DEEP SPACE EXPLORATION SYSTEMS

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Deep Space Exploration Systems	**7,447.6**	**7,468.9**	**7,618.2**	**7,803.7**	**7,959.8**	**8,119.0**	**8,281.4**
Moon to Mars Transportation System			**4,213.0**				
Orion Program			**1,031.0**				
Space Launch System			**2,423.2**				
Exploration Ground Systems			**758.8**				
Moon To Mars Lunar Systems Development			**3,288.1**				
Gateway			**817.7**				
xEVA and Surface Mobility Program			**434.2**				
Human Landing System			**1,896.1**				
Advanced Exploration Systems			**140.2**				
Human Exp Requirements & Architecture			**117.1**				
Strategy and Architecture			**71.2**				
Future Systems			**45.9**				
Grand Total			**7,618.2**				

FY 2023 reflects the funding amount specified in Public Law 117-328, Consolidated Appropriations Act, 2023, as revised in NASA's FY 2023 final Operating Plan, September 2023.

A full-year 2024 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Consolidated Appropriations Act, 2023 (Division B of P.L. 117-328, as amended). The amounts included for 2024 reflect the annualized level provided by the continuing resolution.

Totals may not add due to rounding.

Shown here, NASA's Space Launch System, carrying the Orion spacecraft, lifts off the pad at Launch Complex 39B at the agency's Kennedy Space Center in Florida at 1:47 a.m. EST on November 16, 2022.

The FY 2025 Budget Request includes $7.618 billion for the Deep Space Exploration Systems account. This funding directly supports the Moon to Mars (M2M) Program, which is focused on returning humans to the Moon, conducting pioneering research and technology development activities on the lunar surface, and enabling eventual missions to Mars and beyond. In collaboration with its commercial and international partners, NASA will create the capabilities necessary to sustainably explore high priority destinations on the lunar surface, including in-situ science and resource utilization, surface transportation, and habitation capabilities. The operational knowledge, technological advances, and scientific discoveries NASA gains from exploring the Moon in collaboration with international and commercial partners will position the agency to take the next giant leap — sending astronauts to Mars and returning them safely back to Earth.

DEEP SPACE EXPLORATION SYSTEMS

The Exploration Systems Development Mission Directorate (ESDMD) will leverage the Science Mission Directorate's development of smaller landers for capabilities such as navigation and precision landing of cargo and data about the lunar surface. ESDMD will also leverage technological investments to prove and verify concepts through the Space Technology Mission Directorate's lunar exploration activities. Finally, ESDMD will leverage the Space Operations Mission Directorate's capabilities, such as ISS and the Space Communications and Navigation Program, as a technology and human system testbed and communication capability provider, respectively.

The FY 2025 President's Budget Request manifest supports an Artemis II mission in September 2025, Artemis III mission in September 2026, Artemis IV mission in September 2028, and Artemis V mission in 2030 with subsequent flights on a yearly basis.

The Deep Space Exploration Systems account consists of three themes which provide for the development of systems and capabilities needed for human exploration of deep space:

- M2M Transportation System;
- M2M Lunar Systems Development; and
- Human Exploration Requirements & Architecture (HERA).

M2M Transportation System programs work together to develop three of the key space transportation systems that will enable the agency's Artemis Campaign to land the first woman and first person of color on the Moon and extend human presence into the solar system. The systems being developed are the Orion crew vehicle, Space Launch System (SLS) launch vehicle, and Exploration Ground Systems (EGS). The first uncrewed launch of SLS and Orion occurred in November 2022 and the first launch returning humans to the lunar vicinity in fifty years will occur September 2025.

- The Orion Program is developing the spacecraft which will carry crew to deep space, sustaining the crew during space travel, providing emergency abort capability, and providing safe re-entry from deep space return velocities for Artemis missions.
- The SLS Program is developing the human-rated launch system capable of sending the crewed Orion spacecraft to the Moon, which will be used in each of the Artemis missions.
- The EGS Program is responsible for developing and operating the systems and facilities necessary to process, integrate, transport, and launch NASA's SLS rocket, Orion spacecraft, and any co-manifested SLS payloads for Artemis missions.

M2M Lunar Systems Development is developing the systems that will be used to land humans on the Moon, explore the lunar surface, and prepare for Mars exploration. The theme is developing and testing prototype systems and planning flight missions to the Moon to develop systems and operational practices that will enable an eventual mission to Mars. M2M Lunar Systems Development is comprised of four programs: Gateway; Exploration Extravehicular Activity (xEVA) and Human Surface Mobility Program (EHP); Human Landing System (HLS); and Advanced Exploration Systems (AES). The work done by these programs work will create the exploration infrastructure in lunar orbit and on the lunar surface that astronauts will utilize during Artemis missions and that will inform future missions to Mars.

- Gateway is a platform that will orbit the Moon and support orbital activities, lunar landers, and surface activities. Gateway will initially consist of a Power and Propulsion Element (PPE) and the Habitation and Logistics Outpost (HALO); with later configurations including at least two modules contributed by NASA's international partners; and may be supported by U.S. commercial logistics services.

DEEP SPACE EXPLORATION SYSTEMS

- EHP is formulating the systems that NASA will use to explore the surface of the Moon. These surface systems include: the Lunar Terrain Vehicle; the Pressurized Rover; and xEVA surface suits; providing lessons learned and expertise that will support future Mars missions.
- HLS utilizes commercial partnerships to develop and jointly deploy the integrated landing system that will transport crew to and from the lunar surface and conduct a series of lunar missions using that capability. The budget provides funding for the HLS Program to maintain competition for lunar landing services by supporting the development of multiple different lunar landing systems.
- AES will continue work to identify and address knowledge gaps and deliver fundamental capabilities to provide astronauts a place to live and work with integrated life support systems, radiation protection, food, fire safety, avionics and software, logistics management, and waste management systems.

HERA is identifying the exploration infrastructure required for Artemis missions that will inform future missions to Mars. It also works to ensure that lunar exploration systems are extensible to Mars exploration where technically feasible and cost-effective. HERA is comprised of the Strategy & Architecture Office (SAO) and Future Systems.

- SAO manages the architecture strategy activity that supports mission manifest planning and overall architecture requirements and capability identification.
- Future Systems is conducting trade studies to reduce risk and identify required technologies to be utilized as part of the Artemis Campaign and act as precursor systems for future missions to Mars.

EXPLANATION OF MAJOR CHANGES IN FY 2025

To fully implement the Moon to Mars Program Office concept and effectively manage content across the M2M portfolio, the following changes are being proposed:

- Rename Common Exploration Systems Development as M2M Transportation System;
- Rename Artemis Campaign Development as M2M Lunar Systems Development;
- Retire the Advanced Cislunar and Surface Capabilities (ACSC) program, with all follow-on M2M Integration, Moon & Mars Architecture, and Future Systems content previously in program being re-aligned to appropriate programs;
- Establish Future Systems as a stand-alone program under HERA theme;
- Rename Moon & Mars Architecture as Strategy and Architecture Office (SAO);
- Rename Exploration Capabilities as Advanced Exploration Systems (AES) and move to M2M Lunar Systems Development theme;
- Retire the Mars Campaign Development theme; and
- M2M Program Office and integration funding have been re-aligned across the M2M themes.

For more information, go to: https://www.nasa.gov/directorates/exploration-systems-development

SPACE OPERATIONS

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Space Operations	**4,266.7**	**4,250.0**	**4,389.7**	**4,497.6**	**4,587.6**	**4,679.4**	**4,773.0**
International Space Station			**1,269.6**				
Space Transportation			**1,862.1**				
Crew and Cargo Program			**1,761.5**				
Commercial Crew Program			**100.6**				
Space and Flight Support (SFS)			**1,088.4**				
Space Communications and Navigation			**627.7**				
Communications Services Program			**59.4**				
Human Space Flight Operations			**105.0**				
Human Research Program			**143.4**				
Launch Services			**104.3**				
Rocket Propulsion Test			**48.6**				
Commercial LEO Development			**169.6**				
Grand Total			**4,389.7**				

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Totals may not add due to rounding.

The Space Operations account is dedicated to sustained human presence in low-Earth orbit (LEO), enabling future exploration and advanced operations in our solar system, and advancing scientific discoveries that benefit life on Earth. In the near term, this includes support of International Space Station (ISS) operations and research, while laying the foundation for America to develop and maintain a commercial economy in LEO. This budget request continues to prepare for a smooth transition in 2030 from ISS operations to new LEO destinations that are commercially owned and operated and to safely deorbit the ISS.

NASA astronauts, Loral O'Hara (left) and Jasmin Moghbeli (right), pose for a portrait while installing helmet lights on spacesuits and checking the functionality of their spacesuit's components - (October 27, 2023).

Space Operations is comprised of four themes:

- ISS;
- Space Transportation;
- Space and Flight Support; and
- Commercial LEO Development.

