NASA

Office of Inspector General

NASA's Rocket Propulsion Test Program

September 24, 2024

IG-24-018

Office of Inspector General

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Results in Brief

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IG-24-018 (A-23-13-00-SARD)

Why We Performed This Audit

Rocket engines and their components undergo extreme conditions during launch, including high temperatures, pressures, and vibrations. NASA uses rocket propulsion test (RPT) sites to evaluate how engines and components will react in launch conditions and in space, ensuring that issues can be addressed before launch. NASA publicly announced plans to open a rocket engine test facility at Stennis Space Center (Stennis) in 1961, and RPT sites were critical during the Apollo and Space Shuttle eras. NASA built up significant RPT infrastructure during those periods, and propulsion testing continues to serve a vital role in NASA programs. However, as the space industry has become more commercialized, NASA has seen less internal need for large-scale propulsion testing, but an increase in opportunities for external customers to utilize NASA's RPT infrastructure.

NASA's RPT Program Office, located at Stennis, works with both internal and external customers, making test stand assignments and ensuring critical RPT infrastructure and support are maintained across eight NASA facilities. RPT at NASA is managed as a capability portfolio, so the Program ensures NASA maintains the infrastructure and critical skills for current and future RPT needs. NASA's Rocket Propulsion Test Management Board serves as the decision-making body for NASA's RPT sites. The Board reviews and approves test assignments, facility modifications, and all key decisions. NASA also participates in the National Rocket Propulsion Test Group, where the Agency and the Department of Defense (DOD) collaborate to share best practices, coordinate, and ensure efficiency.

In this audit, we assessed whether NASA effectively and efficiently manages its portfolio of RPT capabilities. We also assessed factors affecting RPT assignments, capital investments, and RPT-related processes and operating procedures. We interviewed officials from the RPT Program Office, Human Spaceflight Capabilities Division, and RPT Centers, as well as from DOD.

What We Found

Much of NASA's RPT infrastructure is aging and requires significant funding to maintain. Meanwhile, the landscape for RPT is changing. Increased commercialization in the space industry has lessened demand for NASA's large-scale RPT facilities. NASA is also transferring some responsibility for payload delivery to commercial partners, such as in the Commercial Lunar Payload Services initiative. These trends lead to NASA's RPT stands sitting unused more often. From fiscal year (FY) 2022 to 2026, the percentage of NASA test stand capabilities in active use is projected to decrease from 47 percent to 26 percent. Of the 10 test stands projected for use in FY 2025, five are being leased to commercial entities. Five of the Program's test stands are in mothball or demolition status, and Stennis's A-2 and A-3 test stands sat idle for nearly a decade before being leased to external customers. In addition to decreased demand, the RPT Program is facing a flat budget, with enough funding to maintain core staff and facilities, but insufficient funding to address major maintenance projects.

The RPT Program Office is working to adjust to changing demand for RPT facilities. NASA has conducted multiple studies to assess future demand and determine the right mix of RPT capabilities to meet that demand. Right-size studies in 2012 and 2020 gave the RPT Program recommendations on which test stands and facilities to divest from or decommission. A study wrapped up in 2022 assessed strengths and weaknesses at Stennis and recommended changes to the E-Complex there, where small engines and components are tested. A Commercial Capability Survey, currently ongoing, aims to help NASA understand RPT capabilities at commercial, governmental, and academic facilities.

NASA is also taking steps to work within the flat RPT budget. Five test stands are currently under lease to external partners. These leases benefit both parties; NASA avoids some of the operations and maintenance costs, and the commercial entities avoid the cost and time required to build their own RPT facilities. The Program is also investing in the E-Complex at Stennis, the Program's busiest facility. Finally, Stennis is piloting a new cost model that requires customers to pay for maintenance and usage costs, a change that could bring up to $1 million per year to the Center. Though the Program Office sees the benefits of this cost model, similar models have not been implemented at other Centers. This is partly because NASA policy documents do not clearly delineate who has the authority to implement a similar cost model at other NASA Centers.

WHAT WE RECOMMENDED

To ensure NASA's RPT capability portfolio is prepared for the future, we recommended that the RPT program manager establish a requirement for recurring right-size studies for the RPT capability portfolio; implement cost models at other Centers similar to the one at Stennis that requires customers to pay maintenance costs for the infrastructure and facilities being utilized; document the current process for prioritizing maintenance projects; and document the results and planned response to the Commercial Capability Survey. We also recommended the Assistant Administrator for the Office of Strategic Infrastructure ensure appropriate revisions are made to NASA policy documents to clarify relevant authority structures.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

For more information on the NASA Office of Inspector General and to view this and other reports visit https://oig.nasa.gov/.

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Acronyms

DOD	Department of Defense
FM&M	Facilities Maintenance and Modernization
FY	fiscal year
NESC	NASA Engineering and Safety Center
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NRPTA	National Rocket Propulsion Test Alliance
NRPTG	National Rocket Propulsion Test Group
OIG	Office of Inspector General
RPT	rocket propulsion test
RPTMB	Rocket Propulsion Test Management Board
SLS	Space Launch System
SOMD	Space Operations Mission Directorate

INTRODUCTION

Developing and testing rocket propulsion systems is foundational to space flight. Rocket engine testing is used to assess and evaluate an engine's performance, efficiency, and durability. It is a critical part of the engine development process and ensures engines function as they should and meet performance requirements. Rocket engines are subjected to extreme conditions during launch, such as high temperatures, pressures, and vibrations. Any failure or malfunction of the engine can have catastrophic consequences for crew and spacecraft. Therefore, it is critical that an engine is tested under similar conditions to identify potential issues and address them before launch. NASA's rocket propulsion testing infrastructure allows for tests of individual components and the engines themselves to see how they will react in launch conditions and in space.

On October 25, 1961, NASA announced plans to build a rocket engine test site in Hancock County, Mississippi. The facility, subsequently named Stennis Space Center (Stennis), began propulsion testing to certify all first and second stages of the Saturn V rocket for the Apollo program, which began in April 1966 and continued through the early 1970s.[1] Beginning in 1975 and continuing for 34 years to 2009, all the main engines used to boost the Space Shuttle into low Earth orbit were flight-certified at Stennis.

NASA's Stennis Space Center

Stennis is the nation's largest rocket propulsion test site, supporting a range of government and commercial test projects.

Source: NASA

In May 1996, NASA designated Stennis as the Agency's lead rocket propulsion test (RPT) Center, and in 2005 it became home to NASA's RPT Program Office. Over the years, Stennis has evolved into a multidisciplinary facility, housing NASA and more than 40 other agencies engaged in national defense, space, and environmental programs. Meanwhile, Stennis continues to test and flight-certify large-thrust engines and engine systems. Stennis also performs propulsion component testing, smaller thruster and engine testing, and subscale testing systems for both commercial and government entities.[2]

Propulsion testing continues to serve a vital role supporting several NASA programs and technology developments to make future missions safer and more affordable. In support of these efforts, NASA's RPT assets are located at several Centers. For example, Stennis has tested engines and the core stage for

[1] The Saturn V rocket was a NASA-built heavy-lift vehicle used in the Apollo Program, which took American astronauts on 11 space flights (the first of which was in 1968) and to the surface of the Moon.

[2] Subscale flight testing uses a smaller model to gain knowledge about the full-scale model of an engine, aircraft, etc.

the Space Launch System (SLS) as part of the Artemis campaign.[3] Also, White Sands Test Facility (White Sands) in New Mexico has 10 test stands capable of testing rocket propulsion systems and certification testing of space propulsion systems in various altitude conditions for crewed and uncrewed spacecraft.

In this audit, we assessed whether NASA is effectively and efficiently managing its portfolio of RPT capabilities. Specifically, we determined whether NASA established adequate internal controls to ensure compliance with National Rocket Propulsion Test Group (NRPTG) and Rocket Propulsion Test Management Board (RPTMB) operating procedures, and effectively aligned the RPT capability portfolio for changes in RPT future demand and increased commercialization. Details of the audit's scope and methodology are outlined in Appendix A.

