

from OSTP within 180 days after enactment of this act on their findings.

NATIONAL SPACE COUNCIL

Appropriations, 2019	\$1,965,000
Budget estimate, 2020	1,870,000
Committee recommendation	1,965,000

The Committee provides \$1,965,000 for the National Space Council. The recommendation is equal to the fiscal year 2019 enacted level and \$95,000 above the request.

The National Space Council was established by title V of Public Law 100-685 and after ceasing operation in 1993, was reestablished by Executive Order 13803. The National Space Council provides advice and assistance to the President on national space policy and strategy. The Council reviews U.S. Government space policy, including long-range goals; develops strategies for national space activities; and develops recommendations for the President on space policy and space-related issues. The National Space Council's additional roles are to monitor and coordinate implementation of the Nation's objectives in space by executive departments and agencies; foster close coordination, cooperation, and technology and information exchange among the civil, national security, and commercial space sectors; and facilitate resolution of differences concerning major space and space-related policy issues.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Appropriations, 2019	\$21,500,000,000
Budget estimate, 2020	22,615,700,000
Committee recommendation	22,750,000,000

The Committee's recommendation provides \$22,750,000,000 for the National Aeronautics and Space Administration. The recommendation is \$1,250,000,000 above the fiscal year 2019 enacted level and \$134,300,000 above the budget request.

NASA was established by the National Aeronautics and Space Act of 1958 (Public Law 85-568) to conduct space and aeronautical research and development and to conduct flight activities for peaceful purposes. NASA's unique mission of exploration, discovery, and innovation is intended to preserve the United States' role as both a leader in world aviation and as the pre-eminent space-faring nation. It is NASA's mission to: advance human and robotic exploration, use, and development of space; advance and communicate scientific knowledge and understanding of the Earth, the Moon, the solar system, and the universe; and research, develop, verify, and transfer advanced aeronautics and space technologies.

For Science, the Committee's recommendation strives to keep NASA's near-term launches on track to continue progress in exploring our solar system and the universe, understanding the sun, and observing our planet. The Committee expects NASA to continue making progress on the recommendations of the National Academies' decadal surveys, now and in the future.

This bill continues investments in human spaceflight that will enable travel to the Moon with NASA developed crew and launch vehicles; enables the burgeoning domestic launch industry that is

bringing cargo, and eventually crew, to the International Space Station; and supports NASA's science and technology programs. These elements should be viewed as complementary pieces of a balanced whole.

NASA is directed to continue providing the Committee with a quarterly launch schedule, by mission, that describes risks associated with launch delays due to problems with the launch vehicle, impacts of launch delays to other missions in the launch queue, and a budget estimate of the anticipated carrying costs for missed launch windows.

The Committee expects NASA to maintain focus on improving oversight and accountability throughout the agency. NASA's acquisition management continues to be on the GAO "high risk" list. GAO's most recent assessment of NASA's large-scale projects found the agency's cost and schedule performance on major projects has deteriorated since last year with 9 of 17 projects in development experiencing cost or schedule growth. NASA is directed to cooperate fully and to provide timely program analysis, evaluation data, and relevant information to GAO so that GAO can report to Congress shortly after the annual budget submission and semiannually thereafter on the status of large-scale NASA programs, projects, and activities.

In addition, NASA is directed to provide the Committee, with its budget justification, the reserves assumed by NASA to be necessary within the amount proposed for each directorate, theme, program, project, and activity, or, if the proposed funding level for a directorate, theme, program, project, or activity is based on confidence level budgeting, the confidence level and reserves assumed in the proposed funding level.

The Committee understands that NASA projects undergo major reviews in addition to regular oversight throughout the year. When one of these reviews results in changing the cost profile of a project in the current or budget request year, the Committee expects to be informed in a timely fashion so that its actions can reflect the most recent NASA analysis and expectation. Keeping the Committee up to date should reduce NASA's propensity to submit spending plans that disregard Congressional direction.

The Federal funding priorities for NASA set forth in this bill and report should not be interpreted as suggestions from the Committee. Rather they should be interpreted like any other statutory requirement levied upon NASA. The Committee objects to NASA's efforts in recent fiscal years to redirect funding away from priorities clearly set by the Congress in law. NASA's continued use of section 505 of this bill in this manner will result in limited funding flexibility in the future.

The Committee is supportive of NASA's STEM engagement efforts that provide hands-on learning experiences for middle, high school, and college students, including space launch activities, and therefore rejects the proposed cancellation of education programs. These types of programs allow students to experience the full range of STEM-related skills involved in designing, testing, and launching vehicles and designing payloads to deepen their interest in science and engineering fields.

The Committee has chosen to articulate the funding levels of programs, where appropriate, in the form of tables and, if necessary, supplemented with explanatory report language.

SCIENCE

Appropriations, 2019	\$6,905,700,000
Budget estimate, 2020	6,393,700,000
Committee recommendation	6,905,700,000

The Committee provides \$6,905,700,000 for Science, which is equal to the fiscal year 2019 enacted level and \$512,000,000 above the budget request. The Science account encompasses: Earth Science, Planetary Science, Astrophysics, the James Webb Space Telescope, Heliophysics, and Education. This funding supports NASA programs that seek to answer fundamental questions concerning the ways in which Earth is changing; the comparison of Earth with other planets in the solar system and around other stars; the connections between the Sun and Earth; and the origin and evolution of planetary systems, the galaxy, and the universe, including the origin and distribution of life in the universe. These objectives are assisted by input from the scientific community through decadal surveys and are achieved through robotic flight missions, ground-based scientific research and data analysis, and the development of new technologies for future missions. NASA shall continue its progress toward implementing the recommendations of decadal surveys in Earth Science, Heliophysics, Planetary Science, and Astrophysics.