SPACE OPERATIONS

Collectively, these themes are developing and operating American-led space infrastructure enabled by a commercial market, enhancing space access and services to both government and commercial entities, and researching and developing capabilities to safeguard astronaut explorers. These activities, which support existing and future space operations for both NASA and non-NASA missions, are catalysts for economic development and lay the groundwork for a commercial future in LEO in which NASA is one of many customers for commercial services. Additionally, these activities continue to return medical and environmental benefits to humanity, advance scientific knowledge, and foster new technologies that improve American lives.

ISS continues to demonstrate American leadership in global space exploration, enabling a U.S.-led multinational partnership to advance shared goals in space. As a testbed for deep space exploration, ISS is helping us learn how to keep astronauts healthy during long-duration space travel and demonstrating technologies for human and robotic exploration beyond LEO, to the Moon, and to Mars. The ISS:

- Promotes commerce in space as new commercialization concepts are explored and stimulates non-NASA demand to support development of commercial destinations under the Commercial LEO Development Program;
- Enables scientists to identify and quantify risks to human health and performance, develop countermeasures, and develop and test technologies that protect astronauts during extended human space exploration;
- Supports NASA research and development in the areas of biological and physical science, as well as Earth and space science missions;
- Conducts research to benefit humanity through the ISS National Lab;
- Continues American leadership in low-Earth orbit in the face of increased human spaceflight activity by foreign competitors; and
- Maintains the ISS international partnership that has brought together astronauts and scientists from dozens of spacefaring nations in peaceful and cooperative activity.

Space Transportation's objective is to transport U.S. Orbital Segment (USOS) astronauts and cargo safely to and from space, including the ISS. Working with industry to develop and provide human transportation services to and from space lays the foundation for more affordable and sustainable future human space transportation. These commercial partnerships bolster American leadership in space, have ended sole reliance on foreign providers for crew transportation services, help stimulate the American aerospace industry, and allow NASA to focus on building the capabilities and expertise necessary for missions to the Moon and Mars. This theme includes the Commercial Crew Program (CCP) and Crew and Cargo Program, which includes the ISS U.S. Deorbit Vehicle (USDV).

- The CCP partners with the U.S. commercial sector to develop and operate safe, reliable, and affordable crew transportation systems capable of carrying humans to and from the ISS and other LEO destinations. Working with industry to develop and provide human transportation services to and from space lays the foundation for more affordable and sustainable future human space transportation.

- The Crew and Cargo Program manages transportation services provided by both international partners and domestic commercial providers. Through the program, NASA has greatly strengthened U.S. competitiveness by awarding ISS cargo resupply contracts to multiple vendors, as well as continuing to advance commercial spaceflight and support American jobs. The Crew and Cargo Program also includes funding for the ISS USDV that will be competitively awarded to U.S. industry.

SPACE OPERATIONS

The Space and Flight Support Theme (SFS) continues to provide mission critical space communication and navigation services, launch and test services, and astronaut training to support its customer missions. The theme is comprised of the Space Communications and Navigation (SCaN) Program, Communications Services Program, Launch Services Program, Rocket Propulsion Test Program, Human Space Flight Operations Program, and Human Research Program.

- The SCaN Program provides communication to missions in LEO, including ISS, suborbital missions, and some lunar orbital missions, utilizing the Near Space Network. The Deep Space Network communicates with missions most distant from Earth and will initially provide primary communication links to early Artemis missions. SCaN is planning for expanded services for missions to the Moon, including lunar relay capability for missions that cannot communicate directly with Earth and enhanced position, navigation, and timing services that are less dependent on tracking stations on Earth.
- The Communications Services Program focuses on demonstrating the feasibility of using commercially provided satellite communications (SATCOM) services to support NASA missions near Earth.
- The Launch Services Program provides expertise and active launch mission management for more than 70 NASA and other government missions in various stages of development.
- The Rocket Propulsion Test Program manages a wide range of facilities capable of ground testing rocket engines and components under controlled conditions.
- The Human Space Flight Operations Program provides the training and readiness to ensure crew health and safety and mission success.
- The Human Research Program improves astronauts' ability to collect data, solve problems, respond to emergencies, and remain healthy during and after extended space travel.

NASA's Commercial LEO Development effort focuses on the development of a robust commercial space economy in LEO. It is stimulating development of commercially owned and operated LEO destinations from which NASA can purchase services to meet enduring LEO human spaceflight and research requirements. The program:

- Ensures NASA can meet its needs in LEO as it transitions in 2030 from ISS operations to new LEO destinations that are commercially owned and operated. NASA’s future requirements that will persist beyond the lifetime of the ISS include crew accommodation and training, human research, physical and biological research, technology demonstration and science, and a National Laboratory;
- Prepares for a sustained human presence in LEO and U.S. leadership in LEO after the ISS;
- Ensures the capability to maintain an American presence in LEO;
- Drives down costs through LEO commercialization so NASA can free up resources to be used for future human space operations and exploration; and
- Utilizes inventive, non-traditional agreements for acquiring commercial space goods and services to meet NASA requirements.

The budget funds ISS operations and research, a vehicle to safely de-orbit ISS after it is retired in 2030, and commercial space stations that NASA will use as soon as they become available. The budget gradually reduces research and other activities on board the ISS in the outyears, beginning in FY 2026, to provide the funding necessary for USDV development and Commercial LEO Development efforts. As a

result of this budget re-balancing, an assessment will be carried out to determine the full trade space of potential changes needed to meet outyear funding levels; such options should include discussion of reducing the number of science payloads/investigations to ISS and/or decreasing the number of astronauts on board the USOS, among other options.

For more information, visit: https://www.nasa.gov/directorates/space-operations-mission-directorate

EXPLANATION OF MAJOR CHANGES IN FY 2025

None.

SPACE TECHNOLOGY

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Space Technology	**1,193.0**	**1,200.0**	**1,181.8**	**1,205.4**	**1,229.5**	**1,254.1**	**1,279.2**
Space Technology			**1,181.8**				
Early Stage Innovation and Partnerships			**140.1**				
Technology Maturation			**340.8**				
Technology Demonstration			**459.1**				
SBIR and STTR			**241.8**				
Grand Total			**1,181.8**				

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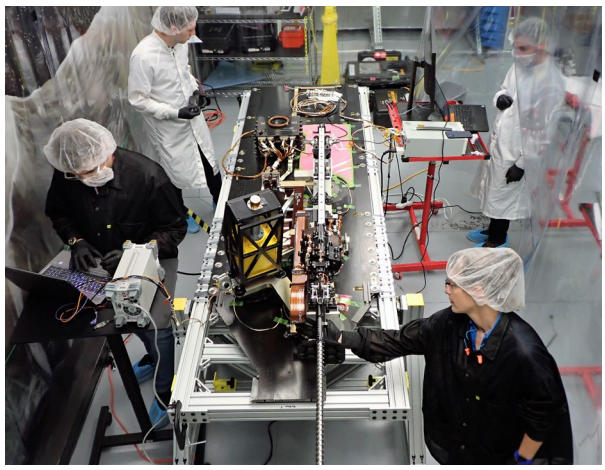
Totals may not add due to rounding.



Shown here, teams with NASA, Honeybee Robotics, and Intuitive Machines work to install The Regolith and Ice Drill for Exploring New Terrain (TRIDENT) drill and the Mass Spectrometer Observing Lunar Operations (MSOLO) instrument with Intuitive Machines' Nova-C lander for NASA's Polar Resources Ice Mining Experiment-1 (PRIME-1) demonstration.

The Space Technology Mission Directorate (STMD) serves as the national technology base for civil space. STMD transforms NASA missions and ensures American leadership in the space economy, rapidly developing, demonstrating, and transferring revolutionary, high-payoff space technologies that enhance mission capabilities and reduce cost. NASA partners with the nation's aerospace industry, including small and large businesses, as well as academia, in its high-risk, high-reward investment activities across the technology development spectrum.

EXPLANATION OF MAJOR CHANGES IN FY 2025

This budget funds the close-out of the On-orbit Servicing, Assembly, and Manufacturing (OSAM-1) Project, which was cancelled in FY 2024. Please see the Technology Demonstration section for more details.

This request proposes to establish Space Nuclear Propulsion Technology as a stand-alone program and is consistent with Public Law 117–167 of August 2022.

