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(Original Signature of Member)

116TH CONGRESS
2D SESSION

H. R. _____

To authorize the programs of the National Aeronautics and Space Administration, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

Ms. KENDRA S. HORN of Oklahoma (for herself, Mr. BABIN, Ms. JOHNSON of Texas, and Mr. LUCAS) introduced the following bill; which was referred to the Committee on _____

A BILL

To authorize the programs of the National Aeronautics and Space Administration, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the ''National Aeronautics and Space Administration Authorization Act of 2020''.

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

SEC. 2. FINDINGS.

Congress makes the following findings:

(1) NASA should remain a multimission agency and continue to carry out, in partnership with academia, industry, and international partners, a balanced program of science, aeronautics, space technology, human exploration, and educational activities.

(2) The Nation's investments in civil space research, technology, and development have and will continue to contribute significantly to the Nation's

innovation capacity and economic strength, and provide applications and benefits that improve the lives of United States citizens and society.

(3) International cooperation and collaboration strengthen the Nation's science, aeronautics, and human exploration programs and unify partner nations in the peaceful uses of outer space.

(4) NASA's leadership in aeronautics has contributed greatly to the Nation's strength in civil and commercial aviation and should remain a priority as innovative technologies and aviation concepts offer the potential to transform the future of aviation and support the Nation's economic growth.

(5) NASA makes essential contributions to our understanding of the global challenge of climate change through its collection of space-based Earth science data, research on global, integrated Earth system science, and development of models that advance our understanding of the climate system and the natural and human impacts on it.

(6) The Nation's human space exploration goal should be to send humans to the surface of Mars.

(7) Reducing the risk and demonstrating the capabilities and operations needed to support a

human mission to Mars may require human exploration of the cis-lunar vicinity and lunar surface.

(8) A constancy of purpose, including clear and consistent goals and objectives, is essential for making effective progress on the Nation's science, aeronautics, space technology, and human exploration programs and for attracting and keeping the Nation's best, brightest, and most capable workforce.

(9) Clearly defined roles, responsibilities, and accountability provides transparency in the implementation of the Nation's civil space goals and objectives.

(10) The innovative capabilities of the commercial space industry are essential to the Nation's science, aeronautics, and human space exploration activities, are an important instrument of technological and economic competitiveness, and should be leveraged, as appropriate, to advance the Nation's objectives in civil space.

SEC. 3. DEFINITIONS.

In this Act:

(1) ADMINISTRATION.—The term ''Administration'' has the meaning given the term in section 10101 of title 51, United States Code.

(2) ADMINISTRATOR.—The term ''Administrator'' has the meaning given the term in section 10101 of title 51, United States Code.

(3) CIS-LUNAR SPACE.—The term ''cis-lunar space'' means the region of space from the Earth out to and including the region around the surface of the Moon.

(4) DEEP SPACE.—The term ''deep space'' means the region of space beyond low-Earth orbit, including cis-lunar space.

(5) ISS.—The term ''ISS'' means the International Space Station.

(6) NASA.—The term ''NASA'' means the National Aeronautics and Space Administration.

(7) ORION.—The term ''Orion'' has the meaning given the term in section 20302 of title 51, United States Code.

(8) SPACE LAUNCH SYSTEM.—The term ''Space Launch System'' has the meaning given the term in section 20302 of title 51, United States Code.

(9) UNITED STATES GOVERNMENT ASTRONAUT.—The term ''United States government astronaut'' has the meaning given the term ''government astronaut'' in section 50902 of title 51, United States Code.

TITLE I—AUTHORIZATION OF APPROPRIATIONS

SEC. 101. FISCAL YEAR 2020.

There are authorized to be appropriated to NASA for fiscal year 2020, $22,629,000,000 as follows:

(1) For exploration, $6,017,600,000, of which $1,406,700,000 shall be for the Orion multi-purpose Crew Vehicle, $2,585,900,000 shall be for the Space Launch System, $590,000,000 shall be for Exploration Ground Systems, and $1,435,000,000 shall be for Exploration Research and Development.

(2) For space operations, $4,140,200,000.

(3) For science, $7,138,900,000, of which $1,971,800,000 shall be for Earth Science, $2,713,400,000 shall be for Planetary Science, $1,306,200,000 shall be for Astrophysics, $423,000,000 shall be for the James Webb Space Telescope, and $724,500,000 shall be for Heliophysics.

(4) For aeronautics, $783,900,000.

(5) For space technology, $1,100,000,000.

(6) For science, technology, and mathematics (STEM), $120,000,000, of which $48,000,000 shall be for the National Space Grant College and Fellowship Program, $24,000,000 shall be for the Estab-

lished Program to Stimulate Competitive Research (EPSCoR), $36,000,000 shall be for the Minority University Research and Education Project (MUREP), and $12,000,000 shall be for STEM Education and Accountability Projects (SEAP).

(7) For safety, security, and mission services, $2,913,300,000.

(8) For construction and environmental compliance and restoration, $373,400,000.

(9) For Inspector General, $41,700,000.

TITLE II—HUMAN SPACE EXPLORATION AND OPERATIONS

Subtitle A—Moon to Mars Program

SEC. 201. SUSTAINABLE HUMAN EXPLORATION PROGRAM.

It is the sense of Congress that the Nation's human exploration program is an important element of United States leadership in space exploration, economic strength, and national security. It is the further sense of Congress that constancy of purpose and the sustainability of the Nation's human exploration goals and objectives should be an inherent principle of a long-term, deep space human exploration program that spans several Congresses and Administrations.

SEC. 202. GOALS AND OBJECTIVES.

(a) IN GENERAL.—The Administrator is authorized under sections 20302 and 70504 of title 51, United States Code, and shall carry out plans and programs to achieve sustainable human exploration of deep space for the purpose of sending humans to the surface of Mars.

(b) ESTABLISHMENT.—The goal of NASA's Moon to Mars program shall be to land humans on Mars in a sustainable manner as soon as practicable. The Moon to Mars program shall have the interim goal of sending a crewed mission to the lunar surface by 2028 and a goal of sending a crewed mission to orbit Mars by 2033.

(c) PRECURSOR ACTIVITIES.—The Administrator shall undertake precursor crewed missions to cis-lunar space and the lunar surface for the purpose of risk reduction for human missions to Mars by developing and testing those systems and operational practices needed for successful crewed Mars missions.

(d) OBJECTIVES.—The objectives of the human missions to Mars shall be to—

(1) validate the capabilities required for sustained human exploration of and operations on the surface of Mars;

(2) pursue scientific investigations, as recommended by the National Academies, that are enabled by the human exploration of Mars; and

(3) develop and maintain the scientific, technical, program management, and human spaceflight operational skills required to support a sustainable deep space exploration program.

SEC. 203. STRUCTURE OF MOON TO MARS PROGRAM.

(a) MOON TO MARS PROGRAM OFFICE.—The Administrator shall establish a Moon to Mars Program Office within 60 days of the enactment of this Act to lead and manage the Moon to Mars program.

(b) PROGRAM DIRECTOR.—The Administrator shall appoint a Program Director of the Office established in subsection (a) who shall report to the Associate Administrator and the Associate Administrator of the Human Exploration and Operations Mission Directorate.

(c) RESPONSIBILITIES.—The Moon to Mars Program Office shall be responsible for developing—

(1) requirements for a human Mars orbital mission and a human mission to the surface of Mars;

(2) an architecture, integrated plan, and overall schedule encompassing the elements of the Moon to Mars Program to carry out a human mission to orbit Mars by 2033. The architecture and plan shall be based on the mission requirements established in paragraph (1); and

(3) an integrated, master plan for the development of required capabilities for the human mission to Mars.

(d) SYSTEMS ENGINEERING AND INTEGRATION.—The Director of the Moon to Mars Program Office shall appoint a Systems Engineering and Integration Manager to manage the systems engineering and integration activities of the Moon to Mars Program.

(e) SPECIAL HIRING AUTHORITIES.—The Administrator shall propose to Congress any special hiring authorities that the Administrator determines are needed to ensure that personnel with the requisite skills and experience are available to the Program Office.

(f) PROGRAM ELEMENTS.—The Moon to Mars Program shall consist of the following:

(1) A Gateway to Mars in cis-lunar space or at a Lagrangian point for the purpose of reducing the risks of the capabilities in paragraph (3) and serving as a testbed for the systems and operational techniques needed to transport crews to, from, and during operations in Mars orbit or on the surface of Mars. The Gateway to Mars shall be developed to operate autonomously and to be crew-tended, as needed, on an intermittent basis. The Gateway to

Mars shall be open and available for international participation and use.

(2) A Lunar Precursor Initiative (LPI) for the purpose of gaining and demonstrating the operational experience and systems needed to enable crewed transport to and from the surface of Mars, as well as for limited operations and habitation on Mars.

(3) A Mars Enabling Technology Initiative (METI) for the purpose of developing and testing the technologies and capabilities needed for a human missions to Mars. Mars-enabling technologies and capabilities to be demonstrated shall include—

(A) Mars entry, descent, and landing systems;

(B) radiation safety;

(C) in-space power and propulsion, including nuclear thermal propulsion;

(D) Mars transport vehicle;

(E) planetary ascent propulsion;

(F) environmental control and life support systems;

(G) Mars habitats;

(H) extravehicular activity suits;

(I) in-situ resource utilization of the Mars atmosphere; and

(J) any other Mars-enabling technologies and capabilities identified by the Administrator.

(4) A Space Launch System for the purpose of providing heavy-lift capability to carry out the Moon to Mars Program. The Administrator shall complete development of the Space Launch System and the Space Launch System variant enabled by an Exploration Upper Stage, pursuant to section 302 of the National Aeronautics and Space Administration Authorization Act of 2010. The Administrator shall take steps to develop the Block 2 variant to provide the full range of launch capability and performance available to the United States for the Administration's crewed and robotic exploration of deep space. The Administrator shall complete the development and testing of the Exploration Upper Stage for the Space Launch System.

(5) An Orion Crew vehicle for the purpose of crewed spaceflight for the Moon to Mars Program.

(6) A Mars Transport Vehicle for the purposes of crewed transport to and around Mars. Not later than 180 days after the date of enactment of this

Act, the Administrator shall initiate pre-formulation activities for a Mars transport vehicle.

(g) COMPLETION.—The Administrator shall plan to have all required testing completed to enable development and manufacture of an operational crewed Mars transport vehicle on a schedule consistent with the goal of a crewed mission to orbit Mars by 2033 and the architecture, integrated plan, and schedule in subsection (c)(2).

SEC. 204. REPORTING AND BRIEFINGS.

(a) IN GENERAL.—The Administrator shall provide regular reports and briefings on the progress and status of the Moon to Mars program, and associated activities to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate in accordance with this section.