SCIENCE

[In thousands of dollars]

	Committee recommendation
Earth Science	1,945,000
Planetary Science	2,631,100
Astrophysics	1,171,600
James Webb Space Telescope	423,000
Heliophysics	735,000
Total, Science	6,905,700

Earth Science.—Within the amount for Earth Science, the Committee recommendation includes \$108,900,000 for Landsat 9 to maintain a 2021 launch profile; \$161,000,000 for the Plankton, Aerosol, Cloud ocean Ecosystem [PACE] mission to maintain a 2022 launch date; \$18,000,000 for CLARREO Pathfinder to continue progress on a Tier-1 decadal survey recommendation; \$10,000,000 for the Carbon Monitoring System; \$205,200,000 for Earth Venture to support missions under development while maintaining the cadence of future missions; and \$1,900,000 for NASA instruments on the Deep Space Climate Observatory. Within 30 days of enactment of this act, NASA shall report on the 5-year budget profile needed for PACE and CLARREO Pathfinder to achieve their planned launch dates and continue originally planned operations.

The recommendation fully supports, at no less than the request level, NASA–ISRO Synthetic Aperture Radar, Small Satellite Con-

stellation Initiative, and Geostationary Carbon Cycle Observatory [GeoCARB]. GeoCARB is due to launch in the summer of 2022 and will demonstrate the feasibility of using a commercial communications satellite to host a scientific NASA payload and could serve as a model for meeting future Earth Science research needs in a cost effective manner. The Committee is also supportive of efforts for the development of aircraft instrumentation and arrays that can conduct remote sensing for scientific and operational research, and directs the agency to continue partnering with non-Federal researchers to test new technologies for analyzing snow, ice, and soil moisture. The Committee remains supportive of collaborative research that works to advance our understanding of the behavior of the Earth engaging academia, particularly students, in its studies and investigations, as these partnerships ensure that NASA's data expertise remains up-to-date and increases the research capacities at universities.

Earth Science Decadal.—The Committee supports the recommendations of the National Academy of Sciences' Earth Science and Applications from Space Decadal Survey report and directs NASA to implement its findings to the extent practicable. As articulated by the report, NASA should plan to competitively select future missions that address high-priority target observables in the designated and explorer categories. The Committee is pleased to see NASA's announcement of the Earth Venture Continuity competition and believes an increase in competed, Principal Investigator-led missions will encourage responsible cost and schedule constraints, develop novel remote sensing technologies, and leverage the talents and expertise of scientists at universities and research institutions.

Unmanned Aerial Vehicles.—The Committee strongly supports NASA's efforts to develop and refine UAV platforms and encourages NASA to improve collaboration and cooperation with other science agencies of the Federal Government to share and expand limited UAV availability, including working with NOAA, to allow expanded utilization and supplement data collection in support of hurricane forecast modeling.

Planetary Science.—The Committee recommendation includes \$160,000,000 for planetary defense of which not less than \$72,400,000 should be for the Double Asteroid Redirect Test [DART] and not less than \$78,000,000 shall be for Near Earth Object Observations. It also includes full funding for the Discovery and New Frontiers programs at \$502,700,000 and \$190,400,000, respectively. The Committee expects NASA to continue the selection and launch cadence of New Frontiers and Discovery class missions in spite of any cost pressures from planetary flagship missions or the Mars program. In addition, the Committee expects NASA to submit a report with the 2021 budget request to frame how the request fulfills the Planetary Community's Decadal Survey.

The recommendation includes the request level for Radioisotope Power Systems. The recommendation also includes up to \$300,000,000, as requested, for Lunar Discovery and Exploration, including \$22,000,000 to continue the Lunar Reconnaissance Orbiter and up to \$80,000,000 for Commercial Lunar Payload Services. The Committee supports NASA's commitment to utilizing pub-

lic-private partnerships to advance its lunar science and exploration agenda and encourages the agency to leverage the resources and expertise of both private industry and universities in pursuit of these goals. The Committee directs that the Lunar Discovery and Exploration program adhere to the lunar science priorities established by decadal surveys and the National Research Council's Scientific Context for the Exploration of the Moon. Activities funded within the program should meet both lunar science and human exploration needs. The funds provided for lunar exploration are intended to support a mix of procurement of lunar payload delivery services; science instrument development; small satellite development; and long-duration lunar rover development. Given the origin of the program and the Committee's desire to foster a healthy domestic industrial base within the context of a growing market for goods and services in space, the Committee expects NASA to provide funding under this program only for lunar landers and rovers majority-designed, developed, and built in the United States. Additionally, this level of funding supports a regular cadence of at least one robotic mission to the lunar surface per year.

DART.—The Committee directs NASA to continue the development of the DART technology demonstration mission, with a target launch not later than 2022. The program provides a cost-effective way to understand how we protect the planet from asteroid threats. The Committee understands that ground based telescopes and radars will be used to provide the needed measurements to assess the degree of deflection resulting from the DART impactor and that this telescope support is already baselined in the NASA mission. The Committee reminds NASA of its mandate to detect 90 percent of objects greater than 140 meters that threaten Earth by 2020. The Committee directs NASA to develop a plan for funding the Planetary Defense Office for DART and subsequent activities, which will support successive space-based survey missions and technology demonstrations that will rapidly advance the Nation's planetary defense capabilities.

Green Bank Observatory.—The Committee recognizes the significant investment NSF has made to develop the world-class scientific facility at the Green Bank Telescope Observatory [GBO] and the benefit other agencies, including NASA, have gained through their use of the GBO facility. The Committee has therefore encouraged the development and support of multi-agency management plans for GBO, including the exploration of partnerships when feasible to maximize research capabilities at the facility.