NASA's RPT Program

The RPT Program was established in 1997 and strategically manages the Agency's chemical propulsion test capabilities. In this role, the Program provides an entry point for internal and external customers interested in using any of NASA's rocket test facilities. The RPT Program evaluates customers' test requirements and their desired outcomes. The Program makes test assignments considering both the customers' interests and the program's strategies for efficient, effective capability sustainment. The Program supports test requirements for NASA, commercial entities, and other government agencies and international partners.

Per NASA policy, the RPT Program is defined as a capability portfolio management program intended to ensure the assets necessary to provide a core capability of infrastructure and critical skills for current and future propulsion testing are maintained.[4] As such, the Program is responsible for the Agency's RPT assets located at eight NASA Centers and facilities, including Glenn Research Center at Armstrong Test Facility and Lewis Field (Glenn-ATF and Glenn-LF), Kennedy Space Center (Kennedy), Marshall Space Flight Center (Marshall), NASA Engineering and Safety Center (NESC), Stennis, Wallops Flight Facility (Wallops), and White Sands.[5] Each of the locations have various RPT capabilities as shown in Table 1.

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[3] With the Artemis campaign, NASA plans to explore the Moon for scientific discovery, technology advancement, and to learn how to live and work on another world as the Agency prepares for human missions to Mars. Artemis I, launched in November 2022, was the first in a series of increasingly complex missions to enable human exploration at the Moon and future missions to Mars. NASA's SLS is a super heavy-lift launch vehicle. The SLS core stage supports the weight of the payload, upper stage, crew vehicle, thrust of four RS-25 engines, and two solid rocket boosters.

[4] NASA Policy Directive (NPD) 8600.1, *Capability Portfolio Management* (November 30, 2018) and NASA Procedural Requirements (NPR) 8600.1, *NASA Capability Portfolio Management Requirements* (April 22, 2019). NPD 8600.1 establishes the responsibilities of Agency officials in the management of the capability portfolios. NPR 8600.1 defines a capability portfolio as a specific collection of functionally similar site-specific capability components and enabling infrastructure strategically and centrally managed together to meet NASA's strategic goals and objectives.

[5] NESC does not have RPT specific assets. However, they serve as the interface to a broad range of technical expertise across the Agency and private enterprise to help resolve complex technical issues.

Table 1: NASA's RPT Capabilities by Location

NASA Location	RPT Capabilities
Glenn-ATF	Tests full-scale upper stage launch vehicles and rocket engines under simulated space conditions.
Glenn-LF	Develops advanced chemical propulsion concepts and evaluates safer propellants for launch vehicles, spacecraft thrusters, and advanced ignition systems for next-generation launch vehicles.
Kennedy	Provides propulsion-related technology development, testing, and evaluation, as well as aerospace fluid acquisition and management support.
Marshall	Tests components, subsystems, subscale motors, and full-scale engines under a variety of configurations and conditions.
NESC	Performs independent testing, analysis, and assessments of NASA's high-risk projects to ensure safety and mission success.
Stennis	Tests and flight-certifies large-thrust engines and engine systems. Propulsion component testing, smaller thruster and engine testing, and subscale testing systems.
Wallops	Operates primarily as a rocket launch site to support science and exploration missions. Also provides mobile telemetry, tracking, and range safety services.
White Sands	Conducts hazardous testing focused around in-space propulsion systems and hypergolic propellants.[a]

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

[a] Hypergolic fluids are toxic liquids that react spontaneously and violently when they contact each other. These fluids are used in many different rocket and aircraft systems for propulsion and hydraulic power.

The RPT Program's primary objectives include efficiently managing RPT; maintaining infrastructure and critical skills for current and future propulsion testing; and helping customers obtain safe, efficient, and cost-effective test services. The RPT portfolio's primary customers are NASA programs and projects that require ground test capabilities. The portfolio's primary stakeholders include the Space Operations Mission Directorate (SOMD), the Exploration Systems Development Mission Directorate, NASA Centers with RPT assets, the Office of the Chief Engineer, and the Office of Safety and Mission Assurance.[6] The U.S. commercial space industry and DOD also use NASA RPT portfolio assets.

RPT Program Office

The RPT Program Office provides the program management structure necessary to optimize utilization of NASA's RPT assets. The office's capabilities include facilities, infrastructure, workforce, data, and technologies. The RPT Program sustains test capabilities supporting launch and in-space operations and the advancement of rocket engine materials, components, designs, and concepts. The Program focuses on rebalancing and applying existing resources to better posture RPT capabilities to meet priority needs, reduce risks, close gaps in test abilities, and eliminate excesses. The RPT Program funds much of the

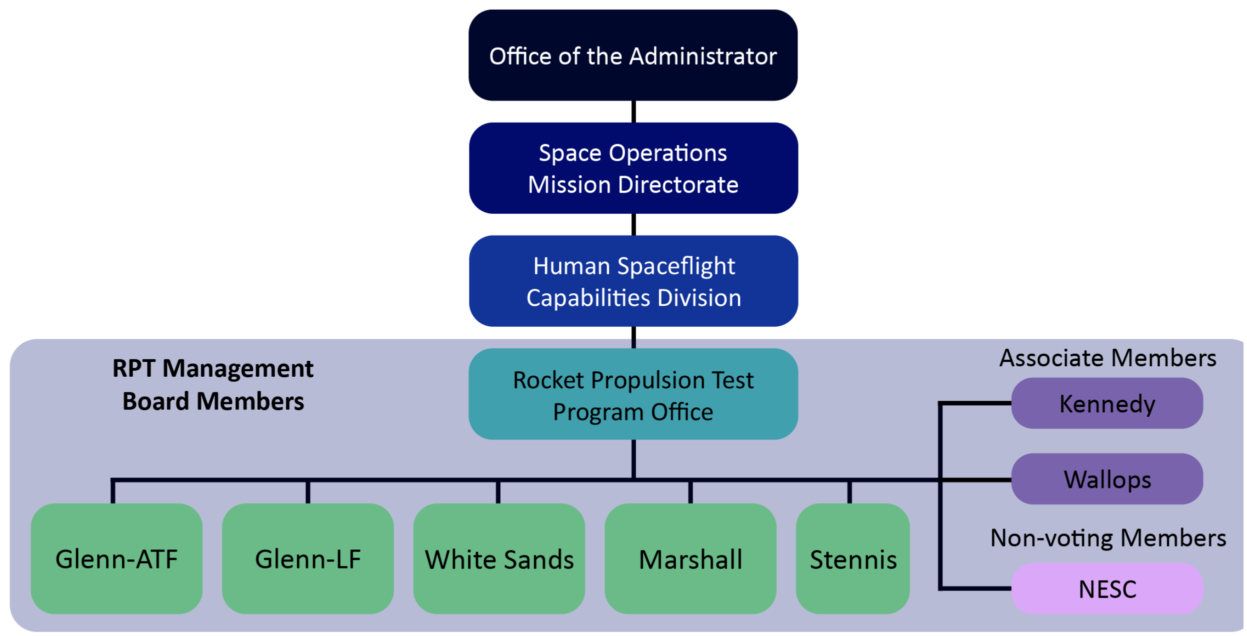
[6] NASA's SOMD is responsible for enabling sustained human exploration missions and operations in our solar system. The Exploration Systems Development Mission Directorate defines and manages systems development for programs critical to NASA's Artemis campaign and planning for NASA's Moon to Mars exploration approach. The Office of the Chief Engineer serves as the principal advisor to the Administrator and other senior officials on matters pertaining to the technical readiness and execution of NASA programs and projects. The Office of Safety and Mission Assurance assures the safety and enhances the success of all NASA activities through the development, implementation, and oversight of Agency-wide safety, reliability, maintainability, and quality assurance policies and procedures.

routine activities that sustain the test facilities, including core test and engineering skills. From fiscal year (FY) 2019 to FY 2023, the RPT budget ranged from $60 million to $48.2 million.[7] The Program requested $48.6 million for FYs 2024 and 2025, and the same amount is projected through FY 2029.