(1) REPORTING WITH 60 DAYS.—Within 60 days of the date of enactment of this Act, the Administrator shall develop a list of the remaining human health risk reduction research tasks that need to be completed to enable crewed missions to Mars and that require the International Space Station, along with a plan for completing all of those tasks within 5 years of the date of the enactment of this Act.

(2) REPORTING WITHIN 120 DAYS.—Within 120 days of the date of enactment of this Act, the Administrator shall develop an overall architecture and plan, consistent with sections 203(c)(1) and 203(c)(2), including—

(A) a list of the minimum set of human and robotic lunar surface activities that must be completed to enable a human mission to Mars, including those to be tested on the Gateway to Mars, along with a plan for completing those tasks within five years after the first human lunar landing; and

(B) a list of the capabilities and risk reduction measures listed in section 203(f)(3).

For each high-priority technology or capability, the Administrator shall develop a plan to include the development milestones, including activities required to be carried out in cis-lunar space or on the lunar surface, and an estimated 5-year funding profile required for demonstrating the capability to a level of readiness for use in a Mars mission within 10 years of the date of the enactment of this Act.

(3) REPORTING WITHIN 270 DAYS.—Within 270 days of the date of enactment of this Act, the Administrator shall transmit—

(A) five-year funding estimates and profiles for the Moon to Mars Program. The budget profiles should include estimated funding requirements and profiles for the program elements in section 203(f), and related infrastructure, facilities, and operations that are consistent with the achievement of a crewed mission to Mars orbit by 2033; and

(B) the Independent Program Analysis and Evaluation Office established in section 1004 shall assess the basis of the five-year budget profiles and shall transmit the results of the assessment to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than six months after the budget profiles have been transmitted to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

(b) BIANNUAL BRIEFINGS.—The Administrator shall provide biannual briefings on the status, progress, and any challenges identified in maturing and developing the key capabilities specified in section 203(c)(3) and section

203(f)(3) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

(c) TRANSMITTAL.—The Administrator shall transmit the architecture and plans enumerated in section 204(a)(2) through section 204(a)(3) to the Committee on Science, Space, and Transportation of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate within 15 days after their scheduled completion dates.

SEC. 205. CRITICAL ENABLING CAPABILITIES.

(a) LUNAR LANDING MISSION ARCHITECTURE.—In order to reduce risk and complexity and make maximum use of taxpayer investments to date, the Administrator shall in the conduct of the Lunar Precursor Initiative employ an architecture that utilizes the Orion vehicle and an integrated lunar landing system carried on an Exploration Upper Stage-enhanced Space Launch System for the human lunar landing missions. The Gateway to Mars shall not be required for the conduct of human lunar landing missions.

(b) HUMAN-RATED LUNAR LANDING SYSTEM.—For the purposes established in section 202(c), the Administrator shall develop and operate an integrated human lunar landing system to provide human access to the lunar

surface. The human-rated integrated lunar landing system shall be designed with safety, sustainability, and affordability as priorities and developed through a means that allows for the United States Government to retain—

(1) full ownership of the human landing system;

(2) unlimited and unfettered insight into the design, development, and testing of the integrated human landing system;

(3) final determination on whether the system meets existing human-rating requirements;

(4) leadership over any anomaly or accident investigation, should it be necessary to carry out such an investigation; and

(5) shall require at least one uncrewed and one crewed in-space test and demonstration prior to its use to carry astronauts to the surface of the Moon and a plan for testing of a Mars human lander in a suitable environment.

(c) EXPLORATION SPACE SUITS.—The Administrator shall develop an exploration space suit to meet the requirements of the Moon to Mars program. In developing an exploration space suit, the Administrator shall, to the greatest extent practicable, leverage prior and existing investments in advanced space suit technologies in order to maximize the benefits of such investments and tech-

nologies. The Administrator shall use the International Space Station for testing of exploration space suits.

(d) LOGISTICS SUPPORT.—To the maximum extent possible, logistics support to the Gateway to Mars and the lunar surface shall be provided by commercial services, provided that the availability of those services does not becoming the limiting critical path factor in NASA's ability to complete its Gateway to Mars and Lunar Precursor initiatives as scheduled. The Administrator shall develop contingency plans for the delivery of the minimum set of needed logistics in the event commercial services are not available when needed.

(e) INTERNATIONAL COLLABORATION.—

(1) IN GENERAL.—The Administrator shall lead and encourage to the maximum extent practicable international partner participation in the implementation of the elements of the Moon to Mars program under overall NASA leadership. The Administrator shall encourage partnerships that enhance the program.

(2) CONGRESSIONAL AUTHORIZATION.—NASA shall seek Congressional authorization prior to finalizing any exploration architecture that depends on international or commercial partnerships for overall mission success.

(f) CREWED LUNAR LANDING MISSIONS.—In order to minimize the time required for the Lunar Precursor Initiative phase of the Moon to Mars Program, NASA shall plan for and implement measures to enable a crewed lunar landing mission rate of at least two per year after the initial crewed lunar landing has been achieved.

(g) LUNAR LANDER MANAGEMENT.—The Moon to Mars Program Office shall manage the overall development of the Human Lunar Landing System, with the Johnson Space Center responsible for the crew-related elements, vehicle structure, and Human Lunar Landing System integration and the Marshall Space Flight Center responsible for the Lander propulsion systems.

(h) GROUND AND FLIGHT TEST ACTIVITIES.—The Moon to Mars Program shall maintain a robust series of ground and flight test activities for each element of the Program, including at least one crewed flight test of each crewed system design prior to its use on a human lunar landing system or Mars mission.

(i) MARS LANDING AND ASCENT SYSTEM DESIGNS.—To the extent funding permits, the Administrator shall maintain two competing integrated crewed Mars landing/ascent system design concepts through the critical design review milestone, at which point the Administrator

shall make a selection of the system to be utilized in the first human Mars landing mission.

SEC. 206. NONCRITICAL PATH ACTIVITIES.

(a) LUNAR OUTPOST.—Any establishment of a continuously crewed lunar outpost or research station shall not be considered an element of the Moon to Mars Program and shall be budgeted separately from the Moon to Mars program.

(b) OTHER CREWED ACTIVITIES.—Crewed activities on or around the surface of the Moon that do not contribute to the goal of landing humans on Mars in as sustainable manner as practical shall not be included in the Moon to Mars Program and shall be budgeted separately from the Moon to Mars Program.

(c) LUNAR IN-SITU RESOURCE UTILIZATION.—Lunar in-situ resource utilization shall not be considered as risk reduction for the initial crewed missions to orbit and land on Mars. Any lunar in-situ resource utilization activities and shall not be included in the Moon to Mars Program and shall be budgeted separately from the Moon to Mars Program.

SEC. 207. CORE EXPLORATION CAPABILITIES.

(a) SENSE OF CONGRESS.—It is the sense of Congress that ground systems, robust testing programs, and a flight cadence necessary to maintain critical human

spaceflight skills are important elements of a safe and sustainable human exploration program.

(b) FLIGHT RATE AND SAFETY.—After the first crewed lunar landing, the Administrator shall, to the extent practicable, and taking into account the results of the Assessment in section 208(b), carry out a flight rate of at least two integrated Space Launch System and Orion crew vehicle missions per year, until the Lunar Precursor Initiative is complete, to maintain the critical human spaceflight production and operations skills necessary for the safety of human spaceflight activities in deep space.

(c) MILESTONES.—Not later than 90 days after the date of enactment of this Act, the Administrator shall transmit a list of the key milestones required for completing each of the Space Launch System variants and an estimated date on which those milestones shall be completed.

(d) EXPLORATION GROUND SYSTEMS INFRASTRUCTURE.—The Administrator shall ensure that elements of a ground system infrastructure are in place to enable the preparation and use of the Space Launch System, specifically its Block 1 (70 mt) and Block 1B (105 mt) and Block 2 (130 mt) variants of the Space Launch System.

(e) MOBILE LAUNCH FACILITY.—In implementing the requirements in subsection (d), the Administrator

shall take all necessary steps to develop and complete a second mobile launch facility that will be in place to support the first Block 1B Space Launch System.

(f) GROUND-BASED TEST PROGRAM IN SUPPORT OF CREWED FLIGHT TEST.—The Administrator shall carry out a robust ground-based test program, including the full Green Run test of the Space Launch System engines and the testing and qualification of the Exploration Upper Stage.

SEC. 208. REVIEWS AND ASSESSMENTS.

(a) INDEPENDENT REVIEW OF HUMAN RESEARCH PROGRAM.—

(1) IN GENERAL.—The Administrator shall enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine for an independent, external review of the Human Research Program. The purpose of the review shall be to examine the effectiveness of approaches currently being taken for identifying, measuring, and mitigating, and establishing countermeasures for human health and performance risks related to long-term human spaceflight, including any human activities in deep space, and to make recommendations to improve the program. The review shall consider the

translation of basic research into the Human Research Program.

(2) REPORT.—The Administrator shall transmit the results of the review to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 18 months after the date of enactment of this Act.

(b) CORE STAGE PRODUCTION CAPACITY.—

(1) ASSESSMENT.—The Administrator shall assess the requirements and resource needed for increasing the production capacity of the Space Launch System core stage from one to two core stages per year, and shall identify the resources, workforce, and infrastructure needed to increase the production capacity.

(2) REPORT.—The Administrator shall transmit the results of the assessment not later than 180 days after the date of enactment of this Act to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Space of the Senate.

(c) VEHICLE ASSEMBLY BUILDING.—Not later than 270 days after the date of enactment of this Act, the Ad-

ministrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate an assessment of requirements for concurrently processing 2 or more Space Launch System vehicles, including Space Launch System vehicles with an exploration upper stage.

(d) REVIEW OF RISK MITIGATION.—Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a review of the Orion crew vehicle and its systems, including the European Service Module, to identify any single-point failure and zero-fault-tolerant systems, components, or designs. The review shall identify and describe all actions taken to mitigate the risks of the systems, components, or designs identified, and any risk mitigation actions that are planned to be taken.

(e) STUDY ON ENHANCED ORION SERVICE MODULE PERFORMANCE.—Not later than 270 days after the date of enactment of the Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report

on the results of an independent technical and cost analysis of the options for developing or acquiring an enhanced Orion service module, as appropriate, that would enable direct low lunar orbit access and departure.

(f) ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM (ECLSS).—Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate the results of a plan and schedule for the completion, full testing, qualification, and validation of the integrated ECLSS system to be used on the Orion crew vehicle. The plan shall include a schedule, milestones, and shall identify any technical or supply chain challenges, as well as approaches to overcoming the challenges, in meeting the schedule and milestone dates.