Green Bank retains unique capabilities that can augment missions across NASA that leverage the taxpayer investment in the Observatory such as Near Earth Object characterization and support for NASA's fleet of robotic and human missions.

In an effort to foster such partnerships, within 180 days after enactment of this act, NASA shall, in consultation with the NSF and the Department of Defense, conduct a comprehensive cost and technical evaluation of constructing a radio frequency transmit capability at the Observatory. The evaluation shall consider options including the development of a state-of-the-art system and acquiring commercially available capability.

Mars Exploration.—The Committee recommendation includes \$570,000,000 for the Mars Exploration Program to ensure the launch of the Mars 2020 mission and to further development of a Mars Sample Return mission to be launched in 2026. Given that sample return was the highest priority of the previous planetary science decadal survey, NASA shall provide the Committee with a year-by-year funding profile for a planned 2026 Mars sample return launch. In addition, the Committee endorses the mid-term decadal survey recommendation for NASA to develop a comprehensive Mars program architecture, strategic plan, and management structure that maximizes synergy among existing and future domestic and international missions and science optimization at the architectural level. The Committee reiterates its previous direction that if the Mars helicopter demonstration would delay the overall Mars 2020 mission, it should not be included in the Mars 2020 program.

Astrophysics.—The Committee recommendation includes no less than \$98,300,000 for the Hubble Space Telescope, no less than \$10,000,000 for search for life technology development to leverage and scale technologies developed for the James Webb Space Telescope, and \$445,700,000 for the Wide-Field InfraRed Survey Telescope [WFIRST] to fully fund the project established at Key Decision Point-B. The Committee has again rejected the proposal to cut Hubble operations given costs that the program has absorbed to continue three fellowship programs, address hardware degradation through software changes, and enhance the long-term value of Hubble's data archive.

WFIRST.—The Committee rejects the proposal to cancel this mission which was the highest priority of the most recent Astrophysics decadal survey to settle fundamental questions about the nature of dark energy and has provided \$445,700,000 for WFIRST to be developed on a timeline that allows a 2025 launch date. The Committee reiterates the expectation that NASA will use a firm \$3,200,000,000 cost cap in its future execution of the mission. To reduce mission costs and ensure that overlap with the James Webb Space Telescope is maximized, NASA should implement the most efficient development program for the telescope and its instruments. The Committee notes that NASA's higher cost profile for WFIRST includes a 30 percent reserve for a telescope that is already built. WFIRST's use of existing hardware and proven technologies should enable a lower risk mission and shorter cycle time from development to launch.

Stratospheric Observatory for Infrared Astronomy [SOFIA].—NASA regularly reviews its missions, as part of the senior review process, to measure mission performance based on scientific merit, national needs, the technical status of the mission, and budget efficiency to help resources prioritize and ensure they are meeting their science goals. NASA shall review SOFIA at the appropriate time to determine if this mission should have its prime mission extended.

Science Mission Directorate [SMD] Education.—The Committee provides no less than \$45,600,000 for education. The Committee supports the recommendation that the Astrophysics program continue to administer this SMD-wide education funding. The Com-

mittee encourages SMD-funded investigators to be directly involved in outreach and education efforts and support citizen science. NASA should continue to prioritize funding for on-going education efforts linked directly to its science missions.

Astrophysics Research.—The Committee recognizes the role of the Astrophysics Research program in supporting the development of novel astrophysics observation technologies that lay the foundation of future mission architectures. Additionally, a strong research program maximizes the scientific value of space-based missions by ensuring that the data collected through such observations can continue to provide new insights into the mechanisms behind cosmological phenomena. The Committee also understands that supporting these activities through extramural grant funding contributes to the long-term viability of the U.S. astrophysics community. As such, the Committee recommends \$250,700,000 for Astrophysics Research.

James Webb Space Telescope.—The Committee maintains its strong support for the completion of the James Webb Space Telescope [JWST], and provides \$423,000,000 for JWST. In June 2018, NASA presented the results of a second independent analysis of JWST cost and schedule. Following the recommendations of NASA and the independent team, Congress provided \$304,600,000 for JWST in fiscal year 2019 and raised the development cost cap by \$802,700,000 to accommodate the cost overrun and schedule slip. JWST will be nearly 100 times more powerful than Hubble and cement continued American leadership in astronomy. That is why the Committee was befuddled by NASA’s fiscal year 2020 request for JWST of \$352,600,000 rather than the \$423,000,000 that was anticipated in the June 2018 updated cost estimate. The Committee has provided the full amount of \$423,000,000 for JWST and has again included a cost cap for JWST in title V of the bill. The Committee expects to be briefed expeditiously and kept fully informed on issues relating to program and risk management, achievement of cost and schedule goals, and the program’s technical status, including any impacts to other projects to accommodate JWST costs. Unfortunately, this expectation, while included in prior acts, has not been met by the agency.

Heliophysics.—The Committee recognizes that a greater understanding of our Sun and the accompanying technologies developed for that purpose will help to mitigate the hazards that solar activity poses to ground- and space-based platforms that strengthen our national security, economic competitiveness, and scientific prowess. The recommendation provides \$735,000,000 for Heliophysics, including \$183,200,000 for Solar Terrestrial Probes, an increase of \$5,300,000 above the request to support continued mission formulation and development of Interstellar Mapping and Acceleration Probe [IMAP], implement accompanying Missions of Opportunity [MOs], and maintain operations for ongoing missions, including the Magnetospheric Multiscale [MMS] mission. The Committee directs NASA to provide not less than the fiscal year 2019 level for operations and scientific analysis for MMS and supports the request level for Research Range.