Rocket Propulsion Testing Management Board

The RPTMB is the principal authority of the RPT Program Office and serves as NASA's RPT decision-making body. RPTMB members include the RPT Program Office and the RPT capability Centers shown in Table 1. In accordance with its operating procedures, the RPTMB reviews, approves, and provides direction for all RPT assignments, including all major facility modifications or refurbishments; annual budget requirements; multi-site test activities; and all key decisions. The RPTMB provides potential customers with cost estimates and proposals for RPT-related activities. Figure 1 shows the organizational structure of RPT at NASA.

Figure 1: RPT Organization at NASA



Source: NASA OIG presentation of Agency information.

NASA and DOD Collaboration

In April 1996, NASA and DOD agreed to work together more efficiently and effectively in six categories of major test facilities, one of which was rocket propulsion.[8] In September 1996, Congress directed NASA and the DOD to collaborate in this area.[9] In 1998, NASA and DOD entered into an agreement and

7 Only in FY 2019 did the RPT Program receive an additional funding allocation of $12 million to address critical repairs and upgrades needed throughout the portfolio; otherwise, the budget has been flat at about $48 million.

8 The other five categories include wind tunnels, air-breathing propulsion, space environmental, hypervelocity ballistic range/impact, and arc-heated facilities.

9 National Defense Authorization Act for Fiscal Year 1997, Pub. L. No. 104-201 (1996).

formed the National Rocket Propulsion Test Alliance (NRPTA) to shape U.S. RPT capability to efficiently meet national test needs through intra- and inter-agency cooperation. The scope of NRPTA was outlined in a memorandum of understanding. In 2021, the NRPTA transitioned from that memorandum of understanding, executed every 5 years between NASA and DOD, to the NRPTG.[10]

NRPTG

The purpose of the NRPTG is to ensure continued cooperation between NASA and the DOD for efficient and effective use of government investments in RPT facilities. Figure 2 shows the current members of the NRPTG.

Figure 2: NRPTG Members

Source: NASA OIG presentation of Agency information

Note: Associate members are U.S. government ranges, facilities, agencies, offices, or organizations not directly associated with the full members, that participate in the NRPTG.

The NRPTG operates as a community of practice for technical exchange, shared insight, coordination, and potential cost savings. The RPT Program Office maintains a list of NASA RPT capabilities, capacities, and plans for investment and divestment, which is available to NRPTG members. The NRPTG provides value to the participating agencies by sharing best practices, striving to improve efficiency between facilities, and creating awareness of community capabilities and schedules. The NRPTG Executive Secretary stated that the primary value of the NRPTG is to its members, as they benefit from the related experience and solutions enacted by the community to challenges facing the rocket test industry at large. In addition, according to the NRPTG Executive Secretary, NASA and DOD coordination within the NRPTG, often in the form of equipment loans, has helped achieve approximately $50 million in cost savings since the group's inception.

[10] The NRPTG is a standing group within DOD's Range Commanders Council. The standing groups are the primary means of exchanging technical and operational information and coordinating and standardizing systems, techniques, methods, and procedures among Council participants.

Prior NASA Office of Inspector General Reviews

There have been two prior NASA Office of Inspector General (OIG) reviews on the RPT Program. In 2008, our office identified inadequate coordination with the NRPTA (now NRPTG) before building the A-3 rocket test stand for J-2X engine testing at Stennis.[11] NRPTA members claimed the A-3 test stand's capabilities could have been implemented at an existing Air Force facility and collaboration could have prevented NASA from building a test stand that would require further modifications and associated costs immediately after completion.

The dual-position B Test Stand at NASA's Stennis Space Center in Mississippi.

Source: NASA

In 2014, we conducted an audit of NASA's decision-making process for SLS core stage testing, for which NASA refurbished the B-2 test stand at Stennis for this new heavy-lift rocket.[12] The OIG determined that while NASA coordinated with DOD before implementing modifications to the abandoned B-2 test stand, NASA's RPTMB did not allow ample time for all appropriate parties to respond with comprehensive proposals. Specifically, NASA only received limited input, including rough cost estimates, from DOD and another NASA Center that could have performed the test. However, the submissions indicated that NASA could have saved time and millions of dollars by refurbishing one of two existing test stands located at the Air Force Research Laboratory and at Marshall. During both OIG reviews, we found that NASA failed to adequately collaborate with necessary parties and comply with the NRPTA review and approval process.

[11] NASA OIG, *Final Memorandum on the Review of NASA's Plan to Build the A-3 Facility for Rocket Propulsion Testing* (IG-08-021, July 8, 2008).

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

NASA's Testing Infrastructure Is Aging, Costly to Maintain, and Facing a Declining Customer Base

The landscape of rocket propulsion testing is changing, and demand for NASA's large-scale rocket propulsion testing capabilities is in decline. Factors including the rapid growth of the commercial space industry and a flat budget profile are challenging the RPT Program's ability to manage its portfolio. While NASA has taken preliminary actions to align its portfolio to an evolving rocket propulsion testing environment, additional measures are needed to adequately prepare the Agency for the future.

Historic Investments in Rocket Propulsion Testing Capabilities

Test stands for large rocket propulsion systems cost hundreds of millions of dollars to build or refurbish and may sit idle for many years after the end of programs for which they were built. NASA made significant investments in large-scale testing during the Apollo, Space Shuttle, and Constellation programs.[13] For example, NASA began construction on the B-2 test stand at Stennis in 1963. The stand is currently the largest full-scale liquid rocket test stand in the United States. NASA used the stand to test the Saturn V rocket from 1967 to 1970, the Space Shuttle main engines from April 1978 through January 1981, and the Boeing Common Booster Core in 2001.[14] Marshall's 4670 test stand, built in 1965, also supported the Apollo program. NASA later modified the stand as part of the Space Shuttle program, using it to test the Shuttle's RS-25 engine and external tanks between 1976 and 1999.[15] In 2013, at a total cost of $349 million, NASA completed construction of the A-3 test stand specifically for the J-2X upper stage testing as part of the Constellation program.[16]

In support of the SLS Program and Artemis campaign, NASA completed refurbishments to the B-2 test stand to test the core stage of the SLS in 2017 at a cost of $230 million. In 2016, NASA spent $53.7 million and $22.3 million to construct Marshall's 4693 and 4697 test stands, respectively. While not part of the RPT portfolio, these stands were designed to perform load testing of SLS liquid oxygen and liquid hydrogen tanks to simulate the conditions the tanks will experience during launch as part of

[13] The Space Shuttle program (1972 to 2011) was NASA's fourth human space flight program and the first to use a reusable spacecraft to carry humans into orbit. The Constellation program (2005 to 2010) was formed to maintain American presence in low Earth orbit, return to the Moon to establish an outpost, and lay the foundation to explore Mars and beyond.

[14] The Common Booster Core consists of a 656,000-pound-thrust main engine, liquid-oxygen and hydrogen tanks, and avionics. The Core allows all five variants of the Delta IV family of rockets to use common systems and assemblies.

[15] The RS-25 is one of the most tested large rocket engines in history, with more than 3,000 starts and more than 1 million seconds of total ground test and flight firing time. During the Space Shuttle program, the RS-25 underwent several design updates to improve service life, durability, reliability, safety, and performance.

[16] The J-2X next generation engine was intended to provide upper-stage power for NASA's SLS.

the Artemis missions. See Appendix B for a table of NASA's test stands and a description of their capabilities.

Decreased Utilization of Legacy Assets

Much of the RPT program's test support infrastructure is aging and has limited use for NASA customers. Per the Agency's FY 2025 budget request, from the beginning of FY 2022 through FY 2026, utilization of RPT assets by NASA and its customers is projected to steadily decrease.[17] Specifically, the number of test stand capabilities being actively used for testing went from 18 of 38, to a projected 10 of 38, an expected decrease in overall utilization from 47 percent to 26 percent over the 5-year period. Further, 5 of the 10 test stand capabilities projected to be used in FY 2025 are being leased to commercial entities.