SPACE TECHNOLOGY

KEY ACHIEVEMENTS PLANNED FOR FY 2025

Early-Stage Innovation and Partnerships (ESIP)

- Space Technology Research Grants supports a robust portfolio across academic researchers, from graduate students to senior faculty members. This program challenges academic researchers to examine the theoretical feasibility of ideas and approaches that are critical to making science and space activities more effective, affordable, and sustainable. In FY 2025, STMD plans to issue over 300 grants similar to prior fiscal years.
- Early Career Initiative engages the early-career NASA workforce in the management and development of two-year, $2.5 million technology projects. In addition to providing leadership opportunities for the early-career NASA workforce, it also helps build and maintain unique skillsets in support of NASA missions. In FY 2025, STMD expects to have nine active awards, an increase of four over FY 2023.
- Center Innovations Fund provides low-cost seed funding to develop new technologies and capabilities at all NASA centers including Jet Propulsion Laboratory. Partnerships with academia, industry, other NASA centers, as well as other government agencies are encouraged. In FY 2025, STMD plans to grant over 120 awards, about 20 awards fewer than FY 2023.
- NASA Innovative Advanced Concepts nurtures highly innovative, visionary ideas that could one day change the possible in aerospace over the next 10 to 20 plus years. In FY 2025, STMD expects about 38 active awards, an increase of about 20 over FY 2023.
- Prizes, Challenges, and Crowdsourcing conducts public-facing challenges in support of all NASA mission directorates, addressing several agency priorities. Using a wide variety of avenues, including the NASA Tournament Lab, NASA@WORK, and Centennial Challenges, nearly every U.S. state has provided solutions. In FY 2025, STMD is planning for nearly 50 new awards, similar to prior years.
- Early-Stage Innovation and Commerce provides the ability for ESIP programs to jointly explore innovative methods to increase the impact of NASA early-stage technology development. Examples include innovative pilots including enhanced support to underrepresented communities, evidence-driven programs, academic research to market, and partnerships. In FY 2025, STMD is planning for 10 awards, similar to prior fiscal years.
- Technology Transfer provides agency-level management and oversight of NASA-developed and NASA-owned intellectual property and manages the transfer of these technologies to external entities. NASA is seeking to accelerate commercialization through entrepreneurial initiatives and partnerships. In FY 2025, STMD has the goal to manage over 5,000 patents and software use agreements and to increase technology transfer activities to all NASA centers.

Technology Maturation

- Game Changing Development (GCD) aims to advance exploratory concepts and deliver transition-ready solutions that enable new capabilities or radically alter current approaches such as High Performance Spaceflight Computing. GCD advances a broad range of mid-TRL technologies, including in the areas of entry, descent, and landing (e.g., Safe and Precise Landing – Integrated Capabilities Evolution and Dragonfly Entry Aerosciences Measurements (DrEAM); power and energy storage (e.g., Tipping Points In-Situ Resource Utilization [ISRU] power on the Moon and Harmonia Radioisotope power supply); propulsion systems (e.g., Liquid Oxygen/Liquid Hydrogen

demonstration engine Announcement of Collaboration Opportunity); materials and structures (e.g., Superlight Aerospace Components); and robotic systems (e.g., ISRU Pilot Excavator).

- Lunar Surface Innovation Initiative develops transformative capabilities for lunar surface exploration across the Space Technology portfolio. Focus areas include in-situ resource utilization, sustainable surface power, excavation and construction, dust mitigation, and ability to operate in extreme environments. The Lunar Surface Innovation Consortium brings together NASA, universities, industry, non-profits, and other government agencies to ensure the United States is the leader in sustainable lunar exploration. In FY 2025, STMD expects to continue to mature technologies critical for a sustained human presence on the Moon. For example, the Moon-to-Mars Planetary Autonomous Construction Technologies (MMPACT) will utilize lunar in-situ materials for the on-demand construction of large-scale infrastructure elements such as habitats, berms, landing pads, and blast shields. Lunar Infrastructure Foundational Technologies (LIFT-1) will be an ISRU lunar surface demonstration of oxygen extraction technologies from lunar regolith for eventual production, capture, and storage of oxygen on the lunar surface.

Technology Demonstration (TDM)

TDM matures crosscutting system-level technologies through demonstration in operational environments. Examples of projects in TDM include high-power solar electric propulsion; cryogenic fluid management; sustainable lunar surface power; and space nuclear propulsion. These technologies are critical for a long-term, sustainable presence on the Moon and deep space exploration.

- The Solar Electric Propulsion Project seeks to develop and qualify an advanced 12 kilowatt-class Electric Propulsion thruster applicable to exploration and commercial spaceflight, and the Qualification System Acceptance Review 1 is planned for FY 2025.
- The Eta Space CFM Tipping Point launch is scheduled for November 2024 and the United Launch Alliance CFM Tipping Point launch readiness review is planned for July 2025.
- Research in both Nuclear Thermal Propulsion (NTP) and Nuclear Electric Propulsion (NEP) will enable robust and reliable energy to both human and scientific exploration missions.
    - Subscale integrated NEP concept design is targeted for completion in FY 2025
    - Final design and initial fabrication of a high-power electric thruster that could be used in a NEP system will be delivered in FY 2025
    - NASA is partnering with DARPA on a cislunar demonstration of NTP technologies, planned for FY 2027, and the mission Critical Design Review is scheduled in early FY 2025

Flight Opportunities (FO) and Small Spacecraft Technology (SST) will continue to increase the pace of space exploration and discovery by leveraging small spacecraft and responsive launch capabilities. By 2025, the 12 current SST demonstrations, including the Starling mission and space traffic management experiment currently on orbit, will be completed. In FY 2024, SST is evaluating four industry-led mission concept studies for transition to one or more orbital demonstrations. During FY 2025, those new missions will be undergoing rapid hardware development in preparation for a target launch before the end of 2026. In FY 2025, FO anticipates using newly awarded Indefinite Delivery / Indefinite Quantity (IDIQ) contracts to continue its rapid pace of technology demonstrate activities in partnership with the U.S. commercial space transportation industry.

SPACE TECHNOLOGY

Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

SBIR and STTR will continue efforts to encourage participation of underrepresented groups across the nation to expand inclusive innovation. In FY 2025, STMD plans to select over 600 new awards, grants, and contracts to small businesses, as well as continue to incubate and mature NASA commercial partnerships through post Phase II activities through sequential Phase II awards. Additionally, STMD will pilot ways to reduce barriers to entry and streamline the experience throughout the program phases, including strategies to encourage transition to NASA, government, and/or commercial use beyond SBIR/STTR awards.

SCIENCE

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Science	7,791.5	7,795.0	7,565.7	7,717.0	7,871.3	8,028.7	8,189.3
Earth Science			2,378.7				
Planetary Science			2,731.5				
Astrophysics			1,578.1				
Heliophysics			786.7				
Biological and Physical Sciences			90.8				
Grand Total			7,565.7				

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Totals may not add due to rounding.

This massive Wolf-Rayet star, WR 124, is 15,000 light-years away in the constellation Sagittarius. It is 30 times the mass of the Sun and has shed 10 Suns worth of material so far. As the ejected gas moves away from the star and cools, cosmic dust forms and glows in the infrared light, detectable by the James Webb Space Telescope.

NASA's Science Mission Directorate (SMD) conducts scientific exploration enabled by space-based observatories, which observe the Earth, perform fundamental research, visit other bodies in the solar system, and gaze out into the galaxy and beyond. NASA's scientific exploration will inform human exploration of the Moon, Mars, and the solar system, providing valuable scientific data for such human missions. NASA also strives to drive discovery by studying biological and physical phenomena in space. SMD utilizes technological advances and partnership opportunities, including public-private partnerships that leverage commercial investments to further NASA's science objectives.

NASA's science programs also help protect and improve life on Earth through research that enables innovative and practical applications for decision-makers, including disaster response, natural resource management, and planetary defense.

SMD uses the recommendations of the National Academies' decadal surveys as important inputs in planning and prioritizing the future of its science programs. SMD uses these recommendations to prioritize future flight missions (including space observatories and probes), as well as technology development and proposals for theoretical and suborbital supporting research.

SCIENCE

The current decadal surveys informing mission priorities include the Decadal Survey for Earth Science and Applications from Space 2018 to 2027; the Origins, Worlds, and Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032; the Pathways to Discovery in Astronomy and Astrophysics for the 2020s; and the Decadal Survey on Biological and Physical Sciences Research in Space 2023-2032. The Heliophysics Division is expecting an updated decadal in 2024.

In determining the content of the Science portfolio, NASA also considers national priorities and policies, budgets, existing technological capabilities, partnership opportunities, and other programmatic factors.

EXPLANATION OF MAJOR CHANGES IN FY 2025

The Budget provides $7.6 billion for Science, a $229.3 million decrease from the FY 2023 enacted level. Within Earth Science, NASA is restructuring missions within the Earth System Observatory. The Atmosphere Observing System (AOS) missions will be restructured to retain the partnership with JAXA on their Precipitation Measurement Mission, formerly part of AOS-Storm. NASA is assessing options for implementing the remainder of the Aerosol and Cloud, Convection, and Precipitation designated observables. Similarly, the Surface Biology and Geology (SBG) mission will be split into two projects, Surface Biology and Geology (SBG)-Thermal Infrared (TIR) and SBG-hyperspectral visible to shortwave infrared (VSWIR), to maximize execution flexibility and reduce near-term budget requirements. The Budget provides $150 million for Landsat Next. NASA will not be able to reliably estimate the launch readiness date until there is a final FY 2024 appropriation, but expects the launch date to be delayed compared to the prior estimate of CY 2030. NASA has established a new Responsive Science Initiatives program in Earth Science. This program consolidates and enhances current activities within Earth Science to increase the impact of NASA's observations, Earth system science, and applied science by aligning, scaling and connecting with user needs.