Heliophysics Explorer.—The Committee is encouraged by NASA’s commitment to implement a 2-year cadence of alternating Small

Explorer and Mid-sized Explorer missions, and enable a regular selection of MOs to allow heliophysics researchers to rapidly respond to and participate in missions both inside and outside of NASA. This commitment follows the recommendations of the National Research Council Decadal Survey and can accelerate scientific understanding while developing the scientific workforce through increased research opportunities for students and faculty. The recommendation provides the request level of \$182,000,000 for Heliophysics Explorers.

Diversify, Realize, Integrate, Venture, Educate [DRIVE] Initiative.—The Committee supports implementation of the DRIVE initiative, a top priority of the National Research Council Decadal Survey, and encourages NASA to implement the goal of increasing the competitive research program to 25 percent of the Heliophysics budget request to enable the development of new technologies, establish competitively-awarded DRIVE Science Centers, support multidisciplinary research collaboration, and support early career investigators. The Committee recognizes the increasingly multidisciplinary nature of Heliophysics and seeks to provide researchers with the necessary tools to enable continued scientific progress in this field.

Heliophysics Technology Program.—The Committee recognizes the critical role that technology development programs play in enabling novel and transformative capabilities and mission concepts, and notes the contributions of these programs in other Divisions within SMD. The Committee directs the administration to formally include such a program as a standalone account line in future budget proposals to Congress.

Space Weather Science Applications.—In response to the Space Weather Action Plan and the recommendations of the Decadal Survey, the Committee recommendation provides no less than \$20,000,000 for space weather science applications to support innovation in observational capabilities and advance research-to-operations, operations-to-research, and computational aspects of space weather mitigation. NASA should coordinate with NOAA, NSF, and the Department of Defense to ensure that NASA is focused on research and technology that enables other agencies to dramatically improve their operational space weather assets and the forecasts they generate using data from those assets, including current and future ground-based telescopes and instruments that are expected to come on line, such as the Daniel K. Inouye Solar Telescope. In addition, the Committee recognizes the diversity of activities within Living With a Star [LWS] that contribute to our understanding of the societal impact of the Sun-Earth system and encourages the Administrator to ensure that future budget proposals support missions that are currently operating and enable the formulation and development of future missions, including the next LWS mission.

AERONAUTICS

Appropriations, 2019	\$725,000,000
Budget estimate, 2020	666,900,000
Committee recommendation	783,900,000

The Committee provides \$783,900,000 for Aeronautics, which is \$58,900,000 above the fiscal year 2019 enacted level and \$117,000,000 above the budget request. The Aeronautics account funds research in key areas related to the development of advanced aircraft technologies and systems, including those related to aircraft safety, ultra-efficient vehicles and fuel efficiency, hypersonics, and research that supports the Next Generation Air Transportation System in partnership with the Joint Planning and Development Office.

The Committee supports New Aviation Horizons and is encouraged by NASA's efforts toward developing a Low Boom Flight Demonstrator X-plane, referred to as the Low Boom Flight Demonstrator [LBFD]. Within the funds provided for Aeronautics, appropriate funds are included to enable the next X-plane demonstration planned beyond LBFD.

University Leadership Initiative.—The Committee recognizes that universities are uniquely suited to contributing revolutionary advances in aeronautical technologies. This is especially relevant to areas where multidisciplinary convergent research is needed to address complex technical challenges in early stage technology development. The Committee commends NASA for establishing the University Leadership Initiative to leverage university-led research in accordance with the Strategic Implementation Plan.

Electric Air Flight.—NASA is encouraged to strengthen collaborations with the Department of Energy to overcome energy storage challenges for novel modes of mobility like electric air flight.

Advanced Materials Research.—The Committee recognizes the continuing role NASA and university research institutions play in developing advanced materials platforms for next-generation air and space vehicles. NASA is encouraged to partner with academic institutions that have strong capabilities in aviation, aerospace structures, and materials testing and evaluation, and provides \$7,000,000 above the request to advance university-led aeronautics materials research.

Unmanned Traffic Management.—The Committee commends NASA for leveraging its capabilities in assisting the Nation's UAS test sites to advance efforts on the unmanned traffic management [UTM] program. NASA is encouraged to work with Federal agencies, States, counties, cities, and tribal jurisdictions on research toward the development of a UTM system that will ensure the broadest level of acceptance from local jurisdictions.

The Committee is interested in NASA research and development efforts designed to further new innovations in propulsion, simplified vehicle operations, increased automation, and the integration of these operations into controlled airspace. The Committee believes these technologies can address critical mobility challenges.

The Committee further expects NASA to work with industry stakeholders and coordinate with the Federal Aviation Administration to expedite technology introduction and maximize improvements in safety, affordability, and environmental benefits like noise and emissions reduction. As part of this effort, NASA is encouraged to leverage other directorates' research efforts, test sites, and industry partnerships where applicable.

Unmanned Aerial Systems Research.—NASA conducts research to reduce technical barriers associated with integrating UAS into the National Airspace System. This research remains a national priority with the potential to increase public safety and bring economic benefits to a wide range of industries.

Advanced Composite Project.—The Committee understands NASA has concluded the Advanced Composites Project [ACP] that enabled public-private partnerships for collaborative research in aeronautic composites toward the goal of reducing the development and certification timeline for composite aircraft. NASA intends to take the results of the ACP to drive research activities across the Aeronautics portfolio. While NASA advances their integrated Materials, Structures, and Manufacturing strategy to follow on the work of the ACP, the agency should keep in mind the work of the Advanced Composites Consortium to reduce the development and certification timeline for composite aircraft. In order to maintain the capabilities developed through public-private partnerships within the ACP, no less than the fiscal year 2019 funding level is provided for maintaining existing capabilities and intellectual property structures of this vital aeronautics science and technology research program as an element of our national aeronautics research strategy. NASA shall submit to the Committee, no later than 120 days after enactment of this act, a report detailing the utilization of public-private partnership activities developed as part of the ACP, the benefits of the program, and how NASA intends to strategically structure follow-on research activities across the directorate, while continuing to engage industry and academia.