Subtitle B—International Space Station

SEC. 221. EXTENSION AND POST-ISS SUPPORT.

(a) POLICY.—Section 70907 of title 51, United States Code, is amended by striking ''at least 2024'' and inserting ''at least 2028'' and adding at the end ''unless continued operations present an increased safety risk or Congress has authorized a detailed plan submitted by the

Administration for a transition from the International Space Station to an alternate platform, platforms or other means for continued research, as determined in section 226(b) and section 307''.

(b) INDEPENDENT COST ESTIMATE.—The Independent Program Analysis and Evaluation Office established in section 1004 shall arrange for an independent estimate of the cost of continuing International Space Station operations through 2028. The estimate shall include the cost of crew and cargo transportation and of the research to be undertaken reflecting the priorities identified in section 222. The assessment shall identify opportunities for operational efficiencies that could result in cost savings and increased research productivity.

(c) TRANSMITTAL.—The Administrator shall transmit the results of the independent cost estimate to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 6 months after the date of enactment of this Act.

(d) STUDY.—Not later than 120 days after the date of enactment of this Act, the Administrator shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Com-

merce, Science, and Transportation of the Senate, the results of an assessment of—

(1) technological challenges to operating the ISS until 2028;

(2) the potential viability of commercial space stations as an alternative to the ISS for carrying out—

(A) the research requirements of the Human Research Program and the requirements recommended in sections 226(b) and 307;

(B) to test systems necessary for crewed, long duration deep space missions; and

(C) key capabilities at NASA Centers that can be leveraged for the Administration's continued safety in and use of low Earth orbit.

SEC. 222. PRIORITIES FOR ISS UTILIZATION.

(a) IN GENERAL.—The Administrator shall prioritize the use of available NASA allocation of crew time and resources on the International Space Station toward research and technology development that enables the Moon to Mars goal in section 202. Priority research and development areas should include—

(1) the research of the Human Research Program, including research on reduction of human

health and performance risks, behavioral and psychological risks, and astronaut safety related to long-duration human spaceflight, and the development of countermeasures to mitigate those risks;

(2) the reduction of risks for exploration technologies, including for ECLSS, extravehicular activity and space suits, environmental monitoring, safety, and emergency response, deep space communications, among other critical enabling technologies for human exploration of deep space identified in section 203(f); and

(3) basic space life and physical science research consistent with the priorities of the most recent space life and physical sciences National Academies decadal survey.

In addressing paragraphs (1) and (2), the Administrator shall take into account the data associated with the Lifetime Surveillance of Astronaut Health program, other relevant data, and recommendations from relevant National Academies reports.

(b) BIANNUAL PROGRESS.—The Administrator shall provide to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a biannual accounting of the use of NASA crew time and

ISS resources, including allocation of such resources toward the priorities established in subsection (a).

(c) PROHIBITION.—The Administration is prohibited from authorizing spaceflight participants access to the International Space Station when fewer than 3 United States Government astronauts are onboard as part of an International Space Station expedition crew.

SEC. 223. ASSURED CREW ACCESS TO THE INTERNATIONAL SPACE STATION.

Not later than 30 days after the date of enactment of this Act, the Administrator shall transmit to Congress a contingency plan, including an implementation timeline, for assured crew access to the International Space Station until certified commercial crew transportation services are taking place, in the event that the availability of those services is delayed or unavailable.

SEC. 224. INTERNATIONAL SPACE STATION DEORBIT CAPABILITY AND PLAN.

Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit to the Congress an International Space Station Deorbit Capability and Plan, including a cost estimate of implementing the plan.

SEC. 225. REPLACEMENT EXTRAVEHICULAR MOBILITY UNITS.

(a) REPLACEMENT SUITS.—The Administrator shall take all necessary steps to provide for upgraded and replacement International Space Station Extravehicular Mobility Units (EMUs), including spares, to ensure the safety of the International Space Station crew and crew operations. The upgraded and replacement units shall be fully tested and demonstrated, including on the ISS, to be certified by the Administration for use by crew as soon as practicable. Upgraded and replacement EMUs, including spares, shall accommodate the diversity of ISS crew, suit sizes, and other requirements established to support extravehicular activities.

(b) PLAN.—Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit a plan for the provision of upgraded and replacement EMUs to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

SEC. 226. LOW EARTH ORBIT DEVELOPMENT.

(a) IN GENERAL.—The Administrator shall carry out development activities in low Earth orbit for the purposes of meeting the requirements established in subsection (b) and of supporting basic space life and physical sciences research and applications, in accordance with the require-

ments identified in section 307, following the end of International Space Station operations.

(b) REQUIREMENTS FOR LOW EARTH ORBIT ACTIVITIES AND RESEARCH IN SUPPORT OF HUMAN EXPLORATION.—The Administrator shall continue to develop and regularly update detailed research, development and associated requirements and capabilities that are needed to support NASA's human spaceflight and Moon to Mars Program and that must be carried out in low Earth orbit. Requirements and capabilities for NASA human spaceflight and exploration should include—

(1) human health and performance research;

(2) crew accommodation and training;

(3) cargo and crew transportation services;

(4) technology demonstration and qualification; and

(5) options for how such requirements could be met, including through the use of suborbital launch systems, free flying orbital platforms, and the feasibility of and potential risks associated with each option.

(c) TRANSMITTAL.—The Administrator shall transmit the requirements in subsection (b) to Congress not later than 270 days after the date of enactment of this Act and shall provide annual updates to Congress.

(d) REQUEST FOR INFORMATION.—Within 1 year after the date of enactment of this Act, the Administrator shall issue a request for information for the development or provision of low Earth orbit platforms, modules, or on-orbit capabilities, including options for ownership and services provisions, that can meet the requirements transmitted in subsection (c).

(e) RESULTS.—The Administrator shall transmit the results of the request for information to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 120 days after the date the responses to the request for information are submitted to the Administration.

TITLE III—SCIENCE

SEC. 301. IMPORTANCE OF A BALANCED SCIENCE PROGRAM.

It is the sense of Congress that a balanced and adequately funded set of activities, consisting of NASA's research and analysis grants programs, technology development, small-, medium-, and large-sized space science missions, and suborbital research activities, continues to contribute to a robust and productive science program and serves as a catalyst for innovation.

SEC. 302. REVIEW OF IMPLEMENTATION OF QUALITY ASSURANCE PROGRAM AND PARTS POLICY IN SCIENCE MISSION DEVELOPMENT.

(a) REVIEW.—The Comptroller General shall review the implementation of quality assurance program and parts policy, processes, and procedures used in the development of instrument and spacecraft for space and Earth science missions. The review shall build on prior work carried out for the 2011 Government Accountability Office report on ''Space and Mission Defense Acquisitions: Periodic Assessment Needed to Correct Parts Quality Problems in Major Programs'', released in 2011, and include an assessment of—

(1) the extent to which NASA is following established policy related to the selection, acquisition, traceability, testing, handling, packaging, storage, and application of materials and mechanical and electrical parts and the reasons for any deviations;

(2) how NASA conducts surveillance of contractor implementation of such policy, processes, and procedures; and

(3) the extent to which established policy, processes, and procedures follows Federal government best practices.

(b) TRANSMITTAL.—The Comptroller General shall transmit the results of the review to the Committee on

Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 303. INDEPENDENT EXTERNAL TECHNICAL, MANAGEMENT, AND COST REVIEWS.

(a) IN GENERAL.—The Administrator shall arrange for independent external technical, management, and cost reviews of science missions with an estimated development cost of $1 billion or more prior to completing the system definition and mission definition reviews—Key Decision Point B—and entering into the preliminary design and technology completion phase—Phase B—of the mission development cycle.

(b) RESULTS.—The Administrator shall transmit the results of the review to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 10 days after the results of the review have been completed.

SEC. 304. SMALL SATELLITES.

(a) SENSE OF CONGRESS.—It is the sense of Congress that small satellites and cubesats are increasingly important elements of NASA's exploration, scientific, and technology demonstration missions, have produced high-

value science, and can contribute, where appropriate, to a balanced science mission portfolio. Cubesat-enabled science missions also provide opportunities for hands-on training and developing project management skills for students and early career professionals, as noted in the 2016 report of the National Academies, ''Achieving Science with CubeSats: Thinking Inside the Box''.

(b) CONTINUATION.—The Administrator should continue to support the use of small satellite research and development in the space and Earth sciences, where appropriate, and for hands-on training and related skills.

SEC. 305. OPTIONS FOR SMALL SATELLITE AND PAYLOAD ACCESS TO THE NEAR-SPACE AND SPACE ENVIRONMENT.

Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report describing the options for small satellites and payload access to the upper atmospheric, near-space, and space environments, including through suborbital rockets, balloons, hosted payloads, rideshares, dedicated launch vehicles, among any other options. The report shall also identify criteria for the selection of an option for small satellite

and payload access to the upper atmospheric, near-space, and space environments, and shall identify the potential benefits and risks of each option.

SEC. 306. STUDY ON SPACE LIFE AND PHYSICAL SCIENCES RESEARCH AND APPLICATIONS PLACEMENT.

Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on an evaluation of the potential transfer of the Space Life and Physical Sciences Research and Applications activities to the Science Mission Directorate. The study shall identify and consider issues related to the potential establishment of a Space Life and Physical Sciences Research and Applications Division under the Science Mission Directorate, the organization of a potential Division, and the potential scope of a Division's research and activities. The study shall include a recommendation on a potential transfer and identification of follow-on actions, if any, that would be required for implementation.

SEC. 307. SPACE LIFE AND PHYSICAL SCIENCES RESEARCH REQUIREMENTS.

(a) REQUIREMENTS.—Not later than 90 days after the date of enactment of this Act, the Administrator shall

enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine for the development of a comprehensive set of requirements to support life and physical sciences research in microgravity following the end of International Space Station operations. The study shall include, among other factors—

(1) requirements to support basic research, as recommended in the most recent National Academies decadal survey, and requirements for applied research and development activities;

(2) environmental requirements including thermal, vibration, micro-g level, noise, sterility, and cleanliness;

(3) laboratory facility hardware (e.g., glovebox, ovens, rodent facilities);

(4) technology demonstration and qualification;

(5) crew time for carrying out basic research activities;

(6) power;

(7) data storage and transmission;

(8) communications;

(9) supporting facilities and infrastructure;

(10) crew and cargo transportation services, including pressurized upmass and downmass, to and

from low Earth orbit following the end of International Space Station operations;

(11) options for how such requirements could be met, including through the use of suborbital launch systems, free flying orbital platforms, and the feasibility, and potential risks associated with ; and

(12) options for governance and management models for non-NASA research and development activities and recommendations on a governance and management approach.