Within Planetary Science, the budget proposes an updated profile for the Near-Earth Object (NEO) Surveyor mission to support a June 2028 launch readiness date. NASA has also increased the Dragonfly budget request, consistent with the updated mission cost estimate expected to be reviewed at the upcoming mission confirmation, and consistent with a launch readiness date of July 2028. Given the need to increase the Dragonfly budget, NASA has delayed the New Frontiers 5 Announcement of Opportunity (AO) from November 2023 to no earlier than 2026. This budget request also extends the New Horizons mission until the spacecraft exits the Kuiper Belt in the 2028 to 2029 timeframe. NASA has also significantly expanded support for the ESA Rosalind Franklin ExoMars Rover mission in the wake of Russia's exit from the mission. The request includes $200M for Mars Sample Return that will allow the project to advance formulation of mission components and capabilities that have a high likelihood of being used in any future sample return architecture, and to evaluate and appropriately incorporate relevant findings from funded industry and center architecture studies.

Within Astrophysics, the budget supports increased investment in the Habitable Worlds Observatory Technology Maturation project, in direct alignment with the Great Observatories Mission and Technology Maturation Program (GOMAP) recommendation in the Astro2020 Decadal Survey. NASA has reduced the Explorer Future missions budget which will preclude the selection of Missions of Opportunity for the 2021 and 2025 AOs. NASA proposes to reduce the budgets of the Hubble and Chandra observatories in order to balance investments in future Astrophysics missions and missions in operations.

Within Heliophysics, the budget proposes the cancellation of Geospace Dynamics Constellation mission to fund higher priorities and increases funding for the Space Weather program. Within Biological and Physical Sciences, NASA has prioritized funding for the Commercially Enabled Rapid Space Science

Initiative (CERISS) project, which, while reduced in scope compared to the FY 2024 Request, will expand suborbital or orbital demonstrations compared to what was funded in FY 2023.

KEY ACHIEVEMENTS PLANNED FOR FY 2025

In FY 2025, NASA plans to launch Europa Clipper; Volatiles Investigating Polar Exploration Rover (VIPER); The Spectro-Photometer for the History of the Universe, Epoch of Reionization and Ices Explorer; The Interstellar Mapping and Acceleration Probe; Polarimeter to Unify the Corona and Heliosphere; The Sun Radio Interferometer Space Experiment; and Total and Spectral Solar Irradiance Sensor-2. In FY 2025, the Lunar Discovery & Exploration Program anticipates the launch and delivery of multiple new lunar science payloads to the surface of the Moon through the Commercial Lunar Payload Services project. The agency will make final selections for the next Heliophysics Small Explorers mission, the first Earth System Explorers missions, and the first Astrophysics Probe mission.

NASA will continue formulation of the Surface Biology & Geology and Gravity Recovery and Climate Experiment-Continuity (GRACE-C) missions and will reformulate the Atmosphere Observing System missions. The Responsive Science Initiatives program will release its first research solicitation. Biological and Physical Sciences will analyze tissue chip samples returned from the Artemis II mission and share insights across NASA and with other government agencies.

NASA will continue development of the Dragonfly and the NEO Surveyor missions. The Lucy mission will continue its journey to explore the Jupiter Trojan asteroids and will encounter the main asteroid belt and observe asteroid Donaldjohansen in April 2025. The Roman Space Telescope will continue development activities and is expected to begin integration and testing as it progresses toward launch in 2027. The Heliophysics division will evaluate the recommendations from the Heliophysics Decadal Survey, expected in 2024.

Themes

NASA's Science budget, managed by SMD, includes five major science areas.

EARTH SCIENCE

NASA's unique capabilities as a space and science agency ultimately enable decision makers to address the most pressing challenges posed by our rapidly changing planet such as changing agricultural conditions, and severe weather challenges, including droughts, tropical storms, and wildfires. NASA develops innovations in instrument, flight, data, and mission technology to improve capability, resolution, and frequency of our remote sensing and in-situ Earth observations. NASA missions use the vantage point of space to observe our planet and continuously improve our scientific understanding of Earth's interconnected systems, from Earth's core to its atmosphere. Missions include continuity measurements made for decades, and advances in observations to advance understanding of the Earth system. NASA selects and funds innovative research enabling the nation's scientific community to build an ever-improving understanding of global-scale changes, connecting causes to effects.

This budget supports translating Earth science into actionable data and information via investments in Applied Sciences, which will support applications and user engagement related to disaster response, wildfires, environmental justice, energy, and agriculture. NASA will work jointly with the Environmental Protection Agency and other agencies to integrate greenhouse gas data from a variety of sources with a

goal of making data more accessible to federal, state, and local governments, as well as other users. Visualization of the information and partnerships in a comprehensive Earth system framework will be enabled by open science and cutting-edge data science techniques. NASA will continue development of the Earth Information Center, a physical and virtual space that provides easily accessible, readily usable, and scalable Earth information – enabling global understanding of the Earth system.

The budget supports continued formulation of the Earth System Observatory missions and Landsat Next, continues the Earth System Explorers program, and supports sustained climate observations. The budget also supports the ongoing development of multiple missions in development within the Earth Venture element. The Applied Sciences program will continue to leverage Earth Science satellite measurements and new scientific knowledge to enable innovative and practical uses by public and private sector organizations, including expanded applications development work in support of agriculture.

PLANETARY SCIENCE

To answer questions about the solar system and the origins of life, NASA sends robotic space probes to the Moon, other planets and their moons, asteroids and comets, and the icy bodies beyond Neptune. NASA is operating spacecraft at Mars, Jupiter, and the Moon. NASA is preparing to deliver new instruments to the lunar surface; will launch the Europa Clipper mission to explore Jupiter's moon, Europa; will develop the Dragonfly mission to explore Saturn's moon, Titan; and will send two missions to explore Venus. The budget funds the Lunar Discovery and Exploration Program that supports Artemis science, commercial collaborations, and innovative approaches to achieving human and science exploration goals. The budget supports future competitive mission selections within Discovery and New Frontiers and a robust research program to support the scientists who use NASA mission data to make discoveries about our solar system.

The budget supports the Open Source Science initiative, an SMD-wide activity that advances open science, supports data science innovation, and increases the accessibility of scientific data through the development of efficient data and computing system capabilities for all SMD divisions.

ASTROPHYSICS

NASA stands on the threshold of new endeavors that will transform not only our understanding of the universe and the processes and physical paradigms that govern it, but also humanity’s place in it. Progress in understanding pathways to habitable worlds, opening new windows on the dynamic universe, and unveiling the drivers of galaxy growth require the essential vantage point of space. Building on the revolutionary advances in our observations of exoplanets, NASA now seeks to identify and characterize Earth-like exoplanets orbiting Sun-like stars, with the ultimate goal of obtaining imaging and spectroscopy of potentially habitable worlds.

NASA aims to exploit the new observational tools of gravitational waves and particles, along with temporal monitoring of the sky across the electromagnetic spectrum and wide-area surveys to probe the most energetic processes in the universe and address the nature of dark matter, dark energy, and cosmological inflation. By linking observations and modeling of the stars, galaxies, and the gas and energetic processes that couple their formation, evolution, and destinies, NASA can revolutionize our understanding of the origins and evolution of galaxies, from the nature of the tenuous cosmic webs of gas that feed them, to the nature of how this gas condenses and drives the formation of stars.

SCIENCE

The budget supports operation of the James Webb Space Telescope and the Hubble Space Telescope, as well as the development of the Nancy Grace Roman Space Telescope. Within the Explorers program, the budget includes funding for SPHEREx and initial selections of the first Astrophysics Probe mission. This budget expands precursor science and technology efforts in planning and preparing for the GOMAP recommendation contained in the Astro2020 Decadal Survey.

HELIOPHYSICS

The Sun, a typical small star midway through its life, governs our solar system. The Sun wields its influence through its gravity, radiation, solar wind, and magnetic fields, all of which interact with the Earth and its space environment. These processes are crucial for our understanding of the universe, and they relate directly to our ability to live in space as they produce space weather, which can affect technological infrastructure and human activities in space. Using a fleet of sensors on various spacecraft in Earth orbit and throughout the heliosphere, NASA seeks to understand the fundamental processes of how and why the Sun varies in many ways, how Earth and our solar system respond to the Sun, how the Sun and the solar system interact with the interstellar medium, and how human activities are affected by these processes. The science of heliophysics, including space weather, enables the predictions necessary to safeguard life and society on Earth and the outward journeys of human and robotic explorers.