Aerosciences Evaluation and Test Capabilities [AETC].—The Committee recommendation provides for all funding for AETC activities to be consolidated within the Aeronautics account. Aeronautics is the single largest user of these facilities and activities. This consolidation of AETC within a single account is intended to provide sufficient funds for operations and maintenance so that the capabilities are available for use across NASA without the need to transfer funds among disparate mission accounts.

SPACE TECHNOLOGY

Appropriations, 2019	\$926,900,000
Budget estimate, 2020	1,146,300,000
Committee recommendation	1,076,400,000

The Committee provides \$1,076,400,000 for Space Technology, which is \$149,500,000 above the fiscal year 2019 enacted level and \$69,900,000 below the budget request. The Space Technology mission directorate funds basic research that can advance multi-purpose technologies to enable new approaches to NASA's current missions. These technologies can serve all NASA mission directorates and are not solely focused on enabling human spaceflight. Funding for the human research program remains in Exploration Research and Technology and is not transferred to Space Technology, as requested. Space Technology also includes funding for NASA's Small Business Innovative Research [SBIR] and Small Business Technology Transfer programs.

The Committee is supportive of many of the technologies being developed within Space Technology, which will have wide ranging benefits for NASA missions and throughout the agency. Of particular note are the enabling technologies of Solar Electric Propulsion; the laser communications relay demonstration; in-space manufacturing and assembly; and composite tanks and structural materials. These key supporting technologies will provide enabling capabilities for multiple robotic and human exploration missions. The Committee is also supportive of the Regional Economic Development Program and encourages NASA to consider expanding the program to all 50 States.

The recommendation includes \$35,000,000 for additive manufacturing, \$20,000,000 for the Flight Opportunities Program, and \$5,000,000 to advance large scale production and use of innovative nanomaterials, including carbon nanotubes.

Satellite Servicing/RESTORE-L.—The Committee recommends \$180,000,000 for the Restore-L Project only to conduct and demonstrate the capabilities to refuel satellites in low-Earth orbit utilizing Landsat-7. The project shall target a launch before Landsat-7's fuel supply runs out in late calendar year 2021. As the program progresses from research to implementation, the Committee encourages NASA to work with private sector and university partners to facilitate commercialization of the technologies developed within the program and directs NASA to submit with its fiscal year 2021 budget request a report on current efforts underway to encourage commercialization of technology within the Restore-L program, with a focus on how intellectual property will be handled. The Committee encourages NASA to make Restore-L's capabilities available to other government agencies that own and operate satellites.

Nuclear Propulsion.—NASA is continuing its work to develop the foundational technologies and advance low-enriched uranium nuclear thermal propulsion systems that can provide significantly faster trip times for crewed missions than non-nuclear options. Not less than \$100,000,000 is for the development of nuclear thermal propulsion, of which not less than \$70,000,000 shall be for the design of a flight demonstration by 2024 for which a multi-year plan is required. Within 180 days of the enactment of this act, NASA, in conjunction with other relevant Federal departments and agencies shall submit a multi-year plan that enables a demonstration no later than 2024 and describes future missions and propulsion and power systems enabled by this capability.

Flight Opportunities Program.—The funding provided for this program may be used to support undergraduate and graduate work in developing flight opportunities payloads. NASA should ensure that funds are available for flight opportunities of science, technology demonstration, and educational payloads developed across all NASA Mission Directorates, as well as external flight opportunities, as authorized under section 907 of the NASA Authorization Act of 2010 (Public Law 111-267), including competitively-selected opportunities in support of payload development and flight of K-12 and collegiate educational payloads.

Small Business Innovation Research.—The Committee recognizes the importance of the SBIR program and its previous success in

commercialization of results from federally funded research and development projects and includes the requested level for SBIR. The SBIR program encourages domestic small businesses to engage in Federal research and development, and creates jobs. The Committee therefore directs NASA to place an increased focus on awarding SBIR awards to firms with fewer than 50 employees.

EXPLORATION

Appropriations, 2019	\$5,050,800,000
Budget estimate, 2020	6,396,400,000
Committee recommendation	6,222,600,000

The Committee provides \$6,222,600,000 for Exploration, which is \$1,171,800,000 above the fiscal year 2019 enacted level and \$173,800,000 below the budget request using the fiscal year 2019 account structure.

The Exploration account funds the capabilities required to develop, demonstrate, and deploy the transportation, life support, and surface systems that will enable sustained human presence beyond low-Earth orbit and throughout the solar system. The Committee believes the Nation deserves a safe and robust human spaceflight program to explore beyond low-Earth orbit.

EXPLORATION

[In thousands of dollars]

	Committee recommendation
Orion	1,406,700
Space Launch System	2,585,900
Exploration Ground Systems	590,000
Exploration Research and Development	1,640,000
Advanced Exploration Systems	255,600
Gateway	500,300
Advanced Cislunar and Surface Capabilities	744,100
Human Research Program	140,000
Total Exploration	6,222,600

NASA has embarked on an ambitious goal to return U.S. astronauts to the surface of the Moon by 2024, known as the “Artemis” mission. This is a significant acceleration of the program compared to the original fiscal year 2020 budget request that envisioned the same mission to be accomplished by 2028. The Committee has used the amended request as a guide in formulating its recommendations but also recognizes that several aspects of the accelerated mission are in the early stages of planning and development, and the estimated costs of elements through completion of the near term goal were not available to the Committee. While there is support for the mission, it is difficult to weigh the impacts of the accelerated mission on the overall budget of NASA with only a single year budget proposal. NASA must provide 5-year budget profiles, similar to all other NASA missions and programs, in order to allow a thorough evaluation by the Committee. In the interim, the Committee has provided funds to allow for NASA to advance its human exploration program and awaits further definition of the program and its estimated associated costs.