(b) TRANSMITTAL.—The Administrator shall transmit the study in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

(c) PROHIBITION.—The nonprofit management entity responsible for managing non-NASA research on the International Space Station, under section 70905(c)(2) of title 51, United States Code, shall not have access to any NASA-funded portion of any potential attached commercial or public-private platform or any free flying commercial or public-private platform until the results of the study directed under subsection (a) have been provided to the Committee on Science, Space, and Technology of the

House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate and acted upon by the Congress.

Subtitle A—Earth Science and Applications

SEC. 311. GOAL.

(a) SENSE OF CONGRESS.—It is the sense of Congress that the Administration's Earth science and applications program are vital for the Nation's ability to research, understand, and take measures to address the challenge of global climate change and provide increasingly valuable data for applied uses, including on natural resource management, agriculture, forestry, food security, air quality monitoring, among many other application areas. It is the further sense of Congress that a robust and balanced Earth science and applications program contributes significantly to the Nation's scientific discovery, economic growth and to supporting the health and safety of Americans and citizens of the world.

(b) REAFFIRMATION.—Congress reaffirms section 60501 of title 51, United States Code, on the goal for NASA's Earth science and applications program, which is that the Administration's Earth Science program shall be to pursue a program of Earth observations, research, and applications activities to better understand the Earth,

how it supports life, and how human activities affect its ability to do so in the future. In pursuit of this goal, the Administration's Earth Science program shall ensure that securing practical benefits for society will be an important measure of its success in addition to securing new knowledge about the Earth system and climate change. In further pursuit of this goal, the Administration shall, together with other relevant agencies, provide United States leadership in developing and carrying out a cooperative international Earth observations-based research program.

(c) PLAN.—The Administrator shall prepare an implementation plan for the most recent National Academies of Sciences, Engineering, and Medicine's decadal survey on Earth science and applications.

(d) TRANSMITTAL.—The Administrator shall transmit the Plan in subsection (c) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Justice in the Senate not later than 180 days after the date of enactment of this Act.

SEC. 312. APPLIED USES OF EARTH SCIENCE DATA.

(a) SENSE OF CONGRESS.—It is the sense of Congress that there are substantive and innovative applications and uses of space-based Earth science observations that are benefitting other Federal Government agencies,

State and local government agencies, and the broader user community and society. It is the further sense of Congress that the Administration should continue to seek means, to the extent practicable and in collaboration with other Federal Government agencies, industry, and academia, to expand the applied uses of NASA space-based Earth science observations and data. It is also the sense of Congress that quantifying the uses of these observations by other Federal Government agencies is important for understanding the impact and value of the Nation's investments in space-based Earth science observations and data.

(b) REPORT.—The Administrator shall prepare a report identifying the use of NASA space-based Earth science observations by other civil Federal Government agencies. The report shall, for each Federal agency, identify the extent of space-based Earth science observations used, the type of Earth science observations used, the purpose of the data use, and any tools or decision support services developed in the use of the space-based Earth science data for operational or research and development purposes.

(c) CONSIDERATION.—The report shall take into account the work of the Satellite Needs Working Group under the U.S. Group on Earth Observations, which identifies high-priority Federal satellite user needs.

SEC. 313. SURVEY OF STATE, TRIBAL, AND TERRITORY USE OF NASA EARTH OBSERVATION DATA.

(a) SURVEY.—The Administrator shall arrange for a survey of the use of NASA Earth observation data by States, tribal organizations and territories.

(b) TRANSMITTAL.—The Director shall transmit the results of the Survey in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 18 months after the date of enactment of this Act.

SEC. 314. COMMERCIAL EARTH OBSERVATION DATA.

(a) STUDY.—Not later than 120 days after the date of enactment of this Act, the Administrator shall enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine to carry out a study on the opportunities and challenges related to the potential use of commercial Earth observation data collected for the purposes of conducting Earth science research.

(b) INCLUSION.—The study in subsection (a) shall include—

(1) an assessment of the Administration's private sector small satellite constellation pilot program;

(2) options for government or private sector roles in performing calibration and validation and reanalysis of commercial Earth observations data;

(3) approaches to ensuring consistency with Administration data and information policies for Earth observation data obtained or purchased from commercial providers;

(4) the results of the assessment in paragraph (1);

(5) the benefits of using commercially-provided data, observations, or services for Earth science research;

(6) recommendations on guidelines, decision rules, and requirements for the use of commercial Earth observation data in support of Earth science research; and

(7) recommendations on any other relevant factors and issues regarding the use of commercial Earth observation data for the purposes of conducting Earth science research.

(c) TRANSMITTAL.—The Administrator shall transmit the results of the study to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transpor-

tation of the Senate not later than 18 months after the date of enactment of this Act.

SEC. 315. PLANKTON, AEROSOL, CLOUD, OCEAN ECOSYSTEM MISSION.

(a) IN GENERAL.—The Administrator shall continue development of the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission to advance 2007 National Academies decadal survey priorities for systematic measurements on clouds and aerosols and global ocean color measurements that extend systematic data records for Earth system and climate science, including on the carbon cycle and ocean biogeochemistry.

(b) COST AND SCHEDULE.—In carrying out the development in subsection (a), the Administrator shall follow all requirements under section 30104 of title 51, United States Code.

SEC. 316. CLARREO PATHFINDER.

(a) IN GENERAL.—The Administrator shall continue development of the Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder mission, as recommended by the 2007 National Academies decadal survey, to demonstrate measurement capabilities, verify the accuracy of radiometry for long-term climate studies, and to help provide a baseline climate record for shortwave reflectance and infrared measurements.

(b) COST AND SCHEDULE.—In carrying out the development in subsection (a), the Administrator shall follow all requirements under section 30104 of title 51, United States Code.

Subtitle B—Astrophysics

SEC. 321. WIDE FIELD INFRARED SURVEY TELESCOPE.

(a) IN GENERAL.—The Administrator shall continue development of the Wide Field Infrared Survey Telescope (WFIRST), in the configuration established through preliminary design review, to meet the objectives prioritized in the 2010 decadal survey of astronomy and astrophysics of the National Academies of Sciences, Engineering, and Medicine.

(b) COST AND SCHEDULE.—In carrying out the development in subsection (a), the Administrator shall follow all requirements under section 30104 of title 51, United States Code.

(c) BASELINE PLAN.—Following Key Decision Point-C or project confirmation, the Administrator shall prepare a cost and schedule baseline plan for the development of WFIRST against which the project performance can be measured by Congress. The plan shall include an annual funding profile required for WFIRST through the completion of its development and initial science phase, including

cost and schedule reserves levels, consistent with NASA policy.

(d) TRANSMITTAL.—Not later than 30 days after Key Decision Point-C has taken place, the Administrator shall provide the plan in subsection (c) to the appropriate Committees of Congress.

(e) QUARTERLY REPORTING.—The Administrator shall provide quarterly reports on the progress of the WFIRST development and the status on cost and schedule relative to the baseline plan developed in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and of the Committee on Commerce, Science, and Transportation of the Senate.

(f) COMPTROLLER GENERAL REVIEW.—The Comptroller General shall provide to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate an annual review of the performance and progress of the WFIRST development under subsections (a) through (c). The review shall examine the Administration's performance in meeting cost, schedule, and technical objectives and overall management of the project's development.

SEC. 322. STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY.

Not later than 270 days after the date of enactment of this Act, the Administrator shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the scientific program and operations of the Stratospheric Observatory for Infrared Astronomy. The report shall provide—

(1) a description of the scientific instruments that are flying, including—

(A) their current operating status;

(B) operating costs;

(C) anticipated operational lifetimes; and

(D) the anticipated scientific impact of each instrument; and

(2) a description of the scientific instruments are planned to be flown on the observatory, including the—

(A) development status;

(B) estimated development costs;

(C) anticipated launch date;

(D) the anticipated operational lifetime; and

(E) the anticipated scientific impact of the instrument.

SEC. 323. RESEARCH ON TECHNOSIGNATURES.

(a) SENSE OF CONGRESS.—It is the sense of Congress that the search for life in the universe is an integral component of the Administration's space science program and that the search for life in the universe has increasingly encompassed a multi- and interdisciplinary approach. It is the further sense of Congress that research related to the search for life has encompassed nongovernment funded research on and searches for intelligent life. Those efforts include searches for signatures of advanced technologies that could be used to indicate the existence of intelligent life beyond Earth, or what is referred to as ''technosignatures''.

(b) RESEARCH.—The Administrator may support, as appropriate, peer-reviewed, competitively-selected research on technosignatures.

Subtitle C—Planetary Science

SEC. 331. MARS COMMUNICATIONS INFRASTRUCTURE.

(a) REQUIREMENTS.—The Administrator shall develop an estimate of the Administration's communication requirements, including bandwidth and communications needs, to serve current and future robotic orbiter, lander, rover and human missions to Mars into the 2040s.

(b) ASSESSMENT.—The Administrator shall prepare an assessment of the existing Mars communication infrastructure and its capabilities to meet the Administration's requirements in subsection (a), including the risk of potential gaps in communications relays between Mars spacecraft and Earth within the next 5 years.

(c) PLAN.—Based on the assessment in subsection (b), the Administrator shall develop a plan for addressing the risk of potential gaps of meeting future robotic and potential human mission requirements into the 2040s.

(d) INCLUSION.—The Plan in subsection (c) shall include—

(1) options for a Mars communication infrastructure that meets the estimated requirements in subsection (a), options for mitigating any risks identified in the Assessment in subsection (b), and a preliminary estimate of the potential costs of each option, including—

(A) the tradeoffs of using a dedicated Mars communications orbiter, a Mars science orbiter that handles communications relays, and other options; and

(B) an identification of any technology, software, and cybersecurity developments anticipated to become available in the next 2–5 years

that could facilitate the capability, accelerate the development, and enable implementation of a Mars communication infrastructure; and

(2) options for acquisition approaches for a Mars communications infrastructure, including partnerships with international or commercial partners.

(e) TRANSMITTAL.—The Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate the assessment and plan in subsections (b) and (c) not later than 180 days after the date of enactment of this Act.

SEC. 332. MARS SAMPLE RETURN STRATEGY AND PLAN.

(a) SENSE OF CONGRESS.—It is the sense of Congress that the 2011 National Academies decadal survey, ''Vision and Voyages for Planetary Science in the Decade 2013-2022'' states that ''The Mars community . . . was emphatic in their view that a sample return mission is the next step in Mars exploration. Mars science has reached a level of sophistication such that fundamental advances in addressing the important questions . . . will come only from analysis of returned samples.''. It is the further sense of Congress that the decadal survey recommended a Mars sample return mission as the highest priority large mission, and that in addition to advancing high priority

science, Mars samples returned to Earth would contribute science and information that is valuable for planning a human mission to Mars.