As of the latest budget request, five of the Program's test stand capabilities were in mothball or demolition status.[18] For example, NASA last used test stand 402 at White Sands for the Delta Clipper program in the mid-1990s.[19] The facility has been in mothball status for 20 years and is slated for demolition in FY 2025.[20] In addition, the RPT Program struggled for years to find customers for the A-2 and A-3 test stands at Stennis—neither of which had been used for nearly a decade. A-2 was last used by a NASA customer in 2013 for J-2X testing. Following test completion, the stand was placed into mothball status in 2014 until Relativity Space entered into a 7-year lease in July 2023. The A-3 test stand was mothballed in 2013 following the Agency's determination that the stand's unique testing capabilities would not be needed for the Constellation program. It remained mothballed until Rocket Lab USA leased it in October 2022.

See Figure 3 for a breakdown of the RPT Program's test stand capability utilization. See Appendix C for the Agency's RPT Program consolidated test stand utilization chart as provided in the Agency's FY 2025 budget request.

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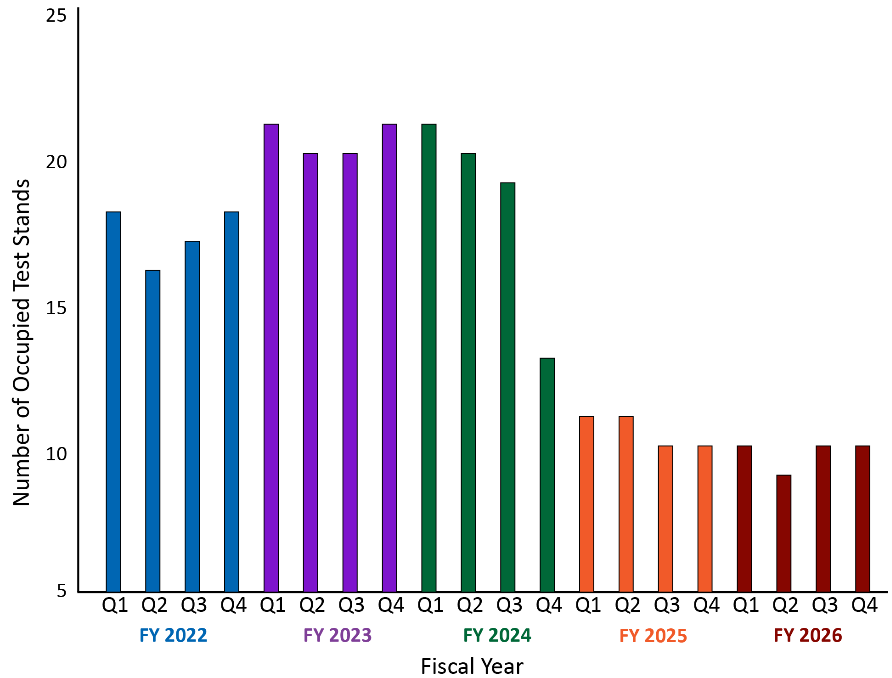
17 The utilization schedule is primarily based on actual agreements and those agreements being drafted for approval. Inquiries and potential future negotiations are not reflected in the projected data.

18 Mothball status refers to facilities that have been deactivated, but maintenance measures have been taken to prevent deterioration of essential systems. This generally results in higher first-year costs, but future annual costs are lower due to reduced maintenance and repair requirements.

19 NASA funded the Delta Clipper program to test vertical takeoff and landing. The program was canceled in 1996 after an accident and lack of funding.

20 According to White Sands officials, NASA has spent $3,000 annually over the last 10 years and there has been no cost associated with the stand since 2020.

Figure 3: Number of RPT Program Test Stand Capabilities Occupied (Actual and Projected) through FY 2026



Source: NASA OIG presentation of Agency information provided in Agency's FY 2025 budget request.

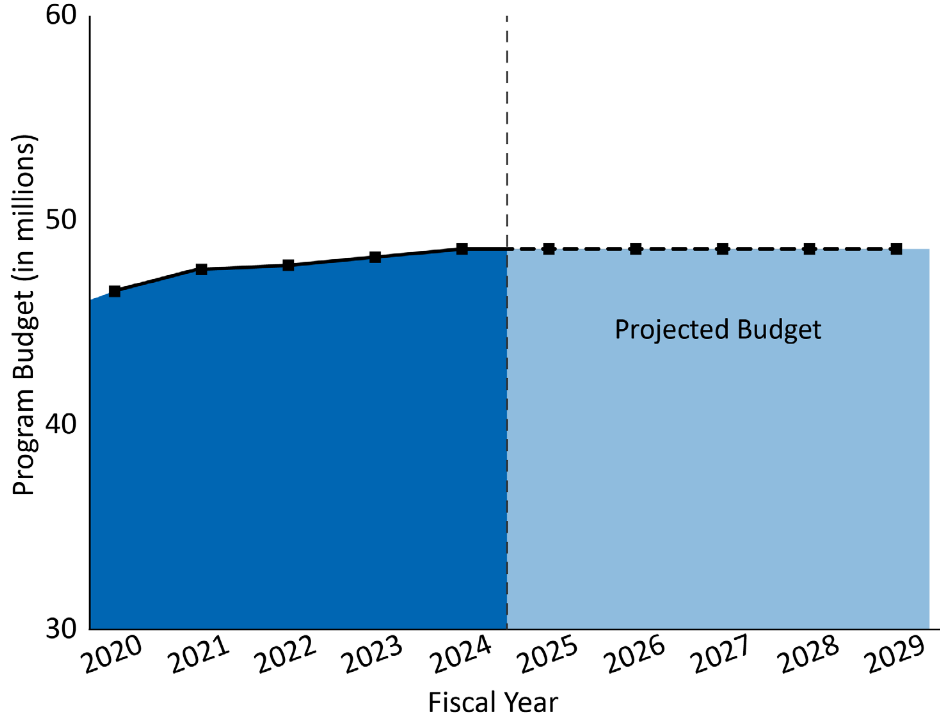
The decreased use of these large-scale legacy RPT assets is primarily due to a change in NASA demand for large-scale engine testing. Currently, the only large-scale testing for NASA is in support of the Artemis missions. The Agency foresees no need for new large-scale testing after FY 2026. NASA intends to use the A-1 test stand to support RS-25 engine testing for the duration of the Artemis campaign and complete Exploration Upper Stage testing on the B-2 test stand. The Agency has not identified any follow-on customers for these stands. NASA will need to develop a plan for A-1 and anticipates making B-2 available for lease once these engine tests are complete.

Several Factors Limit NASA's Ability to Effectively Manage the RPT Portfolio

Flat Budget

Since 2020, the RPT Program has been operating at an annual budget of approximately $46 to $48 million; the budget is projected to remain flat at $48.6 million through FY 2029 (see Figure 4). This level of funding maintains core test and engineering crews, test stand facilities, and supporting infrastructure. However, the RPT Program is not sufficiently funded to address the major maintenance or recapitalization needed as assets age or undergo large-scale repairs. Instead, NASA Centers, programs, or mission directorates fund these investments through construction of facilities budgets or as part of the program and project development cost when using the test assets. According to a Human Spaceflight Capabilities Division official, the RPT Program has never had the budgetary resources to ensure the full portfolio of facilities is available for testing all the time. Instead, the Program balances resources and risks, sustaining testing facilities at differing levels of readiness, from fully active, to levels considered decommissioned, and even abandoned in place.

Figure 4: RPT Program Budget (in Millions)



Source: NASA OIG presentation of information as provided in the Agency's FY 2025 budget request.

The Program's flat budget and decreased NASA customer demand put more burden on the Program to fund maintenance, necessitating a further reduction in operational costs. For example, the RPT program manager stated that the RPT capability at Stennis is operating at a $12-million deficit each year. Given this funding deficit, the RPT Program is unable to prevent further degradation of its infrastructure and must prioritize its investments.