The budget supports the development of the Interstellar Mapping and Acceleration Probe, the Carruthers Geocorona Observatory, and a competitive Explorers Program, including the recently selected Multi-slit Solar Explorer and HelioSwarm missions. The budget increases funding for the Space Weather program, which is focused on applied research and applications to enable the nation to better protect our technology and astronauts from space weather. The budget includes funding for the Diversify, Realize, Integrate, Venture, Educate initiative and funds orbital debris investments to enable characterization of the populations of small debris and dust in space to protect space-based critical infrastructure and humans working in space.

BIOLOGICAL AND PHYSICAL SCIENCES

NASA is a leader in performing fundamental biological and physical sciences research that contributes to transformational discoveries, improves life on Earth and in space, and enables sustained deep-space human exploration. NASA achieves this by pioneering research to understand how spaceflight affects living and physical systems in space and to prepare for future human exploration missions far from Earth. The experiments NASA conducts on the ISS and other platforms examine how astronauts, plants, animals, and physical systems respond to the extreme conditions of space, including microgravity, ionizing radiation, and altered atmosphere.

NASA examines processes of metabolism, reproduction, and development and studies how organisms repair cellular damage and protect themselves from infection and disease in the conditions of deep space. In addition to providing useful information on how living organisms respond and adapt to spaceflight, the discoveries NASA makes in space have significant implications for life on Earth.

NASA also conducts research to understand the fundamental laws of the universe, including quantum science, and determine how physical systems react in spaceflight environments. This research provides basic scientific knowledge and results leading to societal benefit, including contributions to the fundamental understanding of underlying space exploration technologies, such as power generation, storage, and fuel transfer; space propulsion; life support systems; and environmental monitoring and control. NASA research also contributes to scientific discoveries in novel areas, such as the fifth state of

matter, known as Bose-Einstein Condensates, material sciences, and soft matter. This physical sciences research has led to improved space systems and new products on Earth.

AERONAUTICS

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Aeronautics	**935.0**	**935.0**	**965.8**	**985.1**	**1,004.8**	**1,024.9**	**1,045.4**
Aeronautics			**965.8**				
Airspace Operations and Safety Program			**151.2**				
Advanced Air Vehicles Program			**278.8**				
Integrated Aviation Systems Program			**264.4**				
Transformative Aero Concepts Program			**155.3**				
Aerosciences Eval. & Test Capab. Program			**116.2**				
Grand Total			**965.8**				

FY 2023 reflects the funding amount specified in Public Law 117-328, Consolidated Appropriations Act, 2023, as revised in NASA's FY 2023 final Operating Plan, September 2023.

A full-year 2024 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Consolidated Appropriations Act, 2023 (Division B of P.L. 117-328, as amended). The amounts included for 2024 reflect the annualized level provided by the continuing resolution.

Totals may not add due to rounding.

NASA Aeronautics Mission Directorate (ARMD) leads the nation's aviation community in research to maintain and advance American leadership in aviation. ARMD is working to improve efficiency and reduce the noise and emissions of commercial aircraft; advance the safety, capacity, and efficiency of air transportation; and enhance aviation as an economic engine. The Aviation sector is critical to the U.S. economy providing a positive manufacturing trade balance of $51 million in 2021 and 2.1 million aerospace/defense jobs.

NASA's X-59 supersonic aircraft sits on the apron outside Lockheed Martin's Skunk Works. The X-59 seeks to make sonic booms quieter.
Credit: Lockheed Martin Skunk Works

ARMD is working to enable transformation of future air travel in at least four major areas.

- Ultra-Efficient Airliners: NASA is committed to supporting the U.S. climate goal of achieving net-zero greenhouse gas emissions from the aviation sector by 2050. Under the Sustainable Flight National Partnership (SFNP), NASA is leading Federal agencies and industry to accelerate the development of sustainable technologies. The Advanced Air Vehicle Program (AAVP), Integrated Aviation Systems Program (IASP), and Airspace Operations and Safety Program (AOSP) execute the SFNP activities.
- High-Speed Commercial Flight: NASA's Quesst mission will demonstrate that supersonic aircraft (X-59) can fly without generating loud sonic booms and survey what people hear when it flies overhead. Reaction to the quieter sonic "thumps" will be shared with regulators who will then consider writing new rules to lift the ban on faster-than-sound flight over land. AAVP and IASP execute the Quesst mission.

AERONAUTICS

- Future Airspace and Safety: NASA is working with the Federal Aviation Administration (FAA), industry, and academia to transform air traffic management systems to safely accommodate the growing demand of new air vehicles entering the airspace, enabling them to perform a variety of missions no matter what airspace that mission may require. AOSP executes the future airspace activities.
- Advanced Air Mobility (AAM): NASA's AAM mission will help emerging aviation markets safely grow and integrate into the air transportation system, moving people and cargo between places previously not served or underserved by aviation, using revolutionary new aircraft and operational concepts that are only just now becoming possible thanks to converging technologies. AAM management technologies will be leveraged to improve responses to wildfires. AOSP and AAVP execute the AAM mission.

In addition to research that directly aligns with the four major transformation areas, ARMD conducts foundational research on crosscutting ideas and technologies. This research enables a broad range of aeronautics and aerospace applications and explores opportunities for technology convergence from disparate technology areas. Flight and ground capabilities for experimentation and feasibility demonstrations are additional elements that support the entire ARMD portfolio.

ARMD guides these transformation efforts through a strategic implementation plan. The plan lays out NASA's approach to addressing the three key drivers of aviation transformation: the growing demand for global air mobility; energy efficiency and environmental sustainability; and the opportunity for convergence between traditional aeronautical disciplines and technology advances in information technology, communications, energy, and other rapidly evolving technologies. The strategic implementation plan identifies six research thrusts to comprehensively address the three key drivers.

For more information on the Aeronautics strategic plan, go to: https://www.nasa.gov/aeronautics/nasa-releases-newest-vision-for-flight-research/

EXPLANATION OF MAJOR CHANGES IN FY 2025

NASA adjusted funding for elements of the SFNP. The Sustainable Flight Demonstrator project is being allocated increased funding as the X-66 aircraft moves into the design/build phase. Funding for the Electrified Powertrain Flight Demonstrations project is being decreased as it completes the build phase. Additionally, funding for the Hi-Rate Composite Aircraft Manufacturing (HiCAM) project is being increased by more than previously planned to enable the completion of major ground tests of both a wing and fuselage component.

NASA increased funding for the Low Boom Flight Demonstrator (LBFD) to cover rebaselined commitments for cost and schedule. The project was rebaselined due to poor contractor performance and COVID impacts from 2020 through 2022 that caused delays to X-59 aircraft delivery.

NASA increased funding for non-CO2 greenhouse gas emissions research and studies in AAVP. With increased scientific and engineering focus, this research could lead to completely eliminating a major aviation greenhouse gas effect in the relatively near-term.

KEY ACHIEVEMENTS PLANNED FOR FY 2025

The budget request supports five programs within the agency's aeronautics portfolio:

AERONAUTICS

AOSP advances mobility through modernizing and transforming the national air traffic management system, in partnership with the FAA and the aviation community. The program develops and explores advanced technologies for more efficient gate-to-gate flight trajectories, leads research on increasingly autonomous aviation, and provides tools for the integration and analysis of data to support in-time system-wide safety assurance. The program has focused efforts to advance the safe integration of new advanced air mobility vehicles into the airspace. The program is also addressing the need for improved responses to wildfires by leveraging its UAS traffic management capabilities. In FY 2025, AOSP will:

- Evaluate operating standards and performance requirements for the safe operation of small drones in beyond visual line-of-sight missions to assist FAA rulemaking;
- Initiate development of the airspace management technology and mission capabilities needed to improve aerial responses to wildfires based on an interagency concept of operations;
- Deliver tools and methods to the FAA and industry that support safety certification of advanced aerospace technologies and systems; and
- Working with the FAA, mature the vision for future airspace operations in 2045 and establish critical research and development goals to meet desired outcomes.

AAVP develops the tools, technologies, and concepts that enable new generations of civil aircraft that are safer, faster, more energy-efficient, and have a smaller environmental footprint. The program pioneers fundamental aeronautics research and matures the most promising concepts for transition to the community. Key focus areas include: enabling major leaps in the safety, efficiency, and environmental performance of subsonic fixed and rotary wing aircraft; overcoming noise and other technology challenges to high-speed flight, including demonstration of quiet supersonic flight with the X-59 aircraft via community response testing; and understanding and tackling critical challenges of hypersonic flight. In FY 2025, AAVP will:

- Evaluate and select high-rate composite aircraft manufacturing technologies for two major aircraft component demonstrations;
- Continue development of integrated small core aircraft engine technologies for demonstration in FY 2027;
- Conduct fundamental and applied research to enable a broad spectrum of hypersonic systems and missions; and
- Complete preparation for the initial X-59 supersonic aircraft community-response flight test, planned for FY 2026.