(b) STRATEGY.—The Administrator shall develop a strategy, including options, for returning samples that are planned to be cached by the Mars 2020 rover to Earth for terrestrial laboratory study. The strategy shall identify—

(1) technologies required to carry out a sample return mission, including requirements for sample containment and handling in space and upon return to Earth;

(2) research, technology, and developments needed to effectively manage planetary protection;

(3) opportunities for potential international partnership; and

(4) a recommended mission option, and an estimated cost.

(b) IMPLEMENTATION PLAN.—Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit a plan for implementing the strategy in subsection (a), including a timeline and a list of key milestones, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

(c) EARLY TECHNOLOGY DEVELOPMENT.—The Administrator shall continue early technology development work in preparation for a Mars sample return mission.

SEC. 333. COMMERCIAL LUNAR PAYLOAD SERVICES.

(a) IN GENERAL.—The Administrator may establish a Commercial Lunar Payload Services program for the purposes of transporting and landing science instruments and payloads on the lunar surface or to cislunar space.

(b) RELATIONSHIP TO OTHER MISSION DIRECTORATES.—Any lander demonstrations, services, instruments, or payloads, and the commercial lunar payload services required to deliver those payloads or instruments to the lunar surface or lunar vicinity, that are not carried out for the purposes established in subsection (a) or that are carried out for the Human Exploration and Operations Mission Directorate or the Space Technology Mission Directorate shall be funded from the Mission Directorate sponsoring the use of the program established in subsection (a).

(c) COMMERCIAL LANDERS.—In carrying out the program under (a), the Administrator shall procure the services of commercial landers that are majority-designed, majority-developed, and majority-built in the United States.

(d) ASSESSMENT.—The Administrator shall carry out an assessment of the Commercial Lunar Payload Services program to identify lessons learned, ongoing challenges, and approaches to addressing the challenges. The study shall be transmitted to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 3 years after the date of enactment of this Act.

SEC. 334. EUROPA CLIPPER LAUNCH VEHICLE.

(a) ASSESSMENT OF LAUNCH VEHICLE OPTIONS.—Not later than 30 days after the date of enactment of this Act, the Administrator shall carry out and complete an assessment of the launch vehicle options that would be available at the earliest flight readiness date for launch of the Europa Clipper mission. The assessment shall include—

(1) an analysis of the marginal cost, schedule, risk, and benefits associated with launching the Europa Clipper mission on a Space Launch System as compared to an alternative launch vehicle, including any additional cost, schedule, and risk incurred from spacecraft design changes due to alternative interplanetary trajectories; and

(2) a consideration of whether an increased Space Launch System production rate would allow the Europa Clipper orbiter mission to be launched on a Space Launch System on a schedule that is consistent with the flight readiness date for the mission.

(b) AUTHORIZATION.—The Administrator is authorized, based on the results of the assessment in subsection (a), to select the launch vehicle for the Europa Clipper mission taking into account the probability of mission success and based on cost, schedule, vehicle availability, and impact on science requirements.

(c) REPORT.—Not later than 15 days after completing the assessment in subsection (a), the Administrator shall provide to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report including the complete assessment of launch vehicle options in subsection (a), the Administrator's selection of the Europa Clipper launch vehicle as authorized in subsection (b), and the estimated cost of the selected launch option.

SEC. 335. DEDICATED SURVEY MISSION.

(a) DEDICATED SURVEY MISSION.—The Administrator shall develop a dedicated space-based infrared sur-

vey telescope mission, as soon as is practicable, for the purpose of accomplishing the objectives of the George E. Brown, Jr. Near-Earth Object Survey Act, and consistent with section 71101 of title 51, United States Code. The mission design shall take into account the recommendations of the National Academies of Sciences, Engineering, and Medicine's report, ''Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes''.

(b) PLAN.—The Administrator shall transmit a plan for carrying out the dedicated survey mission described in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 180 days after the date of enactment of this Act.

SEC. 336. NEAR-EARTH OBJECT AND PLANETARY DEFENSE ROADMAP.

(a) IN GENERAL.—The Administrator, in collaboration with other relevant Federal agencies, shall lead the development of a Roadmap to improve the detection, tracking, and characterization of near-Earth objects for the purpose of reducing uncertainties and advancing the accuracy of decision-making on potentially hazardous near-Earth objects. The Roadmap shall identify existing or planned telescope programs that could contribute to im-

proving the detection and tracking of near-Earth objects and completing the goals of the George E. Brown, Jr. Near-Earth Object Survey.

(b) NASA RESPONSIBILITIES.—In carrying out subsection (a), NASA shall, in cooperation with relevant Federal agencies and international partners—

(1) lead activities that—

(A) enhance national capabilities for near-Earth object detection, tracking, and characterization; and

(B) seek to develop technologies for fast-response near-Earth object deflection and disruption; and

(2) participate in activities that—

(A) seek to improve national capabilities for potentially-hazardous near-Earth object modeling, predictions, and information integration; and

(B) increase international cooperation on near-Earth object preparation.

SEC. 337. ASSESSMENT OF REQUIREMENTS FOR CATALOGUING AND ARCHIVING NEAR-EARTH OBJECT DATA.

(a) ASSESSMENT.—The Administrator shall enter into an arrangement with the National Academies of

Sciences, Engineering, and Medicine to carry out an assessment to identify the requirements and capabilities needed for the cataloguing, archiving, and maintaining observational space-based and ground-based data of near-Earth objects through 2030, including data from the Large Synoptic Survey Telescope.

(b) INCLUSION.—The assessment in subsection (a) shall address—

(1) the extent to which the existing facilities, including the Minor Planet Center, can accommodate the identified needs;

(2) and any additional facilities, equipment, and capabilities needed to catalogue, archive, and maintain near-Earth object data anticipated to be collected through 2030;

(3) requirements and capabilities for automated analysis of the data and objects in the catalogue and archive, including artificial intelligence; and

(4) an estimated timeline and budget required to support the requirements and capabilities identified in paragraphs (1) through (3).

(c) TRANSMITTAL.—The Administrator shall transmit the results of the assessment to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science,

and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 338. INTERNATIONAL CONFIDENCE AND CAPACITY BUILDING FOR NEAR-EARTH OBJECT IMPACT MITIGATION.

(a) IN GENERAL.—The Administrator shall expand efforts being carried out with international entities, including the Space Missions Planning Advisory Group of the Working Group on near-Earth Objects of the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, to support confidence-building and capacity-building activities related to near-Earth object impact mitigation techniques, such the use of a kinetic impactor, gravity tractor, and nuclear explosive device.

(b) CONFIDENCE AND CAPACITY-BUILDING.—The Administrator may carry out workshops, technical exchanges of information, training, or other means, as appropriate, with international entities for building confidence, and developing technical understanding and awareness of in-space near-Earth object deflection or impact mitigation techniques.

(c) BRIEFING.—Not later than 9 months after the date of enactment of this Act, the Administrator shall provide a briefing to staff of the Committee on Science,

Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on plans for carrying out the activities in subsections (a) and (b).

SEC. 339. CLOSE PASSING NEAR-EARTH OBJECTS.

The Administration should consider planning preparatory actions to take advantage of opportunities related to close passing near-Earth objects for both scientific and public outreach purposes, including the close approach of asteroid 99942 Apophis anticipated to occur in 2029, to conduct close-up studies of a large asteroids as they pass by Earth.

Subtitle D—Heliophysics and Space Weather Research

SEC. 341. IMPORTANCE OF HELIOPHYSICS RESEARCH TO UNDERSTANDING SPACE WEATHER.

It is the sense of Congress that—

(1) NASA's Heliophysics Division is a key contributor to a greater understanding of the Sun, solar activity, and the space environment of Earth and other planets;

(2) fundamental research in Heliophysics plays a key role in understanding and predicting space weather, which describes naturally occurring phenomena that have the potential to severely and ad-

versely affect numerous assets in space and on Earth, including military and commercial satellite communications, the global power grid, and pipelines that provide fuel and water to billions of people; and

(3) understanding space weather is crucial in advance of human exploration activities in order to minimize deleterious effects on humans in space.

SEC. 342. SPACE WEATHER RESEARCH AND APPLICATIONS PROGRAM.

(a) ESTABLISHMENT.—The Administrator, in collaboration with other relevant Federal Government agencies, shall establish within the Heliophysics Division a Space Weather Research and Applications Program to support the transition of scientific research to operations and to carry out competitively-selected applied research for the purposes of improving the modeling, forecasting, and prediction of space weather phenomena. In carrying out the Program established in this subsection, the Administrator shall, to the extent practicable, partner with relevant Federal Government agencies, academia, industry, and the space weather user community.

(b) COMMUNITY COORDINATED MODELING CENTER.—The Administrator, in collaboration with relevant Federal Government agencies and stakeholders, shall lead the coordination of space weather model development,

testing, and validation in preparation for transitioning such models to operational users. In leading the Center, the Administrator should, to the extent practicable—

(1) take steps to support the integration of additional data sources (including international, academic, and commercial) that could improve space weather models, predictive capabilities, and forecasts; and

(2) increase efforts to coordinate the Community Coordinated Modeling Center activities with academia, industry, international, and other space weather modeling and forecasting entities.

(c) OBSERVATIONS.—The Administrator should continue to consider, to the extent practicable, the use of small spacecraft to expand space weather observations and enhance research related to space weather model development.

Subtitle E— Data Science and Management

SEC. 361. DATA SCIENCE AND MANAGEMENT.

It is the sense of Congress that the Administrator should take steps to establish a data science and management initiative to expand data analytic capabilities, such as cloud computing, in the management of the Administration's scientific databases that can enable the pursuit

of new, interdisciplinary areas of scientific investigation and facilitate the broadest possible use of space science and Earth science data for research and applied purposes.

SEC. 362. WORKSHOP ON DATA ANALYTICS FOR EARTH SCIENCE RESEARCH.

(a) WORKSHOP.—The Administrator shall enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine for a workshop on the scientific opportunities related to the use of advanced data analytics and modeling techniques in Earth science research and applications. The workshop should identify—

(1) the opportunities and challenges of using advanced data analytics and modeling techniques for Earth science research, including those areas of Earth science research that currently use advanced data analytics and modeling techniques;

(2) current and future developments in data analytics and modeling techniques; and

(3) potential areas of interdisciplinary Earth science and applications research that could be enabled by advanced data analytics and modeling techniques.

(b) TRANSMITTAL.—The Administrator shall provide a report on the Workshop in subsection (a) not later than 18 months after the date of enactment of this Act.

