

116TH CONGRESS
2D SESSION

H. R. 5666

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

IN THE HOUSE OF REPRESENTATIVES

JANUARY 24, 2020

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 Science, Space, and Technology

A BILL

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

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE; TABLE OF CONTENTS.**

4 (a) **SHORT TITLE.**—This Act may be cited as the
5 “National Aeronautics and Space Administration Author-
6 ization Act of 2020”.

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

- Sec. 1. Short title; table of contents.
- Sec. 2. Findings.
- Sec. 3. Definitions.

TITLE I—AUTHORIZATION OF APPROPRIATIONS

Sec. 101. Fiscal year 2020.

TITLE II—HUMAN SPACE EXPLORATION AND OPERATIONS

Subtitle A—Moon to Mars Program

- Sec. 201. Sustainable human exploration program.
- Sec. 202. Goals and objectives.
- Sec. 203. Structure of Moon to Mars Program.
- Sec. 204. Reporting and briefings.
- Sec. 205. Critical enabling capabilities.
- Sec. 206. Noncritical path activities.
- Sec. 207. Core exploration capabilities.
- Sec. 208. Reviews and assessments.

Subtitle B—International Space Station

- Sec. 221. Extension and post-ISS support.
- Sec. 222. Priorities for ISS utilization.
- Sec. 223. Assured crew access to the International Space Station.
- Sec. 224. International Space Station Deorbit Capability and Plan.
- Sec. 225. Replacement Extravehicular Mobility Units.
- Sec. 226. Low Earth orbit development.

TITLE III—SCIENCE

- Sec. 301. Importance of a balanced science program.
- Sec. 302. Review of implementation of quality assurance program and parts policy in science mission development.
- Sec. 303. Independent external technical, management, and cost reviews.
- Sec. 304. Small satellites.
- Sec. 305. Options for small satellite and payload access to the near-space and space environment.
- Sec. 306. Study on space life and physical sciences research and applications placement.
- Sec. 307. Space life and physical sciences research requirements.

Subtitle A—Earth Science and Applications

- Sec. 311. Goal.
- Sec. 312. Applied uses of Earth science data.
- Sec. 313. Survey of State, Tribal, and territory use of NASA Earth observation data.
- Sec. 314. Commercial Earth observation data.
- Sec. 315. Plankton, Aerosol, Cloud, ocean Ecosystem mission.
- Sec. 316. CLARREO Pathfinder.

Subtitle B—Astrophysics

- Sec. 321. Wide Field Infrared Survey Telescope.
- Sec. 322. Stratospheric Observatory for Infrared Astronomy.
- Sec. 323. Research on technosignatures.

Subtitle C—Planetary Science

- Sec. 331. Mars communications infrastructure.

- Sec. 332. Mars sample return strategy and plan.
- Sec. 333. Commercial Lunar Payload Services.
- Sec. 334. Europa Clipper launch vehicle.
- Sec. 335. Dedicated survey mission.
- Sec. 336. Near-Earth object and planetary defense roadmap.
- Sec. 337. Assessment of requirements for cataloguing and archiving near-Earth object data.
- Sec. 338. International confidence and capacity building for near-Earth object impact mitigation.
- Sec. 339. Close passing near-Earth objects.

Subtitle D—Heliophysics and Space Weather Research

- Sec. 341. Importance of heliophysics research to understanding space weather.
- Sec. 342. Space Weather Research and Applications Program.

Subtitle E—Data Science and Management

- Sec. 361. Data science and management.
- Sec. 362. Workshop on data analytics for Earth science research.

TITLE IV—SPACE COMMUNICATIONS

- Sec. 401. Review of space communications.

TITLE V—AERONAUTICS

- Sec. 501. Research effort to advance sustainable aviation.
- Sec. 502. Workshop on research and development on noise.
- Sec. 503. Aeronautics research and technology roundtable.
- Sec. 504. Experimental aircraft demonstrations.
- Sec. 505. Review of research roadmap on hypersonics.
- Sec. 506. Supersonic flight.
- Sec. 507. Urban air mobility.
- Sec. 508. Aeronautics workforce and modeling and test facilities.
- Sec. 509. University leadership initiative.