IASP explores, assesses, and demonstrates the benefits of the most promising technologies at an integrated system level, including in flight. The program has three major flight projects: Sustainable Flight Demonstrator, Electrified Powertrain Flight Demonstrations, and Low Boom Flight Demonstrator. Also, the program funds flight support capabilities and other aeronautics research related to flight tests. In FY 2025, IASP will:

- Conduct acoustic validation flight testing of the X-59 Low Boom Flight Demonstrator to prove that acoustic characteristics match design targets for quiet supersonic flight;
- Complete final stages of development of electrified powertrain flight demonstrators with GE Aerospace and magniX; and

- Continue working with Boeing on the Sustainable Flight Demonstrator which has a planned first flight date in FY 2028.

The Transformative Aeronautics Concepts Program (TACP) demonstrates initial feasibility of concepts supporting the discovery and development of new transformative solutions supporting the NASA Aeronautics strategy, including exploring opportunities to create a net zero-emissions aviation future. The program encourages revolutionary concepts, creates the environment for researchers to become immersed in new ideas, performs ground and small-scale flight tests, allows failures and learns from them, and drives rapid turnover of new concept development. In FY 2025, TACP will:

- Advance state-of-the-art computational and experimental tools and technologies that are vital to aviation applications;
- Explore new concepts such as data and decision support tools and weather capabilities for advanced air mobility flight within the Convergent Aeronautics Solutions activity; and
- Fund up to three new University Leadership Initiative awards and will evaluate the results of five ongoing awards.

Aerosciences Evaluation and Test Capabilities Portfolio (AETC) manages NASA's portfolio of 12 large wind tunnels used for ground testing of advanced technologies and configurations across all speed regimes: subsonic, transonic, supersonic, and hypersonic. These test facilities also serve the needs of other NASA mission directorates, as well as non-NASA users. In FY 2025, AETC will:

- Conduct wind tunnel experiments for NASA and external customers to assess technology in simulated ground-test environments;
- Assess the condition and health of testing capabilities at Ames Research Center, Glenn Research Center, and Langley Research Center (LaRC) to identify and address equipment with a high-risk of failure due to age or maintenance issues; and
- Develop robust testing methodologies to reduce flight certification time in low-speed, high-lift flight envelope using the LaRC National Transonic Facility.

STEM ENGAGEMENT

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
STEM Engagement	143.5	143.5	143.5	146.4	149.3	152.3	155.3
STEM Engagement			143.5				
Grand Total			143.5				

FY 2023 reflects the funding amount specified in Public Law 117-328, Consolidated Appropriations Act, 2023, as revised in NASA's FY 2023 final Operating Plan, September 2023.

A full-year 2024 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Consolidated Appropriations Act, 2023 (Division B of P.L. 117-328, as amended). The amounts included for 2024 reflect the annualized level provided by the continuing resolution.

Totals may not add due to rounding.

These photos illustrate a wide variety of NASA STEM student opportunities, including the Artemis Student Challenges, Students to Launch partnership, and Minority University Research Education Program (MUREP) Innovation Tech Transfer Idea. Competition (MITTIC).

NASA makes investments in Science, Technology, Engineering, and Mathematics (STEM) engagement, in direct alignment with NASA's Strategic Plan, Goal 4.3 to "build the next generation of explorers," as well as the Administration's priority of building a future diverse STEM workforce. The Office of STEM Engagement (OSTEM) leads the agency's STEM engagement function, providing strategic guidance and direction in partnership with the mission directorates.

The scope of NASA STEM Engagement comprises all endeavors to attract, engage, and educate students and to support educators and educational institutions. STEM Engagement encompasses a broad and diverse set of programs, projects, activities, and products. This includes student internships and fellowships; student learning opportunities (e.g., challenges and competitions, camps, and other hands-on and virtual experiences); informal education and out-of-school learning activities; educational products, tools, and platforms; educator and faculty support; competitive grants and cooperative agreements to educational institutions for research and development and institutional support; and strategic partnerships with organizations to expand reach and impact.

NASA will continue to support federal STEM education priorities and drive strategic alignment of the agency's STEM engagement efforts through the NASA Strategy for STEM Engagement via three strategic goals:

1. Create unique opportunities for a diverse set of students to contribute to NASA's work in exploration and discovery.
2. Build a diverse future STEM workforce by engaging students in authentic learning experiences with NASA's people, content, and facilities.
3. Attract diverse groups of students to STEM through learning opportunities that spark interest and provide connections to NASA's mission and work.

STEM ENGAGEMENT

These goals, along with their corresponding objectives and strategies, guide the agency's STEM engagement efforts and are complemented by five design principles -- (1) mission-driven authentic STEM experiences, (2) evidence-based practices, (3) scalability, (4) outcome-driven, and (5) diversity and inclusion -- that guide the planning and execution of work in direct support of achieving the strategic goals.

OSTEM is accountable for the management of NASA's STEM Engagement program, which is composed of four projects: National Space Grant College and Fellowship Project (Space Grant); Established Program to Stimulate Competitive Research (EPSCoR); Minority University Research and Education Project (MUREP); and Next Generation STEM project (Next Gen STEM). These projects are outlined in detail in subsequent sections.

NASA will continue work begun in FY 2024 to advance its work around three priority focus areas:

- First, NASA will implement strategies to broaden student participation to increase diversity, equity, and inclusion in STEM through NASA opportunities and activities. NASA will continue to foster a culture and commitment across the STEM engagement community, including its grantees, partners, and collaborators, to broaden student participation through implementation of an action plan that was developed in FY 2021.
- Second, NASA will continue to build productive strategic partnerships and networks, expanding NASA’s STEM ecosystem to magnify reach and impact. This will be accomplished through establishing formal partnerships with organizations through Space Act Agreements, in order to scale activities and expand results and impact, capitalizing on existing networks and distribution systems to deploy products and opportunities.
- Third, NASA will expand contributions in engaging K-12 students in STEM pathways, with an approach toward a continuum of experiences. This will include efforts to increase the accessibility and navigability of NASA opportunities and products for students and educators.

EXPLANATION OF MAJOR CHANGES IN FY 2025

Within a constrained budget, the request prioritizes funding for MUREP and Next Gen STEM to expand the reach and impact of NASA's STEM efforts, including expanding NASA programming targeting partnerships with external organizations.

WORK IN PROGRESS IN FY 2024

In FY 2024, OSTEM continues agency-wide coordination in support of agency and federal government priorities to attract, engage, and educate students toward building a future STEM workforce. OSTEM continues to implement enterprise initiatives to improve efficiency and strengthen standards and rigor in program management, fiscal accountability, and performance measurement. In FY 2024, NASA will continue to implement a mission-driven STEM Engagement program through its four projects. Details regarding project plans and activities are provided in dedicated subsequent sections.

In FY 2024, NASA's STEM Engagement enterprise remains committed to continuing the implementation of the following:

STEM ENGAGEMENT

- Drive strategic alignment and a mission-driven programmatic model. This includes conducting a comprehensive analysis of the portfolio and building on programmatic efforts established in partnership with the mission directorates.
- Implement cross-cutting strategies to more effectively reach and serve students, educators, and educational institutions, and to improve operations.
    - NASA will continue to drive the continued use of STEM Gateway, a database to provide oversight and transparency to the agency's STEM activities.
    - NASA will continue to further its work in significantly enhancing its digital footprint to better reach students, including improved products at https://stem.nasa.gov.
    - NASA will continue to drive progress on the agency internships program, with objectives for growth and enhanced student experiences.
    - NASA will continue the implementation of a partnership strategy, cultivating new partnerships to increase reach and impact.
    - NASA will continue progress and evolution of the performance assessment and evaluation approach and Learning Agenda with continued cadence of focused evaluation studies to inform evidence-based program changes.
    - NASA will continue the implementation of an integrated action plan toward broadening student participation in STEM engagement programs and activities.
- Further an enterprise operating model and focus on building skills and capabilities of the NASA STEM Engagement workforce.
- Continue its annual planning process and program management practices in defining and implementing a portfolio of projects, activities, and products directed toward achieving the agency's strategy for STEM Engagement goals and objectives. Ultimately, the work dedicated to this strategy will contribute to achieving NASA's STEM Engagement vision to immerse students in NASA's work, attract students to STEM, and inspire the next generation to explore.

KEY ACHIEVEMENTS PLANNED IN FY 2025

NASA will enable student opportunities aligned with NASA STEM Strategy and objectives and continue to provide mission-driven competitive opportunities via Space Grant, EPSCoR, and MUREP in partnership with mission directorates.