TITLE IV—SPACE COMMUNICATIONS

SEC. 401. REVIEW OF SPACE COMMUNICATIONS.

(a) REVIEW.—The Comptroller General shall undertake a review of the Administration's space communications and navigation programs, activities, and plans.

(b) INCLUSION.—The review in subsection (a) shall include—

(1) the extent to which there is a well-defined plan, architecture, and identification of communications and navigation needs over the next 20 years;

(2) an identification of performance capabilities required to meet the Administration's plans and needs over the next 20 years;

(3) the extent to which the Administration has developed an estimate of the costs, including life cycle costs, of paragraph (2);

(4) approaches the Administrator is taking to sustain the existing space communications and navigations architecture;

(5) any risks to the sustainment and operations of the architecture;

(6) planned upgrades to the architecture;

(7) an estimated cost for the upgrades in paragraph (6);

(8) the extent to which there is an established means for prioritizing investments and how such investments are balanced between sustaining existing operations, upgrading systems, and undertaking new developments;

(9) the technical and programmatic viability of any approaches for meeting space communications needs after all Tracking and Data Relay Satellite System third-generation communications satellites are operational; and

(10) the extent to which the Administration has an established plan and measures for mitigating threats to electromagnetic spectrum use.

(c) TRANSMITTAL.—The review in subsection (a) shall be transmitted to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

TITLE V—AERONAUTICS

SEC. 501. RESEARCH EFFORT TO ADVANCE SUSTAINABLE AVIATION.

(a) IN GENERAL.—The Administrator, in consultation with other relevant Federal agencies, industry, and academia, shall conduct research and development efforts

that contribute to reducing the environmental impact of aviation, providing for a sustainable future for aviation, and improving the efficiency and performance of United States commercial aircraft.

(b) RESEARCH EFFORT.—The research effort in subsection (a) shall include research, development, and demonstration projects on—

(1) subsonic aircraft and engine design and technology;

(2) sustainable aviation fuels;

(3) electric and hybrid-electric propulsion; and

(4) other efforts that contribute to a sustainable future for aviation.

(c) GOALS.—The goals of the initiative in subsection (b) shall be to reach—

(1) two percent annual fuel efficiency improvement through 2050; and

(2) carbon neutral growth.

(d) ANNUAL REPORT.—Not later than June 1 of every year, the Administrator shall submit a report identifying the activities carried out under the research effort under subsection (a) and the progress toward meeting the goals identified in subsection (c).

SEC. 502. WORKSHOP ON RESEARCH AND DEVELOPMENT ON NOISE.

(a) WORKSHOP.—The Administrator shall organize a workshop on the status of existing research and technology activities, and to identify planned research and technology demonstration activities and opportunities for future research and development activities, including noiseless aircraft, related to reducing the noise effects from subsonic aircraft, urban air mobility and uncrewed aviation systems, supersonic aircraft, and commercial space launch vehicles.

(b) PARTICIPANTS.—The Workshop described in subsection (a) shall include participants from relevant Federal government agencies, industry, academia, and nongovernmental organizations.

(c) REPORT.—The Administrator shall transmit a report on the results of the workshop to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 18 months after the date of enactment of this Act.

SEC. 503. AERONAUTICS RESEARCH AND TECHNOLOGY ROUNDTABLE.

It is the sense of Congress that the National Academies Aeronautics Research and Technology Round Table has been a valuable forum for industry, academia, and

government to share knowledge, define strategic issues, identify research topics of interest, and provide input into NASA's Aeronautics Research Mission Directorate's agenda. It is the further sense of Congress, that the Administrator should continue to support the Roundtable to facilitate continuing partnerships in United States aeronautics research going forward.

SEC. 504. EXPERIMENTAL AIRCRAFT DEMONSTRATIONS.

(a) IN GENERAL.—The Administrator shall study, develop, and carry out large-scale testing and demonstrations in relevant environments that are needed to understand complex, transformational flight systems, including structures, aerodynamics, propulsion, controls and flight dynamics interactions, and advanced technologies and systems for their transition into aircraft and airspace systems by the aviation community.

(b) EXPERIMENTAL AIRCRAFT DEMONSTRATIONS.—In meeting the objectives established in subsection (a), the Administrator shall carry out experimental aircraft demonstrations, including a—

(1) subsonic demonstrator to demonstrate the performance and feasibility of advanced, ultra-efficient subsonic flight demonstrator configurations;

(2) low boom flight demonstrator to validate design tools and technologies that can be applied to

low sonic boom commercial supersonic aircraft and support the development of a noise-based standard for supersonic overland flight; and

(3) hybrid wing body demonstrator to demonstrate the performance and feasibility of an ultra-efficient hybrid wing body configuration.

(c) COLLABORATION WITH INDUSTRY AND ACADEMIA.—The Administration shall seek means to increase collaboration with industry and academia in basic research, technology development, and experimental aircraft demonstration activities.

SEC. 505. REVIEW OF RESEARCH ROADMAP ON HYPERSONICS.

(a) IN GENERAL.—The Administrator shall enter into an arrangement with the National Academies of Science, Engineering, and Medicine to review the Roadmap for Hypersonic Research directed in section 603 of the NASA Transition Authorization Act of 2017. The review shall take into account research activities of the Department of Defense. The review shall identify and prioritize critical basic and applied research to be carried out by the Administration in the near-term (within 6 months to 3 years), mid-term (within 3 to 6 years), and long-term (within 6 to 10 years), and shall identify the flight demonstration vehicles and demonstrations, capa-

bilities, infrastructure and facilities, and workforce skills needed to establish global leadership in hypersonics.

(b) TRANSMITTAL.—The Administrator shall transmit the review in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 506. SUPERSONIC FLIGHT.

(a) SENSE OF CONGRESS.—It is the sense of Congress that the development of low boom commercial supersonic transport that is efficient, cost-effective and safe for the environment will be transformative for the aviation industry and will help ensure continued United States leadership in enabling new transportation capabilities. It is the further sense of Congress that NASA, in its work on a low boom flight demonstrator aircraft, should continue consulting with the Federal Aviation Administration (FAA), the International Civil Aviation Organization (ICAO), other international aeronautics research organizations.

(b) CONTINUED RESEARCH.—The Administrator shall continue to conduct research and development activities to enable the development and operational use of low boom supersonic aircraft.

SEC. 507. URBAN AIR MOBILITY.

(a) STRATEGY.—The Administrator shall develop a strategy, including goals and objectives, for the Administration's research and development activities on urban air mobility. The strategy shall—

(1) take into account the Administration's work on uncrewed aviation systems;

(2) consider relevant National Academies reports on the feasibility of a safe and efficient urban air mobility system;

(3) provide a description of the Administration's ''Grand Challenges'' for urban air mobility and how it contributes to achieving the goals and objectives identified in the strategy;

(4) identify any research gaps and options for addressing the gaps; and

(5) identify the means of partnering with the other relevant Federal agencies, academia, and industry on urban air mobility research and development.

(b) TRANSMITTAL.—The Administrator shall transmit the strategy to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 270 days after the date of enactment of this Act.

SEC. 508. AERONAUTICS WORKFORCE AND MODELING AND TEST FACILITIES.

(a) REVIEW.—The Administrator shall enter into an arrangement with the National Academies of Sciences, Engineering, and Medicine to carry out a comprehensive review of—

(1) the Nation's aeronautics workforce and skills-base; and

(2) the status of NASA's aeronautical modeling and test facilities.

The review shall make prioritized recommendations on actions needed to align the workforce with research objectives, strategic goals, and commercial aeronautics opportunities and on the improvements and additions to modeling capabilities and test facilities needed to meet the Nation's aeronautics strategic goals and objectives.

(b) TRANSMITTAL.—The Administrator shall transmit the results of the review not later than 15 months after the date of enactment of this Act to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

(c) IMPLEMENTATION PLAN.—Not later than 120 days after the date that the review is completed and published, the Administrator shall provide to the Committee on Science, Space, and Technology of the House of Rep-

resentatives and the Committee on Commerce, Science, and Transportation of the Senate a plan for implementing the recommendations in the review in subsection (a).

SEC. 509. UNIVERSITY LEADERSHIP INITIATIVE.

(a) SENSE OF CONGRESS.—It is the sense of Congress that United States leadership in aeronautics will depend, in part, on infusing innovation into the Nation's aeronautical research and development programs and in transferring the proven capabilities and technologies established through research and development into commercial aviation. It is the further sense of Congress that the University Leadership Initiative is encouraging innovation by successfully engaging multidisciplinary teams, including academia and industry, in compelling research activities that address the Aeronautics Research Mission Directorate's strategic research goals while also energizing the aeronautics research enterprise. The Administrator should continue to support the University Leadership Initiative.

(b) REVIEW.—The Administrator shall arrange for an external review of the University Leadership Initiative for the purposes of considering the Initiative's progress toward meeting the program's objectives, identifying options and recommendations for strengthening the program, and evaluating the project's efforts to increase the

participation of women, HBCU and underrepresented and minority participants in the program.

(c) REPORT.—The Administrator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

TITLE VI—SPACE TECHNOLOGY

SEC. 601. SPACE NUCLEAR SYSTEMS.

It is the sense of Congress that:

(1) Space nuclear technology development, including nuclear propulsion and surface power reactors, is critical for enabling Moon and Mars missions. Nuclear propulsion technologies can reduce transit times to Mars, particularly making possible opposition class missions. Surface power would enable robotic and human exploration. It is important that the United States lead in developing the safe and sustainable use of space nuclear power.

(2) NASA should continue to develop technologies that rely on low enriched uranium fuel and continue partnerships on such concepts with the commercial sector. Where feasible, the use of low enriched uranium should be prioritized.

SEC. 602. NUCLEAR THERMAL PROPULSION.

(a) IN GENERAL.—The Administrator shall carry out nuclear thermal propulsion research and development activities, including for systems based on the use of low-enriched uranium, for the purposes of developing an in-space propulsion system to support crewed missions to Mars.

(b) PLAN.—The Administrator shall develop a plan, including a cost estimate, to achieve an in-space flight test of a nuclear thermal propulsion system within 10 years of the enactment of this Act.

(c) TRANSMITTAL.—The Administrator shall transmit the plan to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 12 months after the date of enactment of this Act.

SEC. 603. NUCLEAR SURFACE POWER.

(a) SENSE OF CONGRESS.—Developing lightweight fission reactors systems is critical for generating sufficient power to run systems that enable long-term presence, robotic or human, in space. It is the sense of Congress that NASA should continue developing kilopower technology.

(b) PROGRAM.—The Administrator shall establish a program for research, testing, and development of a space surface power reactor design.