TITLE VI—SPACE TECHNOLOGY

- Sec. 601. Space nuclear systems.
- Sec. 602. Nuclear thermal propulsion.
- Sec. 603. Nuclear surface power.
- Sec. 604. Review of flight opportunities program.
- Sec. 605. Sense of Congress on optical communications.
- Sec. 606. Propulsion testing facilities.
- Sec. 607. In-space satellite servicing and assembly.
- Sec. 608. Parachute systems research and development.

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

- Sec. 701. Office of STEM engagement.
- Sec. 702. Independent review of Space Grant.

TITLE VIII—SAFETY, SUPPORT, AND MISSION SERVICES

- Sec. 801. Policy and procedure.
- Sec. 802. Monitoring millimeter-sized orbital debris.

Sec. 803. Planetary protection strategic plan.

TITLE IX—CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE
AND RESTORATION

Sec. 901. Data collection on cost benefits to the Administration of use of enhanced-use leasing.

Sec. 902. Report on enhanced-use leasing requirements.

Sec. 903. Report on current and anticipated effects of climate change and extreme weather on agency infrastructure and facilities.

TITLE X—GENERAL PROVISIONS

Sec. 1001. Space situational awareness and orbital debris mitigation.

Sec. 1002. International framework on active orbital debris removal.

Sec. 1003. Safety and technical risks of active debris removal.

Sec. 1004. Independent program analysis and evaluation office.

Sec. 1005. Report on use of the term “commercial” in NASA activities.

Sec. 1006. Supply chain and supplier base.

Sec. 1007. Use of operational commercial suborbital vehicles for research, development, and education.

Sec. 1008. The space capabilities of the People’s Republic of China.

Sec. 1009. Spectrum interference.

Sec. 1010. Reports to Congress.

Sec. 1011. General accountability office report on large-scale programs, projects, and activities.

Sec. 1012. NASA institutes.

Sec. 1013. Surveys on the industrial base of the United States.

Sec. 1014. Budgets.

1 SEC. 2. FINDINGS.

2 Congress makes the following findings:

3 (1) NASA should remain a multimission agency
4 and continue to carry out, in partnership with aca-
5 demia, industry, and international partners, a bal-
6 anced program of science, aeronautics, space tech-
7 nology, human exploration, and educational activi-
8 ties.

9 (2) The Nation’s investments in civil space re-
10 search, technology, and development have and will
11 continue to contribute significantly to the Nation’s
12 innovation capacity and economic strength, and pro-

1 vide applications and benefits that improve the lives
2 of United States citizens and society.

3 (3) International cooperation and collaboration
4 strengthen the Nation’s science, aeronautics, and
5 human exploration programs and unify partner na-
6 tions in the peaceful uses of outer space.

7 (4) NASA’s leadership in aeronautics has con-
8 tributed greatly to the Nation’s strength in civil and
9 commercial aviation and should remain a priority as
10 innovative technologies and aviation concepts offer
11 the potential to transform the future of aviation and
12 support the Nation’s economic growth.

13 (5) NASA makes essential contributions to our
14 understanding of the global challenge of climate
15 change through its collection of space-based Earth
16 science data, research on global, integrated Earth
17 system science, and development of models that ad-
18 vance our understanding of the climate system and
19 the natural and human impacts on it.

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

22 (7) Reducing the risk and demonstrating the
23 capabilities and operations needed to support a
24 human mission to Mars may require human explo-
25 ration of the cis-lunar vicinity and lunar surface.

1 (8) A constancy of purpose, including clear and
2 consistent goals and objectives, is essential for mak-
3 ing effective progress on the Nation’s science, aero-
4 nautics, space technology, and human exploration
5 programs and for attracting and keeping the Na-
6 tion’s best, brightest, and most capable workforce.

7 (9) Clearly defined roles, responsibilities, and
8 accountability provides transparency in the imple-
9 mentation of the Nation’s civil space goals and ob-
10 jectives.

