASA's SSFL soil cleanup is performed in an environmentally and financially responsible manner based on the intended future use of the property (IG-19-013).

The OIG Report (IG-19-013) identifies many issues and concerns with implementing a soil cleanup at Santa Susana Field Laboratory (SSFL) as prescribed in the 2010 Administrative Order on Consent (AOC) utilizing the provisional Lookup Table (LUT) values the State of California Department of Toxic Substance Control (DTSC) developed. In 2017, the DTSC released a Draft Programmatic Environmental Impact Report (PEIR) that identified environmental impacts associated with the SSFL cleanup. The cleanup outlined in the PEIR would require substantially greater soil removal than NASA estimated in its 2014 Environmental Impact Statement (EIS). The soil quantity estimates established in the DTSC's Draft PEIR have the potential to significantly increase the environmental impacts from what was evaluated in NASA's 2014 EIS, and NASA completed a Supplemental EIS (SEIS) in accordance with the National Environmental Policy Act (NEPA) to evaluate the significance of those impacts. As required by NEPA, NASA's SEIS considered a range of reasonable soil cleanup alternatives in addition to the AOC cleanup to DTSC LUT values. The Final SEIS for soil cleanup was published in the Federal Register on July 24, 2020, and identified the "Suburban Residential" risk-based cleanup as the Agency's preferred alternative, resulting in an estimated savings of over $400M and one third the project duration. NASA has issued a Record of Decision (ROD) selecting the Suburban Residential risk-based cleanup preferred alternative for soil cleanup at SSFL. NASA will continue to monitor DTSC's progress on its PEIR, corresponding Notice of Determination (California equivalent to a ROD) and final LUT for the cleanup phase.

NASA remains firmly committed to achieving a cleanup at SSFL that is protective of public health and the environment. NASA will continue to work with DTSC and all interested stakeholders to implement a cleanup that is based in science, technically achievable, protective of the surrounding community, and eliminates or greatly reduces significant damage to SSFL's habitat and cultural resources and the impacts to the community.

Key Unimplemented Recommendations:

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Ensure life-cycle and milestone reviews incorporate programmatic and technical risks and are conducted with the Associate Administrator for Human Exploration and Operations Mission Directorate and other senior Agency officials (IG-20-013).

NASA agrees with this recommendation. Life-cycle and milestone reviews, that incorporate programmatic and technical risks, will be conducted with the Associate Administrator for Human Exploration and Operations and other senior Agency officials as established in NASA Procedural Requirements (NPR) 7120.5, "NASA Space Flight Program and Project Management Requirements." NASA is working to formalize the life-cycle review and independent assessment plan for the Mobile Launcher-2 and anticipate its completion by spring of 2021.

If you have any questions regarding NASA's response to the 2020 Top Management and Performance Challenges, please contact Anthony Mitchell, Audit Liaison Project Manager, on (202) 358-1758.

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