The Space Launch System [SLS], Orion multi-purpose crew vehicle, and Exploration ground systems are all critical infrastructure for the development and sustainment of the Nation's human exploration goals. These investments will enable the human exploration of space beyond low-Earth orbit, and provide flexibility for a variety of mission destinations including the Moon and Mars.

The Committee provides: \$2,585,900,000 for SLS of which \$300,000,000 is provided for concurrent Exploration Upper Stage [EUS] development and procurement; \$1,406,700,000 for Orion; and \$590,000,000 for Exploration Ground Systems. These funding levels reflect consistent programmatic funding to ensure the earliest possible crewed launch of SLS, as well as prepare for future science and crewed missions.

NASA's Exploration Systems Development is made up of distinct, but equally important pieces: the SLS heavy-lift launch vehicle and its propulsion systems, Orion, and the supporting ground systems that process and enable the launch of these vehicles. If any of these activities are delayed, then the entire exploration enterprise of launching humans beyond low-Earth orbit by NASA is also hindered. Therefore, it is important to view these programs as part of a complete system and to budget accordingly so that the Nation can advance its exploration goals.

It is important to note that the funding levels provided by the Committee support the development of multiple iterations of launch and crew test articles and flight vehicles that are being developed and produced during fiscal year 2020. Flight hardware that will be used for the initial uncrewed and crewed test launches, as well as the flights that will return astronauts to the lunar surface are included within the funding provided, as is funding for procurement of EUS hardware for its initial flight and future missions.

The Committee directs NASA to follow its "Priority of Use" clause for ensuring that its missions are prioritized and that mission related activities and schedules of NASA missions are not impacted by outside activities at its centers. In particular, NASA shall ensure that any non-Federal activities do not interfere with the progress of, and schedule for, the Artemis missions and will report to the Committee any conflicting activities and how the conflict was resolved 15 days prior to any activity taking place.

Exploration Research and Development [ERD].—The Committee provides \$1,640,000,000 for ERD of which \$500,300,000 is for Gateway, \$140,000,000 is for the Human Research Program, \$255,600,000 is for Advanced Exploration Systems, and \$744,100,000 is for Advanced Cislunar and Surface Capabilities. NASA must focus its efforts towards systems enabling a crewed landing on the Moon. This requires quickly identifying requirements and selecting teams that can meet a timeline that will make a safe landing as early as 2024 possible.

Lunar Lander Development.—As NASA embarks on a return to the Moon as part of its larger human exploration strategy, the need for the development of a lander that is tested and ready for crewed missions is of critical importance. In order to support the immediate need for developing a lunar lander capability by 2024, \$44,100,000 is provided for the lunar lander office to lead the support of NASA's accelerated exploration timeline. In order to expe-

dite development of lunar landers, NASA is encouraged to engage in public-private partnerships for lunar lander development and demonstration with at least one U.S. commercial company this year to meet the goal of safely delivering crew to the lunar surface. NASA shall ensure that as part of the lander procurement, an appropriate testing regimen can be executed prior to its crewed use and any selected lander designs can utilize any U.S. launch vehicle, commercial or otherwise, that is available for lunar exploration missions. This will allow for a robust and flexible lander architecture that matches schedule to launch vehicle availability.

Advanced Technologies to Support NASA Air Revitalization Initiative.—NASA could benefit from the Nation’s global leadership in ionic liquid advanced technologies related to mission critical tasks such as air revitalization. The recommendation includes the requested level within AES for applied industry and university research related to development and application of ionic liquid based technologies to aid in air revitalization systems. The Committee encourages NASA to support institutions with strong capabilities in developing these advanced technologies and demonstrated capabilities for translating technology into practice.

SPACE OPERATIONS

Appropriations, 2019	\$4,639,100,000
Budget estimate, 2020	4,285,700,000
Committee recommendation	4,150,200,000

The Committee provides \$4,150,000,000 for Space Operations, which is \$488,900,000 below the fiscal year 2019 enacted level and \$135,500,000 below the budget request. The Space Operations account funds the International Space Station [ISS] and the supporting functions required to conduct operations in space. The ISS is a complex of research laboratories in low-Earth orbit in which American, Russian, and international partner astronauts conduct unique scientific and technological investigations in a microgravity environment.

ISS Research.—Increased crew time aboard the ISS presents more research opportunities. The Committee directs NASA to promote new grant opportunities that will support and further biological and physical sciences research within a microgravity environment, including continued study of and quantifying potential exposure to cosmic rays through initiatives such as the Alpha Magnetic Spectrometer. In making grant opportunities available, the Committee urges the Administrator to abide by the priorities established by the National Academies’ decadal survey titled “Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era.”

Commercial Crew and Cargo.—The Committee recommends up to the requested level of funding for Commercial Crew and Cargo, including the Commercial Crew program. The Commercial Crew program is scheduled to launch U.S. astronauts on U.S. vehicles to the ISS during fiscal year 2020.