11 (10) The innovative capabilities of the commer-
12 cial space industry are essential to the Nation’s
13 science, aeronautics, and human space exploration
14 activities, are an important instrument of techno-
15 logical and economic competitiveness, and should be
16 leveraged, as appropriate, to advance the Nation’s
17 objectives in civil space.

18 **SEC. 3. DEFINITIONS.**

19 In this Act:

20 (1) ADMINISTRATION.—The term “Administra-
21 tion” has the meaning given the term in section
22 10101 of title 51, United States Code.

23 (2) ADMINISTRATOR.—The term “Adminis-
24 trator” has the meaning given the term in section
25 10101 of title 51, United States Code.

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

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

8 (5) ISS.—The term “ISS” means the Inter-
9 national Space Station.

10 (6) NASA.—The term “NASA” means the Na-
11 tional Aeronautics and Space Administration.

12 (7) ORION.—The term “Orion” has the mean-
13 ing given the term in section 20302 of title 51,
14 United States Code.

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

18 (9) UNITED STATES GOVERNMENT ASTRO-
19 NAUT.—The term “United States government astro-
20 naut” has the meaning given the term “government
21 astronaut” in section 50902 of title 51, United
22 States Code.

1 **TITLE I—AUTHORIZATION OF**
2 **APPROPRIATIONS**

3 **SEC. 101. FISCAL YEAR 2020.**

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

6 (1) For exploration, \$6,017,600,000, of which
7 \$1,406,700,000 shall be for the Orion multi-purpose
8 Crew Vehicle, \$2,585,900,000 shall be for the Space
9 Launch System, \$590,000,000 shall be for Explo-
10 ration Ground Systems, and \$1,435,000,000 shall be
11 for Exploration Research and Development.

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

13 (3) For science, \$7,138,900,000, of which
14 \$1,971,800,000 shall be for Earth Science,
15 \$2,713,400,000 shall be for Planetary Science,
16 \$1,306,200,000 shall be for Astrophysics,
17 \$423,000,000 shall be for the James Webb Space
18 Telescope, and \$724,500,000 shall be for
19 Heliophysics.

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

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

22 (6) For science, technology, engineering, and
23 mathematics (STEM), \$120,000,000, of which
24 \$48,000,000 shall be for the National Space Grant
25 College and Fellowship Program, \$24,000,000 shall

1 be for the Established Program to Stimulate Com-
2 petitive Research (EPSCoR), \$36,000,000 shall be
3 for the Minority University Research and Education
4 Project (MUREP), and \$12,000,000 shall be for
5 STEM Education and Accountability Projects
6 (SEAP).

7 (7) For safety, security, and mission services,
8 \$2,913,300,000.

9 (8) For construction and environmental compli-
10 ance and restoration, \$373,400,000.

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

12 **TITLE II—HUMAN SPACE EXPLORATION AND OPERATIONS**

13 **Subtitle A—Moon to Mars Program**

14 **SEC. 201. SUSTAINABLE HUMAN EXPLORATION PROGRAM.**

15 It is the sense of Congress that the Nation’s human
16 exploration program is an important element of United
17 States leadership in space exploration, economic strength,
18 and national security. It is the further sense of Congress
19 that constancy of purpose and the sustainability of the
20 Nation’s human exploration goals and objectives should be
21 an inherent principle of a long-term, deep space human
22 exploration program that spans several Congresses and
23 Administrations.
24

1 **SEC. 202. GOALS AND OBJECTIVES.**

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

7 (b) ESTABLISHMENT.—The goal of NASA’s Moon to
8 Mars Program shall be to land humans on Mars in a sus-
9 tainable manner as soon as practicable. The Moon to Mars
10 Program shall have the interim goal of sending a crewed
11 mission to the lunar surface by 2028 and a goal of sending
12 a crewed mission to orbit Mars by 2033.

13 (c) PRECURSOR ACTIVITIES.—The Administrator
14 shall undertake precursor crewed missions to cis-lunar
15 space and the lunar surface for the purpose of risk reduc-
16 tion for human missions to Mars by developing and testing
17 those systems and operational practices needed for suc-
18 cessful crewed Mars missions.