Commercialization

Global space launches continue to increase in frequency, with U.S. space launch companies supplying a significant portion of the rockets used to power these flights. The increased commercialization of rocket propulsion has lessened the demand for large-scale rocket propulsion testing at NASA. In some cases, commercial entities do not require test stands. For example, SpaceX routinely conducts testing on its own launch pad and in flight, instead of doing component-level engine testing as NASA routinely does when developing a new engine.[21] In March and June 2024, SpaceX's Starship conducted its third and fourth test flights from Starbase in Texas.[22] Per SpaceX, "While [the third flight] didn't happen in a lab or on a test stand, it was absolutely a test. What we achieved on this flight will provide invaluable data to continue rapidly developing Starship." NASA has also transitioned to a more service-based, commercial payload delivery strategy negating much of the previously required testing at NASA facilities.[23] For example, under task orders for NASA's Commercial Lunar Payload Services, commercial partners are responsible for end-to-end payload delivery, including integrating the payload into the lunar landers, launch from Earth, and landing on the Moon.

SpaceX Starship Test Flight

SpaceX launched the third integrated flight test of its Super Heavy booster and Starship upper stage from the company's Starbase orbital launch pad on March 14, 2024

Source: SpaceX

NASA Is Working to Align its RPT Capability Portfolio with Declining Customer Demand, but Challenges Remain

Aging, costly facilities and diminishing demand for large-engine testing make it difficult for the RPT Program to sustain its test infrastructure and technical services. The Program is working across all RPT Centers to ensure the appropriate costs are charged to the users of test infrastructure and to improve associated cost models. The Program also continues to seek cost-sharing opportunities with NASA programs, Centers, and mission directorates. According to RPT program officials, they intend to lease or demolish underutilized facilities to reduce maintenance costs and make funds available for additional facilities maintenance and modernization (FM&M) projects. According to the RPT program manager, the Program's primary objectives are meeting customer needs, transforming Stennis capabilities, ensuring pricing structures are appropriate, and reassessing capital investments and maintenance.

[21] SpaceX has used NASA's E-1 and E-2 test stands to perform component level testing when developing new engines or making major modifications to existing engines when they needed additional or different capabilities than their own.

[22] SpaceX's Starship spacecraft and Super Heavy rocket—collectively referred to as Starship— form a reusable transportation system designed to carry crew and cargo. Development and manufacturing of Starship takes place at Starbase, a commercial spaceport in Texas. Since 2020, SpaceX has performed multiple test flights of Starship from Starbase.

[23] A payload is what a vehicle carries, including crew members, scientific instruments, and supplies.

NASA Has Assessed Future Demand and Its Mix of Capabilities.

Between 2020 and 2023, NASA conducted multiple studies to assess the future demand and appropriate mix of RPT capabilities.

Right-Size Studies

NASA conducted right-size studies in 2012 and 2020 to help determine the appropriate alignment of RPT capabilities with future demand. SOMD conducted the latest study to determine the optimal mix of capabilities to meet Agency requirements and constraints most effectively and efficiently and to align capabilities with demand through calendar year 2030. Based on the results of the study, in April 2021, SOMD made recommendations to divest from test stands A-2 and A-3 at Stennis and test stand 402 at White Sands.[24] The study also identified next steps for the RPT Program, including identifying funding implications of further decommissioning A-2 and A-3 and addressing Stennis issues within the current budget profile.

While the RPT Program is required to ensure that its capability components are needed and to develop and maintain a master plan that includes strategic planning and operations of RPT to align with forecasted requirements, there is no requirement to conduct recurring right-size studies (e.g., every 5 years) of its capability portfolio. In our discussions with senior SOMD officials, they acknowledged the importance of the right-size studies in determining whether an asset is needed and worth maintaining, adding that NASA should be conducting such studies for all its capability portfolios. We agree that the changing demand in RPT necessitates recurring examination of workforce and capability requirements.

Future State Initiative

In 2022, a senior Stennis official completed a multi-year study entitled “Future State Initiative: Adapting to a Changing Propulsion Test Services Market” designed to help the RPT Program adapt to NASA’s and the industry’s evolving RPT landscape and future demand. The study team assessed weaknesses and challenges in testing at Stennis, from both industry and internal perspectives, which led to a series of recommended actions. For example, the study team identified ways to improve processes and cost efficiency, such as establishing common interfaces for high-pressure facilities and gas distribution, and revamping controls of the E-Complex—three test facilities used for small rocket engine and component test projects—to increase efficiency. In response, the Program is incrementally funding projects to address each of the challenges identified within its funding limits, including the first of two phases of work for the high-pressure facilities in FY 2025. In addition, the Program expects to complete both the common interface project and the E-Complex controls systems upgrade in 2026.

Commercial Capability Survey

The evolving level and nature of NASA testing demand and the rapid growth of commercial space have resulted in significant change and uncertainty in future RPT demand and utilization. The RPT Program's most recently drafted program plan establishes a goal to study both commercial and government test capabilities to further understand implications to NASA’s RPT. Most recently, in October 2023, NASA began a survey of current and in-development rocket propulsion testing capabilities at commercial, governmental, and academic facilities. According to program officials, this data will help the RPT

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[24] The RPT Program uses the term “divest” to indicate that NASA is no longer responsible for the upkeep of the asset (for example, it is under lease), or that NASA is demolishing the asset, as is planned for test stand 402 at White Sands in 2025.

Program better understand where the propulsion industry is heading and what NASA and the industry need going forward in terms of capabilities. The study also intends to assist the RPT Program Office with strategic planning for its capabilities and engagement with industry and academia.

The RPT Program is Right-sizing to Meet Future Demand

Based on the results and recommendations of the 2020 right-size study and the expected further decline in large-engine testing, NASA is strategically divesting from specific testing facilities. The Agency is also increasingly using leases to divest from underutilized test capabilities. To meet future test demand levels, NASA is investing in its busiest test facility, the E-Complex at Stennis. The Program is also piloting a new cost model to pass on maintenance and usage costs to customers.

Leasing

Five test stands are currently under lease, including A-2 and A-3 at Stennis as well as 4670 at Marshall. According to NASA officials, leasing test stands removes some of the financial responsibility for the operations and maintenance costs, allowing those funds to be directed to other critical maintenance or investments within the portfolio. Leasing test facilities also allows commercial entities to avoid the costs and time required to build their own facilities. Additionally, NASA prefers leasing the asset over demolition because the funding brought in under a lease helps offset infrastructure modernization costs and avoids the potential cost of demolition. For example, NASA estimates that the demolition of A-2 would cost the Agency approximately $50 to $70 million.

In response to the recommendations in the 2020 right-size study, the RPT Program divested from two of its legacy large-engine test stands by leasing them to commercial entities. Specifically, in October 2022, NASA leased the A-3 test stand to Rocket Lab USA for approximately $3.4 million.[25] In July 2023, an existing lease with Relativity Space was amended to add 30 acres of land and the A-2 test facility for 7 years, for a cost of approximately $2.7 million.[26] These two leases continue until October 2032 and July 2030, respectively, and can be extended for 10 more years. Additionally, in April 2019, NASA leased Marshall's test stand 4670 to Blue Origin for 20 years for approximately $11 million.

Over the last 3 years, the RPT Program's use of leases has led to a total cost avoidance of approximately $400,000 to $500,000 per year. RPT officials stated that the Program will continue to seek additional opportunities for commercial companies to lease NASA test facilities. For example, program officials indicated they plan to make the B-1 and B-2 test stands available for lease following completion of Exploration Upper Stage testing. According to the RPT program manager, discussions about leasing at other RPT Centers are ongoing.

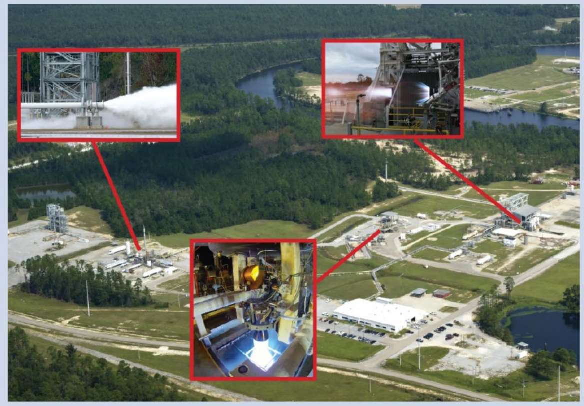
[25] In November 2022, Rocket Lab USA announced that it would use A-3 to develop and test its Archimedes engines to be used on the company's reusable Neutron rocket.