Commercial Low-Earth Orbit Development [LEO].—The Committee supports maintaining the ISS with direct Federal funding beyond 2025 until a viable alternative exists to achieve NASA’s objectives in LEO. The Committee supports public-private partner-

ships to advance commercial capabilities in LEO, particularly those involving in-kind contributions by NASA, such as making a docking node on the ISS available for partnership opportunities. However, the Committee notes that in NASA's March 27, 2019, report to the Committee providing a multi-year plan for lunar activities, NASA highlights: "a long-term LEO marketplace with primarily non-NASA commercial revenue is not viable without a significant transition period during which the U.S. Government continues to make investments in the market and purchases services from it." The report goes on to say that the transition will last for years, during which NASA will be expected to be the anchor tenant of any so-called commercial venture. Other NASA studies have found that the most promising market for LEO is space tourism. At this time, NASA is undertaking an independent review of its legacy commercialization activity, the ISS National Lab, formerly known as the Center for the Advancement of Science in Space to evaluate its commercial strengths and weaknesses. The recommendation provides \$15,000,000 for Commercial LEO activities to allow for continued opportunities for LEO commercialization that are not primarily dependent on NASA funding. NASA is encouraged to consider how regional partnerships between academia and the private sector can be mobilized and organized to better foster the growth of a commercial user base for space services and microgravity operations.

Rocket Propulsion Test Program and Testing Infrastructure.—The Committee recommends the fiscal year 2020 requested amount for the NASA Rocket Propulsion Test program to ensure test infrastructure remains adequate to support the SLS and other propulsion development programs. The Committee notes that NASA is planning to utilize its existing test facilities for the SLS green run test and that NASA anticipates doing so for Exploration Upper Stage testing in the future. The Committee encourages NASA to develop plans to fully utilize NASA-owned rocket testing infrastructure for commercially developed launch vehicles to ensure that these vehicles are not only tested in the same manner as Government-developed launch vehicles, but also at the same facilities, to ensure consistency in testing across all potential vehicles.

Space and Flight Support Launch Services.—The Committee believes that small launch vehicle development will lead to a capability that will maximize benefits to the government, the private sector, and universities while promoting increased participation in the small launch market. The recommendation supports funding in Space Technology, Science, and Exploration, estimated at \$21,500,000, that is provided to the Launch Services Program to procure launch vehicles of small payloads to increase opportunities for improved access to suborbital and orbital launch opportunities once the current round is completed. NASA shall also keep the Committee informed of the two upcoming demonstration launches planned for 2019, as well as its future plans to maximize utilization of this program that will lower small launch costs and increase access to space.

Space Communications.—The recommendation supports the completion of the Space Network Ground Segment Sustainment project. The Committee recognizes and appreciates the complexities

involved in sustaining NASA's Near Earth, Space, and Deep Space communications networks and infrastructure, which support NASA's scientific and exploration activities. The Committee directs NASA to develop a plan, budget, and timeline for sustainment of NASA's existing communications network and infrastructure. No funding is provided for the proposed new Communications Services Program.

21st Century Launch Complex.—The Committee notes that maintaining multiple launch sites contributes to assured access to the ISS for NASA, researchers, and industry. The recommendation includes \$15,000,000 for NASA-owned launch facilities, of which \$10,000,000 shall be for the Wallops Flight Facility launch complex. Within 45 days of enactment of this act, NASA shall submit to the Committees on Appropriations a prioritized list of remaining needs for NASA-owned launch facilities necessary for range modernization to meet critical maintenance, capacity, and range safety needs over the next 5 years, along with an indication of whether these projects are planned to be funded under Exploration or Construction of Facilities [CoF]. The Committee notes that significant funding for Kennedy Space Center and Wallops Flight Facility projects have been previously included in CoF in both the fiscal year 2019 enacted bill and in this act.

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS
ENGAGEMENT

Appropriations, 2019	\$110,000,000
Budget estimate, 2020	
Committee recommendation	112,000,000

The Committee does not agree with the proposed cancellation of the activities within the Science, Technology, Engineering, and Mathematics Engagement account. The Committee provides \$112,000,000 for STEM Engagement, which is \$2,000,000 above the fiscal year 2019 enacted level and \$112,000,000 above the budget request. As part of this activity, NASA is directed to continue progress toward the Committee and NASA's shared goal of capping administrative costs at no more than 5 percent. This account funds STEM education activities to educate and inspire our next generation of explorers and innovators.

STEM ENGAGEMENT
[In thousands of dollars]

	Committee recommendation
NASA Space Grant	47,000
Established Program to Stimulate Competitive Research [EPSCOR]	22,000
Minority University Research and Education Project	33,000
STEM Education and Accountability Projects	10,000
TOTAL	112,000

Space Grant.—The Committee provides \$47,000,000 for Space Grant and directs that all 52 participating jurisdictions be supported at no less than \$760,000. NASA shall limit administrative costs to the fiscal year 2019 level and shall continue to have a goal

of reducing administrative costs to no higher than 5 percent. The Committee encourages NASA to use increased funding to evaluate program performance, augment base grants, and competitively respond to local, regional, and national needs.

Competitive Program.—The Committee provides \$5,000,000 for the Competitive Program for Science, Museums, Planetariums, and NASA Visitors Centers within the STEM Education and Accountability Projects. This competitive grant program supports interactive exhibits, professional development activities, and community-based programs to engage students, teachers, and the public in STEM. The Committee is concerned that the program is now focused on coalition building rather than developing cutting-edge educational products for wide distribution, and that this change occurred without community input. The Committee encourages NASA to follow the program’s authorized purpose.

SAFETY, SECURITY, AND MISSION SERVICES

Appropriations, 2019	\$2,755,000,000
Budget estimate, 2020	3,084,600,000
Committee recommendation	2,934,800,000

The Committee provides \$2,934,800,000 for Safety, Security, and Mission Services, which is \$179,800,000 above the fiscal year 2019 enacted level and \$149,800,000 below the budget request. The Safety, Security, and Mission Services account funds agency management, including headquarters and each of the nine NASA field centers, as well as the design and execution of non-programmatic Construction of Facilities and Environmental Compliance and Restoration activities.

Independent Verification and Validation [IV&V] Program.—Within the amounts provided for cross-agency support, the Committee recommends \$39,100,000 for NASA’s IV&V Program. If necessary, NASA shall fund additional IV&V activities from within the mission directorates that make use of IV&V services.