19 (d) OBJECTIVES.—The objectives of the human mis-
20 sions to Mars shall be to—

21 (1) validate the capabilities required for sus-
22 tained human exploration of and operations on the
23 surface of Mars;

24 (2) pursue scientific investigations, as rec-
25 ommended by the National Academies, that are en-
26 abled by the human exploration of Mars; and

1 (3) develop and maintain the scientific, tech-
2 nical, program management, and human spaceflight
3 operational skills required to support a sustainable
4 deep space exploration program.

5 **SEC. 203. STRUCTURE OF MOON TO MARS PROGRAM.**

6 (a) MOON TO MARS PROGRAM OFFICE.—The Admin-
7 istrator shall establish a Moon to Mars Program Office
8 within 60 days of the enactment of this Act to lead and
9 manage the Moon to Mars Program.

10 (b) PROGRAM DIRECTOR.—The Administrator shall
11 appoint a Program Director of the Office established in
12 subsection (a) who shall report to the Associate Adminis-
13 trator and the Associate Administrator of the Human Ex-
14 ploration and Operations Mission Directorate.

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

17 (1) requirements for a human Mars orbital mis-
18 sion and a human mission to the surface of Mars;

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

1 (3) an integrated, master plan for the develop-
2 ment of required capabilities for the human mission
3 to Mars.

4 (d) SYSTEMS ENGINEERING AND INTEGRATION.—
5 The Director of the Moon to Mars Program Office shall
6 appoint a Systems Engineering and Integration Manager
7 to manage the systems engineering and integration activi-
8 ties of the Moon to Mars Program.

9 (e) SPECIAL HIRING AUTHORITIES.—The Adminis-
10 trator shall propose to Congress any special hiring au-
11 thorities that the Administrator determines are needed to
12 ensure that personnel with the requisite skills and experi-
13 ence are available to the Program Office.

14 (f) PROGRAM ELEMENTS.—The Moon to Mars Pro-
15 gram shall consist of the following:

16 (1) A Gateway to Mars in cis-lunar space or at
17 a Lagrangian point for the purpose of reducing the
18 risks of the capabilities in paragraph (3) and serving
19 as a testbed for the systems and operational tech-
20 niques needed to transport crews to, from, and dur-
21 ing operations in Mars orbit or on the surface of
22 Mars. The Gateway to Mars shall be developed to
23 operate autonomously and to be crew-tended, as
24 needed, on an intermittent basis. The Gateway to

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

3 (2) A Lunar Precursor Initiative (LPI) for the
4 purpose of gaining and demonstrating the oper-
5 ational experience and systems needed to enable
6 crewed transport to and from the surface of Mars,
7 as well as for limited operations and habitation on
8 Mars.

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

14 (A) Mars entry, descent, and landing sys-
15 tems;

16 (B) radiation safety;

17 (C) in-space power and propulsion, includ-
18 ing nuclear thermal propulsion;

19 (D) Mars transport vehicle;

20 (E) planetary ascent propulsion;

21 (F) environmental control and life support
22 systems;

23 (G) Mars habitats;

24 (H) extravehicular activity suits;

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

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

5 (4) A Space Launch System for the purpose of
6 providing heavy-lift capability to carry out the Moon
7 to Mars Program. The Administrator shall complete
8 development of the Space Launch System and the
9 Space Launch System variant enabled by an Explo-
10 ration Upper Stage, pursuant to section 302 of the
11 National Aeronautics and Space Administration Au-
12 thorization Act of 2010. The Administrator shall
13 take steps to develop the Block 2 variant to provide
14 the full range of launch capability and performance
15 available to the United States for the Administra-
16 tion's crewed and robotic exploration of deep space.
17 The Administrator shall complete the development
18 and testing of the Exploration Upper Stage for the
19 Space Launch System.