[26] In September 2023, Relativity Space announced that it would use A-2 to develop its Terran R medium-heavy lift reusable launch vehicle. In addition to the large-scale A-2 test stand, the company also occupies several operational facilities at Stennis E-Complex. These include the four test stands at E-4 and two test stands at E-2, as well as a commercial use agreement for the E-1 site.

Investing in the E-Complex at Stennis

In response to changing demand for test services, the RPT Program evaluated options to better support internal and external test needs. With most Stennis testing completed at the E-Complex, the RPT Program indicated that future funding at Stennis will likely prioritize investments there to improve the state of technology and ensure critical skills. The three-stand complex includes seven separate test cells that can support testing with ultra high-pressure gases and cryogenic fluids. For example, the E-1 Test Facility is used for component development testing of combustion devices, turbo-pump assemblies, and other rocket components and engines requiring high flow rates and ultra-high pressure. According to RPT program officials, these changes at the complex are needed to sustain critical capabilities for the Agency, as well as to ensure the future success of Stennis and the commercial entities that rely on the expertise and test support provided there.

The E-Complex at Stennis Space Center



Source: NASA

Currently, the RPT Program is making incremental investments at the complex in areas such as power generation, cryogenic propellants delivery, and high-pressure gas distribution to improve operational efficiencies while reducing the burden of future operations and maintenance costs to the RPT Program and the test customers. The Program intends to use any savings realized to invest in upgrades to capabilities in the E-Complex. Specifically, the RPT Program identified enhancements to the current system interfaces and core capabilities at E-1 that can improve efficiencies and make services more affordable and responsive.

Implementing a New Cost Model

Historically, the RPT Program funded most of the operations and maintenance costs for RPT facilities used by NASA customers, as Centers did not charge customers for maintenance. However, the RPT Program is piloting a new cost model at Stennis to pass on maintenance and usage costs to both internal and external customers so that the Program avoids subsidizing the costs of test stand maintenance. In FY 2023, the RPT Program began transferring some budget responsibility for the operations and maintenance of occupied large test facilities (such as the A-1 test stand supporting RS-25 engine testing) from the RPT Program to the NASA test customer (in this case, the SLS Program).

This change in the cost model is designed to transfer maintenance costs that are based on usage, such as high-pressure industrial water, high-pressure gas, cryogenic propellants, and emergency power generation, to the customer when a test stand is dedicated to that customer's sole use over multiple years. NASA has used this method for other programs, such as the Space Communication and Navigation program, which takes the costs of building stations and their life expectancy into account and passes on these costs to customers.[27] Moreover, the Stennis Chief Financial Officer stated that implementing this cost model could bring up to $1 million per year to the Center.

[27] The Space Communication and Navigation program serves as the program office for all of NASA's space communication operations.

The RPT Program plans to implement similar cost models at all RPT Centers and is working collaboratively with leadership at those Centers. According to the RPT program manager, the Program is conducting an assessment to evaluate additional changes needed to implement a consistent pricing policy across RPT Centers. The RPT Program is working with the Glenn, Marshall, and White Sands facilities to update their cost models. NASA's Director of the Human Spaceflight Capabilities Division supports this initiative and expects the new model to make a significant difference for the RPT Program once implemented across the Centers.

RPT Program Could Benefit from a Clearer Authority Structure and Formalized FM&M Process

NASA Policy Creates an Unclear Authority Structure

NASA Procedural Requirements (NPR) 8600.1 requires capability portfolio managers to "facilitate value-added consistency and standardization across capability components in developing processes for providing products and services," and "establish, maintain, and update processes and guidelines for developing cost estimates for delivering products and services to customers." However, this policy also establishes duplication in some of the assigned responsibilities. Per the policy, program managers are responsible for obtaining concurrence for investments, divestments, acquisition strategies, procurements, agreements, and changes to portfolio capability components. This same responsibility is given to the Center Director for their Center's capability portfolio components. Additionally, the policy establishes duplicate responsibilities for the Center Director and the program manager in providing proposals to Agency leadership for changes to the capability portfolio.

These duplicate responsibilities make it unclear who has the authority to implement decisions that affect the entire RPT portfolio, such as the new cost model. In our discussions with SOMD, the RPT Program Office, and Center officials, they provided conflicting understandings of whether the RPT program manager or the Center Director has the ultimate authority to implement the new cost model and agreed that the policy lacked clarity. Without a clear delineation of authority, the Program may be unable to consistently implement the new cost model across all RPT Centers. According to program officials, the Agency is revising NPR and NASA Policy Directive (NPD) 8600.1, both of which expire in November 2024, and intends to clarify the authority structure.

The RPT Program Lacks a Formal Policy for FM&M Prioritization

The RPT Program uses an annual FM&M prioritization process to evaluate top capability risks and investment needs. This process prioritizes funding to competing projects of varying interest, risk, and future need.

Each RPT Center submits their annual FM&M project proposals for review by the RPTMB. These proposals include detailed risk statements, a description of the project and how it mitigates the risks, and the potential benefits of the proposed project. Each RPT Center reviews and scores the submissions. Next, the scores are aggregated, ranked, and presented to the RPT program manager—who was excluded from the earlier phase of the process—to select the projects to fund that year. The Program uses approximately 10 percent of its annual budget for FM&M efforts. Due to limited funds, the RPT

Program’s FM&M efforts are often denied, postponed, or broken down into smaller projects to fit within the Program’s budget constraints.[28]

NPR 8600.1 requires that the RPT Program establish processes, operational norms, and thresholds for strategically and centrally managing the capability portfolio and its components in governing documents. The FM&M process appears to be an effective method to review and prioritize FM&M projects with the Program’s limited funding. However, this process, which the Program routinely relies on to make funding decisions that impact NASA’s RPT capability portfolio, is not established in any formal governing documents.

[28] Recently denied or postponed FM&M efforts include layer pressure vessel replacements at Marshall and heating, ventilation, and air conditioning system projects at two NASA Centers.

CONCLUSION

Developing and testing rocket propulsion systems is foundational to safe and successful space flight. Due to a large degree of change in NASA and industry RPT demand, the Agency must be more effective and efficient in meeting its RPT requirements. Specifically, the Agency is facing challenges managing its RPT program: declining demand for NASA's large-scale RPT, the rapid growth of the commercial space industry, a flat budget, and unclear lines of authority. Although NASA has taken multiple proactive measures to align its RPT capability portfolio to an ever-changing environment, including strategic divestments and a revised cost model, NASA will need to continuously reexamine the RPT capability portfolio to determine core workforce and capability needs and, in light of increasing commercialization, its role in the future of rocket propulsion testing.

Recommendations, Management's Response, and Our Evaluation

To ensure the RPT capability portfolio is adequately prepared for the future, we recommended the Associate Administrator for SOMD direct the RPT program manager to:

1. Establish a requirement in the RPT Program Plan for recurring right-size studies for the RPT capability portfolio and use the results to reexamine workforce and capability requirements for the future.
2. Ensure that cost models deployed at all RPT Centers include full recovery of applicable maintenance costs for the infrastructure and facilities being utilized, similar to that being piloted at Stennis.
3. Formally document and establish the FM&M process in the RPT Program Plan or RPTMB Operating Procedures.
4. Document the results and planned RPT actions following completion of the Commercial Capability Survey.

In addition, we recommended the Assistant Administrator for the Office of Strategic Infrastructure:

5. Ensure that the appropriate revisions are made to NPR and NPD 8600.1 to clarify the authority structure.

We provided a draft of this report to NASA management who concurred with our recommendations and described planned actions to address them. We consider management's comments responsive; therefore, the recommendations are resolved and will be closed upon completion and verification of the proposed corrective actions.