Moon to Mars Office.—As NASA moves forward with its plans to emphasize lunar research and human exploration of the Moon, it is important for NASA to have a clear, agency-wide vision to align efforts toward the implementation of an integrated Moon to Mars campaign. The Committee encourages NASA to consider a structure similar to other offices, such as the Office of the Chief Technologist and the Office of Chief Scientist as a model that could be followed. Such an office with a focus on lunar exploration would allow for agency-wide coordination of resources and activities across multiple directorates, while not disrupting NASA’s current organization with major structural reorganizations. The Committee believes that sufficient funding is available if NASA chooses to pursue the organization of such an office pursuant to section 505 of this act.

Information Technology.—The Committee is extremely concerned with reports from the Inspector General [IG] and GAO on the state of NASA’s Information Technology security. NASA needs to have outward facing systems that provide information and scientific data to users. These systems must have protections in place for sensitive data and internal operations. NASA requires an appropriate workforce to ensure the agency’s IT systems are secure. Both the IG and

GAO highlight deficiencies within the Office of the Chief Information Officer. NASA is directed to provide the Committee with its plans to implement the recent recommendations of the IG and GAO on IT security no later than 30 days after enactment of this act.

Cybersecurity.—The Committee’s recommendation includes the full request for Agency Information Technology Services to support shifting NASA’s IT model to one that enhances cybersecurity with strong governance and information security practices.

Annual Financial Audit.—Over the past 8 fiscal years, NASA has received clean financial audit opinions. The Committee expects that NASA will take every action necessary to achieve clean financial audits this year and in the future. In order to maintain a stable financial base for executing NASA’s mission, no funds are provided to implement, alter, or configure changes to its financial system to accommodate Category B apportionments for amounts below NASA appropriation account levels.

Buy American Provisions.—NASA is reminded of language included in the NOAA section of this report regarding Buy American provisions which apply to NOAA, NASA, and NSF related to the acquisition, construction, or conversion of a marine vessel or marine vessel components.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

Appropriations, 2019	\$348,200,000
Budget estimate, 2020	600,400,000
Committee recommendation	524,400,000

The Committee provides \$524,400,000 for Construction and Environmental Compliance and Restoration, which is \$176,200,000 above the fiscal year 2019 enacted level and \$76,000,000 below the budget request. The Construction and Environmental Compliance and Restoration account provides for design and execution of programmatic, discrete and minor revitalization, construction of facilities projects, facility demolition projects, and environmental compliance and restoration activities.

PFAS.—The Committee is aware that NASA, in collaboration with local, State, and Federal agencies, has conducted testing of the groundwater monitoring wells and drinking water wells near Wallops Flight Facility for the presence of PFAS. The Committee supports this action and urges NASA to act expeditiously to understand the extent of PFAS in and around the Wallops facility and to determine the need for action. The Committee also acknowledges NASA’s role in the development of PFAS guidelines and standards promulgated by the Administration, and urges NASA to take steps to improve transparency of the underlying data recommendations used in the formation of this guidance.

OFFICE OF INSPECTOR GENERAL

Appropriations, 2019	\$39,300,000
Budget estimate, 2020	41,700,000
Committee recommendation	40,000,000

The Committee’s recommendation provides \$40,000,000 for the Office of Inspector General, which is \$700,000 above the fiscal year 2019 enacted level and \$1,700,000 below the budget request. The

Office is responsible for promoting efficiency and preventing and detecting crime, fraud, waste, and mismanagement.

ADMINISTRATIVE PROVISIONS

The Committee includes bill language regarding the availability of funds for certain prizes. NASA is reminded that under the authority provided in section 20144 of title 52, United States Code, no prize may be announced until the funds needed to pay it have been appropriated or committed to in writing by a private source. NASA is directed to provide any written notification under subsection (h)(4) of that section to the Committees on Appropriations of the Senate and the House of Representatives.

The Committee also includes bill language regarding transfers of funds between accounts and the NASA spending plan for fiscal year 2020.

NATIONAL SCIENCE FOUNDATION

Appropriations, 2019	\$8,075,000,000
Budget estimate, 2020	7,066,000,000
Committee recommendation	8,317,000,000

The Committee's recommendation provides \$8,317,000,000 for the National Science Foundation [NSF]. The recommendation is \$242,000,000 above the fiscal year 2019 enacted level and \$1,251,000,000 above the budget request.

NSF was established as an independent agency by the National Science Foundation Act of 1950 (Public Law 81–507) and is authorized to support research and education programs that promote the progress of science and engineering in the United States. The Foundation supports research and education in all major scientific and engineering disciplines through grants, cooperative agreements, contracts, and other forms of assistance in all parts of the United States. NSF also supports unique domestic and international large-scale research facilities.

RESEARCH AND RELATED ACTIVITIES

Appropriations, 2019	\$6,520,000,000
Budget estimate, 2020	5,662,960,000
Committee recommendation	6,769,670,000

The Committee's recommendation provides \$6,769,670,000. The recommendation is \$249,670,000 above the fiscal year 2019 enacted level and \$1,106,710,000 above the budget request.

The Research and Related Activities [R&RA] appropriation funds scientific discovery, trains a dynamic workforce, and supports broadly accessible state-of-the-art tools and facilities. Research activities contribute to the achievement of these outcomes through expansion of the knowledge base; integration of research and education; stimulation of knowledge transfer between academia and the public and private sectors, and international activities; and brings the perspectives of many scientific disciplines to bear on complex problems important to the Nation. NSF's discipline-oriented R&RA account includes: Biological Sciences; Computer and Information Science and Engineering; Engineering; Geosciences; Mathematical and Physical Sciences; Social, Behavioral and Eco-