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

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

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

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

9 **SEC. 204. REPORTING AND BRIEFINGS.**

10 (a) IN GENERAL.—The Administrator shall provide
11 regular reports and briefings on the progress and status
12 of the Moon to Mars Program, and associated activities
13 to the Committee on Science, Space, and Technology of
14 the House of Representatives and the Committee on Com-
15 merce, Science, and Transportation of the Senate in ac-
16 cordance with this section.

17 (1) REPORTING WITH 60 DAYS.—Within 60
18 days of the date of enactment of this Act, the Ad-
19 ministrator shall develop a list of the remaining
20 human health risk reduction research tasks that
21 need to be completed to enable crewed missions to
22 Mars and that require the International Space Sta-
23 tion, along with a plan for completing all of those
24 tasks within 5 years of the date of the enactment of
25 this Act.

1 (2) REPORTING WITHIN 120 DAYS.—Within 120
2 days of the date of enactment of this Act, the Ad-
3 ministrator shall develop an overall architecture and
4 plan, consistent with sections 203(c)(1) and
5 203(c)(2), including—

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

13 (B) a list of the capabilities and risk re-
14 duction measures listed in section 203(f)(3).

15 For each high-priority technology or capability, the
16 Administrator shall develop a plan to include the de-
17 velopment milestones, including activities required to
18 be carried out in cis-lunar space or on the lunar sur-
19 face, and an estimated 5-year funding profile re-
20 quired for demonstrating the capability to a level of
21 readiness for use in a Mars mission within 10 years
22 of the date of the enactment of this Act.

23 (3) REPORTING WITHIN 270 DAYS.—Within 270
24 days of the date of enactment of this Act, the Ad-
25 ministrator shall transmit—

1 (A) five-year funding estimates and pro-
2 files for the Moon to Mars Program. The budg-
3 et profiles should include estimated funding re-
4 quirements and profiles for the program ele-
5 ments in section 203(f), and related infrastruc-
6 ture, facilities, and operations that are con-
7 sistent with the achievement of a crewed mis-
8 sion to Mars orbit by 2033; and

9 (B) the Independent Program Analysis and
10 Evaluation Office established in section 1004
11 shall assess the basis of the five-year budget
12 profiles and shall transmit the results of the as-
13 sessment to the Committee on Science, Space,
14 and Technology of the House of Representa-
15 tives and the Committee on Commerce, Science,
16 and Transportation of the Senate not later than
17 six months after the budget profiles have been
18 transmitted to the Committee on Science,
19 Space, and Technology of the House of Rep-
20 resentatives and the Committee on Commerce,
21 Science, and Transportation of the Senate.

22 (b) BIENNIAL BRIEFINGS.—The Administrator shall
23 provide biennial briefings on the status, progress, and any
24 challenges identified in maturing and developing the key
25 capabilities specified in section 203(c)(3) and section

1 203(f)(3) to the Committee on Science, Space, and Tech-
2 nology of the House of Representatives and the Committee
3 on Commerce, Science, and Transportation of the Senate.

4 (c) TRANSMITTAL.—The Administrator shall trans-
5 mit the architecture and plans enumerated in section
6 204(a)(2) through section 204(a)(3) to the Committee on
7 Science, Space, and Technology of the House of Rep-
8 resentatives and the Committee on Commerce, Science,
9 and Transportation of the Senate within 15 days after
10 their scheduled completion dates.

11 **SEC. 205. CRITICAL ENABLING CAPABILITIES.**

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

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

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

5 (1) full ownership of the human landing system;

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

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

11 (4) leadership over any anomaly or accident in-
12 vestigation, should it be necessary to carry out such
13 an investigation; and

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

19 (c) EXPLORATION SPACE SUITS.—The Administrator
20 shall develop an exploration space suit to meet the require-
21 ments of the Moon to Mars Program. In developing an
22 exploration space suit, the Administrator shall, to the
23 greatest extent practicable, leverage prior and existing in-
24 vestments in advanced space suit technologies in order to
25 maximize the benefits of such investments and tech-

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

3 (d) LOGISTICS SUPPORT.—To the maximum extent
4 possible, logistics support to the Gateway to Mars and the
5 lunar surface shall be provided by commercial services,
6 provided that the availability of those services does not
7 becoming the limiting critical path factor in NASA’s abil-
8 ity to complete its Gateway to Mars and Lunar Precursor
9 initiatives as scheduled. The Administrator shall develop
10 contingency plans for the delivery of the minimum set of
11 needed logistics in the event commercial services are not
12 available when needed.