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

Major contributors to this report include Raymond Tolomeo, Science and Aeronautics Research Audits Director; Sarah Beckwith, Assistant Director; Theresa Becker; Derek Gainsboro; Gregory Lokey; and Courtney Daniels.

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

George A. Scott

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George A. Scott
Deputy Inspector General

Appendix A: Scope and Methodology

We performed this audit from September 2023 through August 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

In this report, we assessed whether NASA effectively and efficiently managed its portfolio of RPT capabilities. We also assessed whether NASA considered commercial RPT capabilities when making decisions for RPT assignments and capital investments, NASA/DOD collaboration, RPTMB and NRPTG processes, and compliance with operating procedures.

Our assessment included a review of NASA documents and interviews with NASA officials from the RPT Program Office, Human Spaceflight Capabilities Division, and RPT Centers, as well as the Acting Center Director and Chief Financial Officer from Stennis. We also interviewed a DOD official. Our primary criteria for assessing the aforementioned practices and procedures were Pub. L. No. 104-201, NPD 8600.1, NPR 8600.1, RPTMB Operating Procedures, and the NRPTG Operations Guide.

Assessment of Data Reliability

The findings and conclusions of this report do not rely on computer-generated data.

Review of Internal Controls

We assessed internal controls and compliance with laws and regulations necessary to satisfy the audit's objectives. Specifically, we assessed RPT Program's compliance with internal operating procedures and plans, RPTMB and NRPTG processes, whether NASA considered commercial RPT capabilities when making decisions for RPT assignments and capital investments, and NASA Policy Directives and NASA Procedural Requirements applicable to the RPT portfolio. We identified internal control weaknesses with NPD 8600.1 relating to a lack of clarity in authority structure and RPT Program internal guidance relating to the FM&M process. Our recommendations, if implemented, will improve NASA's management of its RPT capability portfolio.

Prior Coverage

During the last 5 years, the NASA Office of Inspector General and Government Accountability Office have not issued any reports of significant relevance to the subject of this report.

Appendix B: Overview of NASA's RPT Capabilities

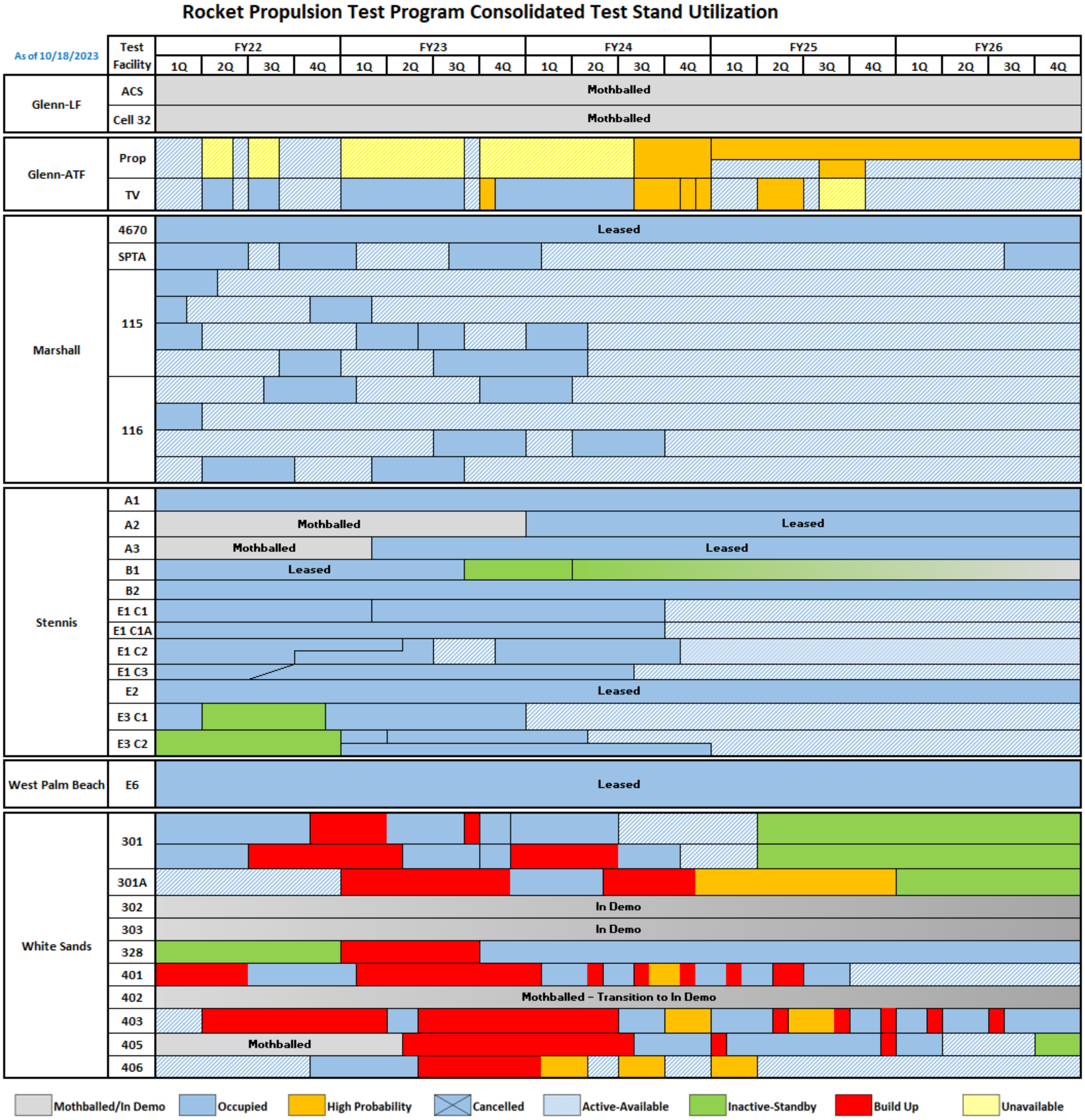
Table 2: Overview of NASA's RPT Capabilities

Location	Test Facility	Capability
Glenn-ATF	In-Space Propulsion facility	Testing of full-scale upper stage launch vehicles and rocket engines up to 50,000 pounds of thrust under simulated high-altitude conditions with or without thermal conditioning.
Glenn-LF	Altitude Combustion Stand facility	Testing of combustion components at a simulated altitude with up to 2,000 pounds of thrust and combustion chamber pressure to 1,000 pounds per square inch. Engines can be fired at sea level or to a simulated altitude up to 100,000 feet.
	Cell 32	Testing of combustion components at sea-level conditions. The system can accommodate engines with up to 2,000 pounds of thrust and chamber pressures of 1,000 pounds per square inch.
Marshall	115	Testing of small-scale combustion devices including injectors, combustion chambers, and nozzles with up to 10,000 pounds of thrust.
	116	Full- and sub-scale testing for component, system, and full-engine testing with up to 75,000 pounds of thrust.
	4670	Hot-fire testing of engines and stage-level propulsion systems with up to 750,000 pounds of thrust at ambient conditions in the vertical position.
	Solid Propulsion Test Area	Testing for solid-propulsion motors with up to 100,000 pounds of thrust in a vertical or horizontal test position.
Stennis	A1	Testing of engines and stages at sea-level conditions with up to 600,000 pounds of thrust.
	A2	Testing of cryogenic liquid rocket engines in a vertical position under simulated altitude conditions with up to 600,000 pounds of thrust.
	A3	Testing of cryogenic liquid rocket engines in a vertical position at ambient and simulated altitude conditions with up to 600,000 pounds of thrust.
	B1	Testing of articles and stages at sea-level conditions with up to 750,000 pounds of thrust.
	B2	Testing of articles and stages at sea-level conditions with up to 2 million pounds of thrust.
	E1	Testing of combustion devices, turbo-pump assemblies, and other engine systems with up to 500,000 pounds of thrust in a vertical position or 750,000 pounds of thrust in a horizontal position.
	E2	Testing of combustion devices and turbo-pump components with up to 100,000 pounds of thrust in a horizontal position or testing of flight stages with up to 324,000 pounds of thrust in a vertical position.
	E3	Testing of combustion devices, rocket engine components, and small/subscale engines and boosters with up to 60,000 pounds of thrust in a horizontal position or up to 25,000 pounds of thrust in a vertical position.
	E4	Never fully completed. Customers that lease this facility are responsible for building test capabilities.