(c) PLAN.—NASA shall develop a plan and timeline for a kilopower program taking into consideration mission needs and shall include opportunities for participation by United States commercial entities.

(d) TRANSMITTAL.—The Administrator shall transmit plan to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 12 months after the date of enactment of this Act.

SEC. 604. REVIEW OF FLIGHT OPPORTUNITIES PROGRAM.

(a) REVIEW.—The Comptroller General shall carry out a review of the Flight Opportunities Program to assess—

(1) the goals and objectives of the program, and the basis for those goals and objectives;

(2) the extent to which the program goals and objectives have changed over time since the establishment of the program, and the rationale for such changes;

(3) the performance measurements NASA has established to oversee progress toward meeting the goals and objectives of the program;

(4) the activities conducted and level of resources provided to date toward meeting the goals;

(5) the basis for the resource requirements;

(6) the extent to which NASA is using the results of the flight opportunities research activities to advance the agency's strategic goals;

(7) the challenges in achieving program objectives; and

(8) the factors that should be considered in evaluating whether the program, as structured and funded, could be expanded to include science and education projects, and any potential implications of such an expansion.

(b) TRANSMITTAL.—The report in subsection (a) shall be transmitted to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 605. SENSE OF CONGRESS ON OPTICAL COMMUNICATIONS.

It is the sense of Congress that advances in interplanetary communications are an essential enabler for future robotic and human exploration, and that optical communications can provide increased bandwidth at farther distances with greater accuracy and speed than radio frequency transmissions. Optical communications involve op-

portunities and challenges that can transform scientific investigations in space and support deep space human exploration operations that will require broadband communications with Earth. In addition, optical communications systems are lighter, more compact and use less power than radio frequency communications, and the Government's investment in advancing optical communications also has the potential to offer significant benefits to the private sector and future space commerce.

SEC. 606. PROPULSION TESTING FACILITIES.

(a) SENSE OF CONGRESS.—It is the sense of Congress that the Administration's development of next generation in-space and electric propulsion will help enable the Nation's goal of sending humans to Mars, especially for use in emplacing the cargo and infrastructure necessary to support human activities at Mars. It is the further sense of Congress that additional testing capabilities may be needed to support research and development on in-space propulsion and that such facilities could serve government, industry, and university work on maturing in-space propulsion development work.

(b) NEEDS ASSESSMENT.—The Administrator shall carry out a needs assessment for facilities and technical capabilities required to support advanced research and development on in-space propulsion, including high-power

electric propulsion devices and ground-based testing of a full-scale, full-power nuclear thermal engine. The assessment should consider the potential development of facilities that will support long-term research and development of in-space propulsion systems.

(c) TRANSMITTAL.—The Administrator shall transmit the results of the assessment to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 607. IN-SPACE SATELLITE SERVICING AND ASSEMBLY.

(a) RESTORE-L.—The Administrator shall continue development of RESTORE-L technologies and capabilities for a planned on-orbit demonstration to refuel the Landsat 7 spacecraft.

(b) ASSESSMENT.—The Administrator shall carry out an assessment of in-space assembly and servicing technologies, the potential uses of those technologies, and related issues. The assessment shall include—

(1) the capabilities, technological readiness levels, and relevant applications of the Administration's existing in-space servicing and assembly technology across directorates and divisions;

(2) the projected requirements for in-space satellite servicing and assembly and the research and development, other than that being conducted under subsection (b), needed to address the requirements;

(3) the potential advantages of incorporating in-space assembly and servicing into spacecraft design, construction, and operations;

(4) a determination of any areas of overlap or alignment among Administration directorates and divisions of current capabilities and potential enabling technologies for in-space servicing and assembly;

(5) a description of the criteria, information needed in order to develop criteria, that could be used in determining whether in-space servicing and assembly could increase the capabilities, mitigate risks, reduce the costs, or otherwise benefit a given mission or project;

(6) a comparison of the relative opportunities and challenges of human versus robotic assembly and servicing, taking into account prior and current servicing activities;

(7) a description of ways in which the Administration could partner with the private sector or oth-

erwise use available private sector in-space satellite servicing and assembly services; and

(8) a description of the approaches the Administration is taking to ensure that the project under subsection (a) does not involve competition with the private sector and does not preclude the development of commercial capabilities for in-space satellite servicing and assembly.

(c) TRANSMITTAL.—The results of the Assessment in subsection (c) shall be transmitted to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 608. PARACHUTE SYSTEMS RESEARCH AND DEVELOPMENT.

It is the sense of Congress that parachute design, development, and performance is essential for the safety and success of both robotic and human spaceflight systems, including the Orion crew vehicle, capsules being developed under the Commercial Crew Program, as well as some robotic spacecraft that are to be landed on solar system bodies. It is the further sense of Congress that the risks and complexities involved in parachute systems warrant additional research and development that could benefit

both internal development programs and those of United States industry partners. The Administrator should strongly consider supporting research and development on parachute systems for the purposes of contributing to the overall safety and success of United States robotic and human spaceflight systems.

TITLE VII—SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS EDUCATION

SEC. 701. OFFICE OF STEM ENGAGEMENT.

(a) SENSE OF THE CONGRESS.—It is the sense of the Congress that NASA's inspiring mission, specialized facilities, skilled engineering and scientific workforce, and research activities present unique opportunities for inspiring public engagement in STEM and increasing the number of students pursuing STEM degrees and careers.

(b) IN GENERAL.—The Administrator shall establish an Office of STEM Engagement for the purpose of advancing progress toward the Nation's Federal STEM education goals for enhancing STEM literacy, increasing diversity, equity, and inclusion in STEM, and preparing the STEM workforce for the future.

(c) RESPONSIBILITIES.—The Office established in subsection (b) shall be responsible for coordinating efforts to administer and support evidence-based formal and in-

formal education programs, research experiences, and related activities among organizations across the agency, including NASA headquarters, Mission Directorates, and Centers, to administer and support evidence-based formal and informal education programs, research experiences, and related activities designed to—

(1) create unique opportunities for students and the public to learn from and contribute to NASA's work in exploration and discovery;

(2) contribute to the growth of a diverse STEM workforce; and

(3) strengthen public understanding of science by enabling connections to NASA's mission and work.

(a) PORTFOLIO.—The Office shall coordinate and administer—

(1) the National Space Grant College and Fellowship Program;

(2) the Established Program to Stimulate Competitive Research;

(3) the Minority University Research and Education Project;

(4) the NextGen STEM Project; and

(5) any other programs or activities determined appropriate by the Administrator.

SEC. 702. INDEPENDENT REVIEW OF SPACE GRANT.

(a) REVIEW.—The Administrator shall make arrangements for an independent external review of the National Space Grant College and Fellowship Program to evaluate its management, accomplishments, and responsiveness to the purposes and goals defined in Chapter 403 of title 51, United States Code.

(b) REPORT.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit a report on the independent external review of the National Space Grant College and Fellowship Program described in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

TITLE VIII—SAFETY, SUPPORT, AND MISSION SERVICES

SEC. 801. POLICY AND PROCEDURE.

(a) POLICY AND PROCEDURE.—The Administrator shall develop an Administration policy and procedure for assessment every 3 to 5 years of the Administration's strategic capabilities, including infrastructure and facilities, and workforce skills and capabilities. The policy and procedure shall include acquiring data and support for Administration decisions and recommendations on strategic capabilities, including on infrastructure and facilities, and

workforce skills and capabilities needed to support the Administration's goals and objectives through 2040.

(b) TRANSMITTAL.—The Administrator shall transmit the policy and procedure in subsection (a) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 802. MONITORING MILLIMETER-SIZED ORBITAL DEBRIS.

(a) REPORT.—Not later than 270 days after the date of enactment of this Act, the Administrator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on—

(1) the risks of millimeter sized and larger orbital debris objects to NASA orbiting assets and space activities; and

(2) the gaps in monitoring of millimeter-sized orbital debris data, orbital debris object sizes of 2-10 centimeters, and orbital debris objects larger than 10 centimeters;

(3) an identification of options to address any identified risks and gaps; and

(4) a recommended option for further analysis and potential implementation.

SEC. 803. PLANETARY PROTECTION STRATEGIC PLAN.

(a) STRATEGIC PLAN.—The Administrator shall develop a strategic plan for the Administration's planetary protection policy, research, and development activities.

(b) INCLUSION.—The strategic plan shall include the Administration's approach to—

(1) managing planetary protection policy implementation;

(2) organizing and receiving input from independent, external experts on planetary protection;

(3) understanding the application of planetary protection to cubesats;

(4) setting planetary protection research and technology investment priorities, including on planetary protection techniques and measures for verifying compliance with planetary protection guidelines; and

(5) coordinating the strategic plan and any planetary protection issues related to sample return and human missions to Mars in the Administration's robotic and human solar system exploration activities, as informed by the National Academies report,

''Review and Assessment of Planetary Protection Policy Development Processes''.

(c) TRANSMITTAL.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit the results of the Strategic Plan in subsection (a) and to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

TITLE IX—CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

SEC. 901. DATA COLLECTION ON COST BENEFITS TO THE ADMINISTRATION OF USE OF ENHANCED-USE LEASING.

(a) DATA COLLECTION.—The Administrator shall establish and follow a means to collect quantitative data on—

(1) the annual and cumulative number of enhanced used leases entered into;

(2) the annual and cumulative costs savings to the Administration on reduced maintenance, operating, and associated costs resulting from entering into enhanced-use leases at NASA Centers; and

(3) other quantifiable benefits to the Administration of the use of enhanced-use leasing authority.

(b) INCLUSION.—The data collected in subsection (a) shall be included the annual report required under section 20145(f) of title 51, United States Code.

SEC. 902. REPORT ON ENHANCED-USE LEASING REQUIREMENTS.

Not later than 270 days after the date of enactment of this Act, the Administrator shall prepare and transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on requirements for enhanced-use leasing applicants, including requirements related to the involvement of foreign entities, foreign entity ownership, and foreign entity investment in the entities applying for enhanced-use leases.

SEC. 903. REPORT ON CURRENT AND ANTICIPATED EFFECTS OF CLIMATE CHANGE AND EXTREME WEATHER ON AGENCY INFRASTRUCTURE AND FACILITIES.

(a) REPORT.—Not later than 270 days after the date of enactment of this Act, the Administrator shall provide to the appropriate committees of Congress a report on vulnerabilities of Administration facilities and infrastructure resulting from climate change and extreme weather events over the next 20 years.