13 (e) INTERNATIONAL COLLABORATION.—

14 (1) IN GENERAL.—The Administrator shall lead
15 and encourage to the maximum extent practicable
16 international partner participation in the implemen-
17 tation of the elements of the Moon to Mars Program
18 under overall NASA leadership. The Administrator
19 shall encourage partnerships that enhance the pro-
20 gram.

21 (2) CONGRESSIONAL AUTHORIZATION.—NASA
22 shall seek Congressional authorization prior to final-
23 izing any exploration architecture that depends on
24 international or commercial partnerships for overall
25 mission success.

1 (f) CREWED LUNAR LANDING MISSIONS.—In order
2 to minimize the time required for the Lunar Precursor Ini-
3 tiative phase of the Moon to Mars Program, NASA shall
4 plan for and implement measures to enable a crewed lunar
5 landing mission rate of at least two per year after the ini-
6 tial crewed lunar landing has been achieved.

7 (g) LUNAR LANDER MANAGEMENT.—The Moon to
8 Mars Program Office shall manage the overall develop-
9 ment of the Human Lunar Landing System, with the
10 Johnson Space Center responsible for the crew-related ele-
11 ments, vehicle structure, and Human Lunar Landing Sys-
12 tem integration and the Marshall Space Flight Center re-
13 sponsible for the Lander propulsion systems.

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

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

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

3 **SEC. 206. NONCRITICAL PATH ACTIVITIES.**

4 (a) LUNAR OUTPOST.—Any establishment of a con-
5 tinuously crewed lunar outpost or research station shall
6 not be considered an element of the Moon to Mars Pro-
7 gram and shall be budgeted separately from the Moon to
8 Mars Program.

9 (b) OTHER CREWED ACTIVITIES.—Crewed activities
10 on or around the surface of the Moon that do not con-
11 tribute to the goal of landing humans on Mars in as sus-
12 tainable manner as practical shall not be included in the
13 Moon to Mars Program and shall be budgeted separately
14 from the Moon to Mars Program.

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

22 **SEC. 207. CORE EXPLORATION CAPABILITIES.**

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

1 spaceflight skills are important elements of a safe and sus-
2 tainable human exploration program.

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

12 (c) MILESTONES.—Not later than 90 days after the
13 date of enactment of this Act, the Administrator shall
14 transmit a list of the key milestones required for com-
15 pleting each of the Space Launch System variants and an
16 estimated date on which those milestones shall be com-
17 pleted.

18 (d) EXPLORATION GROUND SYSTEMS INFRASTRUC-
19 TURE.—The Administrator shall ensure that elements of
20 a ground system infrastructure are in place to enable the
21 preparation and use of the Space Launch System, specifi-
22 cally its Block 1 (70 mt) and Block 1B (105 mt) and
23 Block 2 (130 mt) variants of the Space Launch System.

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

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

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

10 **SEC. 208. REVIEWS AND ASSESSMENTS.**

11 (a) INDEPENDENT REVIEW OF HUMAN RESEARCH
12 PROGRAM.—

13 (1) IN GENERAL.—The Administrator shall
14 enter into an arrangement with the National Acad-
15 emies of Sciences, Engineering, and Medicine for an
16 independent, external review of the Human Research
17 Program. The purpose of the review shall be to ex-
18 amine the effectiveness of approaches currently
19 being taken for identifying, measuring, and miti-
20 gating, and establishing countermeasures for human
21 health and performance risks related to long-term
22 human spaceflight, including any human activities in
23 deep space, and to make recommendations to im-
24 prove the program. The review shall consider the

1 translation of basic research into the Human Re-
2 search Program.