NASA will continue to enhance and evolve the STEM Gateway, enable performance measurement and analytics, and implement the next stage of the STEM engagement learning agenda, with completion of targeted studies to drive design and evolution of products and activities.

Specific achievements planned for the Space Grant, MUREP, EPSCoR, and Next Gen STEM projects are summarized in subsequent sections.

SAFETY, SECURITY, & MISSION SERVICES

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Safety, Security, and Mission Services	**3,136.5**	**3,129.5**	**3,044.4**	**3,105.3**	**3,167.4**	**3,230.7**	**3,295.3**
Mission Services & Capabilities			**2,058.1**				
Information Technology (IT)			**628.6**				
Mission Enabling Services			**732.7**				
Infrastructure & Technical Capabilities			**696.8**				
Engineering, Safety, & Operations			**986.3**				
Agency Technical Authority			**180.3**				
Center Engineering, Safety, & Operations			**806.0**				
Grand Total			**3,044.4**				

FY 2023 reflects the funding amount specified in Public Law 117-328, Consolidated Appropriations Act, 2023, as revised in NASA's FY 2023 final Operating Plan, September 2023. Amounts include $8 million that was transferred to NASA's Information Technology Modernization Working Capital Fund.

A full-year 2024 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Consolidated Appropriations Act, 2023 (Division B of P.L. 117-328, as amended). The amounts included for 2024 reflect the annualized level provided by the continuing resolution.

Totals may not add due to rounding.

The Safety, Security, and Mission Services (SSMS) account enables NASA's missions by providing foundational support capabilities responsive to evolving mission needs. SSMS also funds independent oversight over NASA's missions and programs to ensure the health, safety, and security of NASA people and property as well as the public. SSMS programs provide the services and capabilities that ensure NASA has the technical skills, physical assets, financial resources, and top talent to be successful. The SSMS FY 2025 budget is comprised of two themes: Mission Services and Capabilities (MSaC) and Engineering, Safety, and Operations (ESO).

EXPLANATION OF MAJOR CHANGES IN FY 2025

None.

MISSION SERVICES AND CAPABILITIES

MSaC provides enterprise solutions under three programs: Information Technology (IT), Mission Enabling Services (MES), and Infrastructure and Technical Capabilities (I&TC). Strategically, these programs meet workforce, infrastructure, information technology, and business operations requirements necessary to enable NASA's mission. MSaC ensures critical Agency operations are effective, efficient, safe, and meet statutory, regulatory, and fiduciary responsibilities. These mission enabling services and capabilities provide efficient and effective administration across all NASA centers and Headquarters (HQ).

- **Information Technology (IT)** provides the information services needed to fulfill NASA's multifaceted missions and operations, including cybersecurity, IT asset planning and management,

and technical support. NASA's IT Program helps improve Agency outcomes by accelerating results through tools that increase productivity, sharing NASA's data and discoveries, enabling access to transformational Artificial Intelligence capabilities, and increasing the quality, resiliency, and cost-effectiveness of its information systems. Reliable, adaptable, and secure authorized cloud-based IT, data and AI services are increasingly important to NASA's mission portfolio because they are key enablers for advances in science, technology, aeronautics, and space exploration. In FY 2025, the Information Technology Program will:

- Strengthen the agency's cybersecurity posture through the deployment of new tools and implementation of a strategy aimed to modernize and improve NASA's overall network security.
- Transform IT business services through utilization of artificial intelligence, cloud adoption, and robotic process automation.
- Continue to invest in the high-tech tools needed to improve authorized collaboration capabilities across the agency, including transitioning to hybrid workspaces that will increase productivity through remote and virtual collaborative work.
- Appoint a Chief Artificial Intelligence (AI) Officer and establish AI governance to maximize NASA's benefit from AI in a safe, secure, ethical, responsible, and respectful manner, in accordance with Executive Order 14110 on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence and other Federal directives.
- Lead innovative adoption of AI use cases in direct support of advanced mission outcomes, improved cyber security detection and response, accelerated cyber security assessments, and to gain efficiencies across all mission support functions.

- **Mission-Enabling Services (MES)** provides an enterprise approach to managing NASA business operations and mission support activities. Missions rely on these institutional services to provide the business services and skilled staff required to accomplish their objectives. Enterprise management of these areas ensures that critical agency operations are effective, efficient, and meet statutory, regulatory, and fiduciary responsibilities. Business services include financial management, human capital management, procurement, small business, legislative affairs, equal opportunity and diversity management, legal, communications, international and interagency relations, and protective services. In FY 2025, the MES program will:
  - Continue to partner with all NASA Organizations in execution of their Diversity, Equity, Inclusion, and Accessibility (DEIA) implementation plans in accordance with the DEIA and Equity Strategic Plans.
  - Enhance NASA's workforce by strengthening the professional development framework to build the current and future talent pool.
- **Infrastructure and Technical Capabilities (I&TC)** provides sustainment, operations, and maintenance for facilities and technical capabilities. The program also provides effective oversight and management of real property, environmental program activities, aircraft operations, and logistics functions. These capabilities enable NASA to meet statutory and regulatory responsibilities and ensures that the necessary infrastructure is available to meet mission requirements. This mission is accomplished through effective management of assets and capabilities, proactive coordination with NASA mission directorates, institutional planning, proactive deployment of sustainable practices, ongoing regulatory compliance, and reduction of current and future infrastructure-related risks. In FY 2025, the I&TC Program will:

- Maintain the agency's most critical infrastructure capabilities and assets using condition-based maintenance to prevent failures and increase operational readiness while maintaining compliance with environmental and mandatory standards.
- Optimize the agency's infrastructure portfolio through implementation of the Agency Masterplan (AMP) processes, including divestment of facilities no longer needed to execute NASA's mission thereby reducing future facilities maintenance costs.
- Continue agency efforts to transition to 100 percent Zero Emission Vehicle acquisitions by 2035, including 100 percent light-duty acquisitions by 2027.

ENGINEERING SAFETY AND OPERATIONS

ESO provides for the management and operations of NASA Headquarters, nine centers, and component facilities under two programs: (1) Agency Technical Authority (ATA); and (2) Center Engineering, Safety, and Operations (CESO). Both programs support scientific and engineering activities. They contribute to the reduction of program risks by ensuring that: technical skills and assets are ready and available to meet program and project milestones; mission and research endeavors are technically and scientifically sound; and center practices are safe and reliable, including the highly skilled staff and specialized infrastructure at the centers that facilitate NASA missions.

- **Agency Technical Authority (ATA)** provides the foundation for NASA's system of checks and balances, defined in NASA's Strategic Management and Governance Handbook, by providing independent technical authority over health, safety, and engineering requirements for the missions. Through independent analysis and deep subject matter expertise, ATA develops policy, designs procedural requirements, and provides recommendations to NASA's Administrator, mission directorates, center directors, and program managers, who are ultimately responsible for the safety and mission success of all NASA activities. In FY 2025, the ATA Program will:
  - Work to improve orbital debris environment models, tools, and algorithms to improve orbit predictions, understand spacecraft anomalies, and better interpret sensor data.
  - Continue providing key guidance, testing, and oversight over NASA missions and programs to ensure health, safety, and stewardship of resources.
- **Center Engineering, Safety, and Operations (CESO)** ensures NASA's unique, technical, and innovative capabilities are mission-ready by supporting center-level institutional and technical capabilities through independent research, development projects, and maintenance of facilities, laboratories, and other mission-critical assets. CESO fulfills a key component of NASA's overall approach to risk management by providing center-level independent technical authority. Center-level oversight and reporting activities uphold the strategy and guidance from ATAs, putting checks on safety, engineering, and mission assurance that are separate from mission directorates. CESO funds NASA HQ operations and center management activities across the agency. Institutional administration and operational safety programs allow centers the flexibility to address and manage conditions unique and specialized to their facilities. CESO also ensures that agency policies and guidance are operationalized across centers with consistency and efficiency. In FY 2025, the CESO Program will:
  - Continue to maintain critical strategic investments in laboratories, technical equipment, and facilities as aligned with agency goals and objectives in support of all NASA missions.

SAFETY, SECURITY, & MISSION SERVICES

BALANCING SSMS AND CECR

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Much of NASA's infrastructure dates back to Apollo-era space exploration. Maintenance activities funded by SSMS are necessary to prevent costly delays to missions and risks to health and safety. Meanwhile, failures require immediate repairs and account for an increasing share of the SSMS facilities maintenance budget. These activities are vital to support evolving mission requirements. SSMS also funds proactive maintenance initiatives such as Condition Based Maintenance to identify issues and provide lower cost, scheduled maintenance. Without a sufficient facilities maintenance budget, assets and facilities worsen to a state requiring CECR funding for more expensive solutions. The increasing deep space exploration development and testing requirements place an additional strain on NASA's infrastructure and mission-unique facilities. Both SSMS and CECR activities are vital to support mission infrastructure requirements. MSD takes an agency-wide approach to make difficult trade-off decisions that ensure critical capabilities and assets are mission-ready, while also investing in the long-term asset health, sustainability, and footprint reductions that ensure NASA's future mission success. This approach allows NASA the ability to prioritize investments in support of long-term asset health, sustainability, and footprint reductions that ensure NASA's future mission success.