(b) CONTENTS.—The assessment shall include—

(1) an identification of existing facilities and infrastructure vulnerable to climate change and extreme weather events based on the effects of sea level rise, increased flooding, drought, desertification, wildfires, thawing permafrost, increases in heavy precipitation events, and any other categories the Administrator deems necessary;

(2) a description of the potential impacts to facilities and infrastructure identified in paragraph (1);

(3) an overview of measures that may be necessary to ensure the continued operational viability and to increase the resiliency of the identified vulnerable facilities and infrastructure and the cost of such measures; and

(4) considerations and recommendations for policies and practices for future Administration facilities and infrastructure design, construction, and operation that would promote resilience to changing environmental conditions and extreme weather events.

(c) CONSIDERATION AND INCORPORATION OF RELIABLE AND AUTHORIZED SOURCES.—In conducting the assessment, the Administrator shall consider and incorporate climate change impacts, projections and analyses

from reliable and authorized sources, such as the National Academies of Sciences, the United States Geological Survey, the U.S. Global Change Research Office and National Climate Assessment, and the Administration's Earth Science Division.

TITLE X—GENERAL PROVISIONS

SEC. 1001. SPACE SITUATIONAL AWARENESS AND ORBITAL DEBRIS MITIGATION.

(a) IN GENERAL.—The Administrator is authorized to carry out activities, including research and development, orbital debris measurement, tracking, modeling, mitigation, remediation, conjunction analysis, and collision avoidance, for the purposes of maintaining the safety of the Administration's human spaceflight crew and spacecraft operations and for advancing the understanding of practical approaches to ensuring the sustainability of the space environment for the future of civil and commercial activities in space.

(b) RESEARCH AND TECHNOLOGY STRATEGY.—The Administrator, in collaboration with other relevant Federal agencies, academia, and industry, shall develop a research and technology strategy for advancing the Nation's capability for conducting space situational awareness and orbital debris mitigation activities. The strategy shall identify and prioritize—

(1) basic and applied research to improve object identification, orbit determination, object characterization, data cataloguing, and orbit propagation tracking and prediction;

(2) technology development and demonstrations needed to further the activities identified in subsection (a);

(3) specific research and technology activities regarding small satellite constellations, projections for debris production by small satellite constellations, and potential means for the prevention of debris by such constellations;

(4) other relevant research and technology activities that have the potential to materially improve the Nation's understanding and capabilities in space situational awareness and orbital debris mitigation;

(5) mechanisms to coordinate and transition basic and applied research on space situational awareness into space situational awareness operations; and

(6) methods for communicating the research and technology activities in paragraphs (1) through (4) to external stakeholders.

(c) TRANSMITTAL.—The Administrator shall transmit the Strategy in subsection (b) to the Committee on

Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 270 days after the date of enactment of this Act.

SEC. 1002. INTERNATIONAL FRAMEWORK ON ACTIVE ORBITAL DEBRIS REMOVAL.

(a) IN GENERAL.—The Administrator, in consultation with other relevant Federal agencies, shall carry out international discussions and capacity-building activities on orbital debris removal, including active satellite debris removal, for the purposes of making progress toward international guidelines on orbital debris removal, including active satellite debris removal.

(b) INCLUSION.—The international discussions and capacity-building activities in subsection (a) shall identify—

(1) opportunities for shared responsibilities for orbital debris removal;

(2) legal issues related to international responsibilities for orbital debris removal, including active satellite debris removal; and

(3) research and technology developments being carried out by national entities.

(c) REPORT.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit

a report to the Committee on Science, Space and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on the status of international discussions and capacity-building activities in subsection (a), including the status of progress toward the development of international guidelines under subsection (a).

SEC. 1003. SAFETY AND TECHNICAL RISKS OF ACTIVE DEBRIS REMOVAL.

(a) REPORT.—The Administrator shall identify safety and technical risks associated with active debris removal that would need to be addressed in active debris removal operations of the Administration's assets and provide report on the identified safety and technical risks to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 1 year after the date of enactment of this Act.

SEC. 1004. INDEPENDENT PROGRAM ANALYSIS AND EVALUATION OFFICE.

(a) IN GENERAL.—The Administrator shall establish within NASA an independent program analysis and evaluation capability for the purposes of independently assessing program performance, making programmatic, technical risk mitigation and institutional recommendations,

performing cost estimates and analyses, and conducting strategic planning activities, among other functions.

(b) ESTABLISHMENT.—The Administrator shall establish an Independent Program Analysis and Evaluation Office to carry out the functions in subsection (a). The Office shall remain independent of any Program, and shall have no programmatic responsibilities so as to maintain its independent assessment integrity.

(c) AUTHORIZATION.—The Administrator is authorized to carry out research on program assessment; cost, schedule, and technical estimation; and other relevant functions for the purposes of obtaining the highest level of expertise and the most effective decision-making tools with which to inform the Administrator.

(d) MOON TO MARS PROGRAM.—The Office established in subsection (b) shall maintain an ongoing, focused effort to assess the goals, objectives, requirements, architectural approach, cost and schedule, and progress of the Moon to Mars Program established under section 202.

SEC. 1005. REPORT ON USE OF THE TERM "COMMERCIAL" IN NASA ACTIVITIES.

Not later than 90 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce,

Science, and Transportation of the Senate a report on the definitions of ''commercial'' being used across the Administration.

SEC. 1006. SUPPLY CHAIN AND SUPPLIER BASE.

(a) REVIEW.—The Administrator, in collaboration with industry and other Federal agencies, shall carry out a review of the health of the supply chain and supplier base for critical materials, parts, and systems used in the manufacturing and production of development systems, spacecraft, instruments, and other relevant elements and shall provide recommendations to address any identified vulnerabilities.

(b) TRANSMITTAL.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit the results of the review, including any recommended actions in response to the review, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

SEC. 1007. USE OF OPERATIONAL COMMERCIAL SUBORBITAL VEHICLES FOR RESEARCH, DEVELOPMENT, AND EDUCATION.

(a) ASSESSMENT.—The Administrator shall conduct an assessment of the issues and risks related to the potential use of operational commercial reusable suborbital

flight vehicles for carrying out potential NASA-sponsored science and engineering investigations, technology demonstrations, and educational activities involving NASA-sponsored researchers. The report shall—

(1) characterize the risks of using potential commercial reusable suborbital flights to NASA-sponsored researchers and scientific investigations and flight hardware;

(2) identify and describe the United States Government and space flight operator responsibilities for liability and indemnification with respect to commercial suborbital vehicle flights that involve NASA-sponsored payloads or activities, potential NASA-supported space flight participants, or other NASA-related contributions; and

(3) identify any statutory provisions that may be required to authorize and enforce the liability and indemnification responsibilities described in paragraph (2).

(b) TRANSMITTAL.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit the plan and assessment described in subsections (a) and (b) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

SEC. 1008. THE SPACE CAPABILITIES OF THE PEOPLE'S REPUBLIC OF CHINA.

(a) REPORT.—Not later than 1 year after the date of enactment of this Act, the National Space Council shall coordinate an interagency assessment of the space exploration capabilities of the People's Republic of China, including any threats to United States assets in space as well as the impact of cooperation and participation of the People's Republic of China with other nations on space activities.

(b) STRATEGY.—The report required in subsection (a) shall include a strategy to ensure United States leadership in space exploration and counter any identified threats posed by the People's Republic of China.

(c) CLASSIFIED ANNEX.— The report identified in subsection (a) may include a classified annex.

SEC. 1009. SPECTRUM INTERFERENCE.

(a) IN GENERAL.—The Administrator shall conduct an assessment of the impact of the loss of observations based on protection limits derived from the Word Radio Conference 19 (WRC19) international agreement.

(b) TRANSMITTAL.—The assessment conducted in subsection (a) shall be delivered to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science,

and Transportation of the Senate not later than 90 days after the date of enactment of this Act.

SEC. 1010. REPORTS TO CONGRESS.

(a) IN GENERAL.—Chapter 301 of title 51, United States Code, is amended by adding at the end the following:

"SEC. 30105. REPORTS TO CONGRESS.

''Any report or notification provided to Congress by NASA, including on the status of balances of funding at the account level and on cost increases of 10 percent or more, shall be provided the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate concurrently with its delivery to any other committee or office.''.

(b) CONFORMING AMENDMENT.—The table of sections for chapter 301 of title 51, United States Code, is amended by adding after the item relating to section 30104 the following:

''30105. Reports to Congress.''.

SEC. 1011. GENERAL ACCOUNTABILITY OFFICE REPORT ON LARGE-SCALE PROGRAMS, PROJECTS, AND ACTIVITIES.

Section 30104(c) of title 51, United States Code, is amended by adding at the end the following:

''(4) GAO REPORT.—The GAO shall issue an annual report on the status of large-scale the National Aeronautics and Space Administration's major programs, programs, projects and activities.

''(5) SCHEDULE.—The report directed in this subsection shall be delivered to the Congress annually and in advance of the annual budget submission of the President.

''(6) ACCESS.—The Administrator is directed to cooperate fully and to provide timely program analysis, evaluation data and relevant information to the GAO so that it can conduct this review and meet the annual schedule. Such information includes, but is not limited to, copies of preliminary cost estimates, access to relevant online agency applications, databases, and web portals, and access to information from contractor and agency personnel.''.

SEC. 1012. NASA INSTITUTES.

(a) IN GENERAL.—Section 30103(a) of title 51, United States Code, is amended—

(1) by striking ''and'' at the end of paragraph (5);

(2) by redesignating paragraph (6) as paragraph (7); and

(3) by inserting after paragraph (5) the following:

''(6) the budget for each NASA-funded Institute; and''.

(b) REPORT.—Not later than 90 days after the date of enactment of this Act, the Administrator shall deliver to the Authorizing Committees of Congress, a report that recommends guidance and metrics for the management, utilization, expectations for return on investment, and financial condition for NASA-funded institutes.

SEC. 1013. SURVEYS ON THE INDUSTRIAL BASE OF THE UNITED STATES.

(a) IN GENERAL.— Chapter 315 of title 51, United States Code, is amended by adding at the end the following:

''SEC. 30506. INDUSTRIAL BASE SURVEYS.

''No funds may be obligated or expended by the Administrator of NASA for the purpose of carrying out a Bureau of Industry and Security survey with respect to the United States space and aerospace industrial base until the date that is 90 days after the date on which the Administrator submits to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a written notification that includes—

''(1) the proposed subject matter of such survey;

''(2) a description of the information to be required of survey respondents; and

''(3) any penalties to be assessed against respondents for noncompliance with survey requirements.''.

(b) CONFORMING AMENDMENT.—The table of sections for chapter 315 of title 51, United States Code, is amended by adding after the item relating to section 30505 the following:

''30506. Industrial base surveys.''.

SEC. 1014. BUDGETS.

Section 30103(a)(1)(A) of title 51, United States Code, is amended by striking ''space shuttle'' and inserting ''Commercial Crew and Commercial Cargo''.