3 (2) REPORT.—The Administrator shall trans-
4 mit the results of the review to the Committee on
5 Science, Space, and Technology of the House of
6 Representatives and the Committee on Commerce,
7 Science, and Transportation of the Senate not later
8 than 18 months after the date of enactment of this
9 Act.

10 (b) CORE STAGE PRODUCTION CAPACITY.—

11 (1) ASSESSMENT.—The Administrator shall as-
12 sess the requirements and resource needed for in-
13 creasing the production capacity of the Space
14 Launch System core stage from one to two core
15 stages per year, and shall identify the resources,
16 workforce, and infrastructure needed to increase the
17 production capacity.

18 (2) REPORT.—The Administrator shall trans-
19 mit the results of the assessment not later than 180
20 days after the date of enactment of this Act to the
21 Committee on Science, Space, and Technology of the
22 House of Representatives and the Committee on
23 Commerce, Science, and Transportation of the Sen-
24 ate.

1 (c) VEHICLE ASSEMBLY BUILDING.—Not later than
2 270 days after the date of enactment of this Act, the Ad-
3 ministrator shall transmit to the Committee on Science,
4 Space, and Technology of the House of Representatives
5 and the Committee on Commerce, Science, and Transpor-
6 tation of the Senate an assessment of requirements for
7 concurrently processing 2 or more Space Launch System
8 vehicles, including Space Launch System vehicles with an
9 exploration upper stage.

10 (d) REVIEW OF RISK MITIGATION.—Not later than
11 180 days after the date of enactment of this Act, the Ad-
12 ministrator shall transmit to the Committee on Science,
13 Space, and Technology of the House of Representatives
14 and the Committee on Commerce, Science, and Transpor-
15 tation of the Senate a review of the Orion crew vehicle
16 and its systems, including the European Service Module,
17 to identify any single-point failure and zero-fault-tolerant
18 systems, components, or designs. The review shall identify
19 and describe all actions taken to mitigate the risks of the
20 systems, components, or designs identified, and any risk
21 mitigation actions that are planned to be taken.

22 (e) STUDY ON ENHANCED ORION SERVICE MODULE
23 PERFORMANCE.—Not later than 270 days after the date
24 of enactment of the Act, the Administrator shall transmit
25 to the Committee on Science, Space, and Technology of

1 the House of Representatives and the Committee on Com-
2 merce, Science, and Transportation of the Senate a report
3 on the results of an independent technical and cost anal-
4 ysis of the options for developing or acquiring an enhanced
5 Orion service module, as appropriate, that would enable
6 direct low lunar orbit access and departure.

7 (f) ENVIRONMENTAL CONTROL AND LIFE SUPPORT
8 SYSTEM (ECLSS).—Not later than 180 days after the
9 date of enactment of this Act, the Administrator shall
10 transmit to the Committee on Science, Space, and Tech-
11 nology of the House of Representatives and the Committee
12 on Commerce, Science, and Transportation of the Senate
13 the results of a plan and schedule for the completion, full
14 testing, qualification, and validation of the integrated
15 ECLSS system to be used on the Orion crew vehicle. The
16 plan shall include a schedule, milestones, and shall identify
17 any technical or supply chain challenges, as well as ap-
18 proaches to overcoming the challenges, in meeting the
19 schedule and milestone dates.

20 **Subtitle B—International Space** 21 **Station**

22 **SEC. 221. EXTENSION AND POST-ISS SUPPORT.**

23 (a) POLICY.—Section 70907 of title 51, United
24 States Code, is amended by striking “at least 2024” and
25 inserting “at least 2028” and adding at the end “unless

1 continued operations present an increased safety risk or
2 Congress has authorized a detailed plan submitted by the
3 Administration for a transition from the International
4 Space Station to an alternate platform, platforms or other
5 means for continued research, as determined in section
6 226(b) and section 307”.