Location	Test Facility	Capability
West Palm Beach	E6	Vertical hot-fire testing in altitude conditions with up to 30,000 pounds of thrust.
White Sands	301	Testing of stages, systems, or engines in ambient conditions with up to 25,000 pounds of thrust.
	301A	Testing of stage, system, or engines in ambient conditions with up to 180,000 pounds of thrust.
	302	Testing of components and systems in vertical or horizontal positions in altitude conditions with up to 1,000 pounds of thrust.
	303	Testing of stages, propulsion systems, and engines in altitude conditions with up to 25,000 pounds of thrust.
	328	Testing of supporting propulsion systems, including multiple engines with up to 1,000 pounds of thrust each, firing along different axes in ambient conditions.
	401	Testing of supporting stages and propulsion systems, as well as static engine testing, with up to 25,000 pounds of thrust.
	402	Testing of components, systems, and stages in a vertical position with up to 60,000 pounds of thrust in ambient conditions.
	403	Testing of supporting stages and propulsion systems, as well as static engine testing, with up to 25,000 pounds of thrust in altitude conditions.
	405	Static engine testing in a horizontal position with up to 1,000 pounds of thrust in altitude conditions.
	406	Testing of small systems, as well as static testing of single engines, with up to 1,000 pounds of thrust in altitude conditions.

Source: NASA OIG presentation of Agency information.

APPENDIX C: RPT PROGRAM CONSOLIDATED TEST STAND UTILIZATION



Source: NASA.

Appendix D: Management's Comments

National Aeronautics and Space Administration

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

Reply to Attn of: Space Operations Mission Directorate

TO: Assistant Inspector General for Audits

FROM: Associate Administrator for Space Operations Mission Directorate
Assistant Administrator for the Office of Strategic Infrastructure

SUBJECT: Agency Response to OIG Draft Report, "NASA's Rocket Propulsion Test Program" (A-23-13-00-SARD)

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review and comment on the Office of Inspector General (OIG) draft report entitled, "NASA's Rocket Propulsion Test Program" (A-23-13-00-SARD), dated August 7, 2024.

In this draft report, the OIG assessed whether NASA is effectively and efficiently managing its portfolio of Rocket Propulsion Test (RPT) capabilities. While NASA has taken multiple proactive measures to align its RPT capability portfolio to an ever-changing environment, the OIG found NASA will need to continuously reexamine the RPT capability portfolio to determine core workforce and capability needs and its role in the future of rocket propulsion testing.

NASA is concerned with the impression given that overall test demand is declining, particularly the statement that NASA test stands in active use are projected to decrease to 26 percent by 2026. Although the OIG breaks out the individual test stands into capabilities, if the occupancy rate is calculated based on the number of test stands, our occupancy rate is actually much higher. Additional demand does exist, and historical trends reflect a significant level of short-lead time demand requirements will mature. At this time, NASA believes testing of advanced technologies and newly developed NASA and commercial engines, thrusters, and components will remain strong over the timeframe assessed and will introduce new requirements beyond those identified in the assessed utilization schedules.

The OIG makes four recommendations addressed to the Associate Administrator for Space Operations Mission Directorate (SOMD) and one recommendation to the Assistant Administrator for the Office of Strategic Infrastructure (OSI)

Specifically, to ensure the RPT capability portfolio is adequately prepared for the future, the OIG recommends the Associate Administrator for SOMD direct the RPT program manager to:

Recommendation 1: Establish a requirement in the RPT Program Plan for recurring right-size studies for the RPT capability portfolio and use the results to reexamine workforce and capability requirements for the future.

> **Management's Response:** NASA concurs with this recommendation. The RPT Program will establish this requirement to review the portfolio no later than once every 3 years. We will document this in the RPT Program Management Plan and will re-baseline the plan by the end of fiscal year (FY) 2025.
>
> **Estimated Completion Date:** September 30, 2025.

Recommendation 2: Ensure that cost models deployed at all RPT Centers include full recovery of applicable maintenance costs for the infrastructure and facilities being utilized, similar to that being piloted at Stennis Space Center.

> **Management's Response:** NASA concurs with this recommendation. The RPT Program will direct all RPT Level 3 offices (the four Centers) to review and validate that they comply with this recommendation. It will be included in the formal reporting to the SOMD quarterly Program Management Council at or before the fourth quarter of FY 2025.
>
> **Estimated Completion Date:** September 30, 2025.

Recommendation 3: Formally document and establish the Facilities Maintenance and Modernization (FM&M) process in the RPT Program Plan or Rocket Propulsion Testing Management Board (RPTMB) Operating Procedures.

> **Management's Response:** NASA concurs with this recommendation. The FM&M Policy will be clarified in the Program Plan with associated process details added to the Operating Procedures by the end of the fourth quarter of FY 2025.
>
> **Estimated Completion Date:** September 30, 2025.

Recommendation 4: Document the results and planned RPT actions following completion of the Commercial Capability Survey.

> **Management's Response:** NASA concurs with this recommendation. The initial Commercial Capability Survey results have been documented and received by the RPT Program Office. Additional market research is needed and will be gathered and documented into a FY 2025 U.S. Rocket Test Capabilities report by the end of the third quarter of FY 2025. This report will be used to inform right-size assessments, the FM&M investments decision process, and Program Office stakeholder engagement processes.
>
> **Estimated Completion Date:** June 30, 2025.

Additionally, the OIG recommends the Assistant Administrator for OSI:

Recommendation 5: Ensure that the appropriate revisions are made to NASA Procedural Requirements (NPR) and NASA Policy Directive (NPD) 8600.1 to clarify the authority structure.

> **Management's Response:** NASA concurs with this recommendation. Revisions have been made to NPD 8600.1A to add responsibilities to clarify, develop, and establish a governance and authority structure to effectively operate the capability portfolios. Revisions also have been made to NPR 8600.1A to clarify the generic authority structure. Both documents are routing through the NASA Online Directives Information System for comment and approval.
>
> **Estimated Completion Date:** March 31, 2025.

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

Once again, thank you for the opportunity to review and comment on the subject draft report. If you have any questions or require additional information regarding this response, please contact Michelle Bascoe at (202) 358-1574.

Kenneth Bowersox Digitally signed by Kenneth Bowersox Date: 2024.09.10 11:47:24 -07'00'

Kenneth Bowersox
Associate Administrator for
Space Operations Mission Directorate

Joel Carney Digitally signed by Joel Carney Date: 2024.09.05 15:08:49 -04'00'

Joel Carney
Assistant Administrator for
the Office of Strategic Infrastructure

APPENDIX E: REPORT DISTRIBUTION

National Aeronautics and Space Administration

Administrator
Deputy Administrator
Associate Administrator
Chief of Staff
Associate Administrator for Space Operations Mission Directorate
Assistant Administrator for the Office of Strategic Infrastructure
Human Spaceflight Capabilities Division Director
Rocket Propulsion Test Program Manager
Director, Glenn Research Center
Director, Goddard Space Flight Center
Director, Johnson Space Center
Director, Kennedy Space Center
Director, Marshall Space Flight Center
Director, Stennis Space Center
Director, NASA Engineering and Safety Center

Non-NASA Organizations and Individuals

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

Government Accountability Office
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Blue Origin

Relativity Space

Rocket Lab USA

SpaceX

Congressional Committees and Subcommittees, Chair and Ranking Member

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

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

Senate Committee on Homeland Security and Governmental Affairs

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

House Committee on Oversight and Accountability
Subcommittee on Government Operations and the Federal Workforce

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

(Assignment No. A-23-13-00-SARD)