MISSION SUPPORT PRIORITIES

NASA Strategic Plan 2022, Goal 4, directs NASA's mission support functions to enhance capabilities and operations to catalyze current and future mission success through three key objectives: 1) attract and develop a talented and diverse workforce; 2) transform mission support capabilities for the next era of aerospace; and 3) build the next generation of explorers. Functions and capabilities that align to these three priorities comprise the foundational business that supports NASA activities, including the agency’s mission goals.

Mission Support’s strategic approach ensures that critical services are mission-ready as requirements evolve and foundational services are keeping pace with cybersecurity, industry standards, and agency needs. NASA Mission Support will continue to support the critical capabilities needed for mission success by staying focused on mission needs, center conditions, and transformational opportunities. Mission support content is prioritized to achieve the Administration, NASA, and mission support goals and objectives, to include:

- Workforce, Essential Services, Partners:
    - Support mission-critical services that enable NASA's activities and address workforce needs, including procurement of essential goods and "best-in-class" contracts.
- Critical Infrastructure:
    - Conduct vital construction, repairs, and demolition to reduce risk in NASA's infrastructure portfolio and ensure the right capabilities are mission-ready at the right time.
- Business Transformation:

  - Introduce technologies and new processes to create strategic cohesion, service resilience, new efficiencies, and cutting-edge capabilities to enhance how people work and reduce costs

- Cybersecurity
  - Strengthen NASA's IT infrastructure, monitoring, detection systems, encryption, cloud security, and authentication to enhance protection for data and telecommunications.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

($ in Millions)	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
Construction and Environmental Compliance and Restoration	**422.4**	**414.3**	**424.1**	**379.3**	**386.9**	**394.6**	**402.5**
Construction of Facilities			**344.7**				
Institutional CoF			**292.5**				
Exploration CoF			**32.5**				
Space Operations CoF			**19.7**				
Environmental Compliance and Restoration			**79.4**				
Grand Total			**424.1**				

FY 2023 reflects Division B funding amount of $47.3 million and Division N funding amount of $367 million, as specified in Public Law 117-328, Consolidated Appropriations Act, 2023.

A full-year 2024 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Consolidated Appropriations Act, 2023 (Division B of P.L. 117-328, as amended). The amounts included for 2024 reflect the annualized level provided by the continuing resolution.

FY 2025 reflects Division N funding amount of $296 million, designated for an emergency requirement pursuant to section 251(b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985.

Totals may not add due to rounding.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

The Aerospace Communications Facility at the NASA Glenn Research Center, completed in 2023, is a state-of-the-art research facility consisting of efficient, flexible laboratories, anechoic test chambers, an RF-shielded high-bay space, collaboration spaces, information technology support areas, and both a rooftop and ground-based platforms for communication antennas. The new facility consolidates more than 80 researchers in over 50 labs located in seven separate buildings across Glenn's main campus into one cutting-edge 55,000 square-foot building. Inside the new building, researchers and scientists will develop advanced communication methods for use on Earth as well as supporting the agency's Artemis and Advanced Air Mobility missions.

Through the Construction and Environmental Compliance and Restoration (CECR) account, NASA manages two themes related to the agency's asset portfolio: capital repairs and improvements to NASA's infrastructure, and environmental compliance and restoration activities. Activities related to the design, construction, and demolition of infrastructure, including utility systems and facilities, are funded through Construction of Facilities (CoF). Environmental compliance, cleanup, and restoration activities are funded through Environmental Compliance and Restoration (ECR).

CECR funding enables NASA to address challenging infrastructure needs. More than 83 percent of NASA's infrastructure is beyond its design life, posing significant risk of failure, inefficiency, and potential impacts to health and wellness. Apollo-era infrastructure is inefficient and costly to maintain, as well as insufficient to accomplish NASA's future missions that require facilities with leading-edge capabilities. The agency currently faces a deferred maintenance backlog of $3 billion, resulting in unscheduled maintenance that can cost up to three times more than scheduled maintenance to repair or replace equipment after it has failed. To address these growing challenges, CECR is focused on modernizing and consolidating NASA's infrastructure into fewer, more efficient, and more sustainable facilities, and on repairing and upgrading infrastructure before it has failed.

CECR funding also enables NASA to address its commitment to environmental stewardship by conducting critical cleanup efforts, maintaining compliance with regulatory requirements, and managing environmental issues. NASA's estimated current environmental liability, excluding asbestos removal that is not funded by the ECR appropriation, is approaching $2.3 billion and is expected to grow as plans to address 173 areas of potential concerns for emerging per- and polyfluoroalkyl substances (PFAS) contaminant are developed.

CECR funding ensures that NASA's assets are ready, available, and appropriately sized to conduct NASA's current and future missions, while remaining compliant with the agency and governmental environmental regulations. This funding is critical to fulfill NASA's 2022 Strategic Plan Objective 4.2 to "Transform mission support capabilities for the next era of aerospace." CECR programs strive to execute construction priorities identified in the Agency Master Plan and reduce the agency's physical footprint and environmental burden.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

CECR Priorities

CECR focuses on ensuring the viability and readiness of mission-critical infrastructure, while also supporting NASA's commitment to environmental stewardship and sustainability. The activities below outline how CECR allocations are made:

- Construct new facilities and replace, repair, or upgrade existing infrastructure to support NASA's mission requirements and timeline.
- Design facilities and infrastructure solutions to support construction and repairs, while optimizing sustainability, increasing efficiency, and reducing NASA's footprint.
- Demolish unneeded and degraded facilities to avoid costs and improve sustainability.
- Invest in energy and water savings opportunities to improve NASA's environmental stewardship.
- Comply with mandates, regulations, and best practices to protect the health and wellness of the environment, NASA's workforce, and the general public.

EXPLANATION OF MAJOR CHANGES IN FY 2025

None.

KEY ACHIEVEMENTS PLANNED FOR FY 2025

CECR will continue to enable critical mission work in FY 2025, while maintaining NASA's dedication to environmental stewardship. The following list highlights high-priority FY 2025 projects. A more robust list with project descriptions is available in each program section.

- Construct, repair, or revitalize institutional infrastructure and facilities that have capabilities and impacts that span NASA centers and enable mission directorate priorities:
  - Upgrade Mechanical Systems, Component Refurbishment and Chemical Analysis Facility at Kennedy Space Center (KSC).
  - Repair canal impoundment system - inlet/outlet valves at Stennis Space Center (SSC).
  - Natural gas system gas replacement at White Sands.
  - Renew the High-Pressure Gas Facility at SSC (Phase 1 of 2), which supports all rocket engine testing programs.
  - Sanitary sewer repairs at Langley Research Center (LaRC).
  - Electromagnetic interference / compatibility Relocation at LaRC.
  - Sewage system conveyance and treatment repairs at SSC (Phase 3 of 3)
- Support Exploration Systems Development Mission Directorate (ESDMD) priorities with the construction, repair, or revitalization of critical facilities and infrastructure:
  - Modification to KSC launch infrastructure for The Space Launch System (SLS).
  - Sustainment of Exploration Ground Systems Infrastructure for Artemis.
- Support Space Operations Mission Directorate (SOMD) priorities with the construction, repair, or revitalization of critical facilities and infrastructure:

  - Continue the Deep Space Network Aperture Enhancement Project Beam Wave Guide (DAEP BWG) antenna projects with the construction of DSS-23 at Goldstone, DSS-33 at Canberra and pedestal replacement of DSS-54 at Madrid.
  - Continue underground tank replacements, replace aging generators, and replace heating, ventilation, and air conditioning (HVAC) and mechanical systems.
  - Replace obsolete BWG antenna drives and cabinets and provide additional BWG redundant power feed Apollo substations at Goldstone Deep Space Communications Complex (GDSCC).
- Demolish unneeded or degraded facilities to support a more sustainable NASA with a smaller footprint while avoiding repair and operational costs.
- Invest in energy savings projects that reduce operational costs and utility usage across NASA.
- Conduct facility planning and design associated with all construction and revitalization projects to ensure optimal consolidation, energy savings, cost effectiveness, and mission success.
- Maintain NASA's commitment to environmental stewardship by conducting critical cleanup efforts, maintaining agency-wide compliance with regulatory requirements, and managing environmental issues.

Balancing SSMS and CECR

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