7 (b) INDEPENDENT COST ESTIMATE.—The Inde-
8 pendent Program Analysis and Evaluation Office estab-
9 lished in section 1004 shall arrange for an independent
10 estimate of the cost of continuing International Space Sta-
11 tion operations through 2028. The estimate shall include
12 the cost of crew and cargo transportation and of the re-
13 search to be undertaken reflecting the priorities identified
14 in section 222. The assessment shall identify opportunities
15 for operational efficiencies that could result in cost savings
16 and increased research productivity.

17 (c) TRANSMITTAL.—The Administrator shall trans-
18 mit the results of the independent cost estimate to the
19 Committee on Science, Space, and Technology of the
20 House of Representatives and the Committee on Com-
21 merce, Science, and Transportation of the Senate not later
22 than 6 months after the date of enactment of this Act.

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

1 the House of Representatives and the Committee on Com-
2 merce, Science, and Transportation of the Senate, the re-
3 sults of an assessment of—

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

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

9 (A) the research requirements of the
10 Human Research Program and the require-
11 ments recommended in sections 226(b) and
12 307;

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

15 (C) key capabilities at NASA Centers that
16 can be leveraged for the Administration’s con-
17 tinued safety in and use of low Earth orbit.

18 **SEC. 222. PRIORITIES FOR ISS UTILIZATION.**

19 (a) IN GENERAL.—The Administrator shall prioritize
20 the use of available NASA allocation of crew time and re-
21 sources on the International Space Station toward re-
22 search and technology development that enables the Moon
23 to Mars goal in section 202. Priority research and develop-
24 ment areas should include—

1 (1) the research of the Human Research Pro-
2 gram, including research on reduction of human
3 health and performance risks, behavioral and psy-
4 chological risks, and astronaut safety related to
5 long-duration human spaceflight, and the develop-
6 ment of countermeasures to mitigate those risks;

7 (2) the reduction of risks for exploration tech-
8 nologies, including for ECLSS, extravehicular activ-
9 ity and space suits, environmental monitoring, safe-
10 ty, and emergency response, deep space communica-
11 tions, among other critical enabling technologies for
12 human exploration of deep space identified in section
13 203(f); and

14 (3) basic space life and physical science re-
15 search consistent with the priorities of the most re-
16 cent space life and physical sciences National Acad-
17 emies decadal survey.

18 In addressing paragraphs (1) and (2), the Administrator
19 shall take into account the data associated with the Life-
20 time Surveillance of Astronaut Health program, other rel-
21 evant data, and recommendations from relevant National
22 Academies reports.

23 (b) BIENNIAL PROGRESS.—The Administrator shall
24 provide to the Committee on Science, Space, and Tech-
25 nology of the House of Representatives and the Committee

1 on Commerce, Science, and Transportation of the Senate
2 a biannual accounting of the use of NASA crew time and
3 ISS resources, including allocation of such resources to-
4 ward the priorities established in subsection (a).

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

10 **SEC. 223. ASSURED CREW ACCESS TO THE INTERNATIONAL**
11 **SPACE STATION.**

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

19 **SEC. 224. INTERNATIONAL SPACE STATION DEORBIT CAPA-**
20 **BILITY AND PLAN.**

21 Not later than 180 days after the date of enactment
22 of this Act, the Administrator shall transmit to the Con-
23 gress an International Space Station Deorbit Capability
24 and Plan, including a cost estimate of implementing the
25 plan.

1 **SEC. 225. REPLACEMENT EXTRAVEHICULAR MOBILITY**
2 **UNITS.**

3 (a) **REPLACEMENT SUITS.**—The Administrator shall
4 take all necessary steps to provide for upgraded and re-
5 placement International Space Station Extravehicular Mo-
6 bility Units (EMUs), including spares, to ensure the safety
7 of the International Space Station crew and crew oper-
8 ations. The upgraded and replacement units shall be fully
9 tested and demonstrated, including on the ISS, to be cer-
10 tified by the Administration for use by crew as soon as
11 practicable. Upgraded and replacement EMUs, including
12 spares, shall accommodate the diversity of ISS crew, suit
13 sizes, and other requirements established to support
14 extravehicular activities.

15 (b) **PLAN.**—Not later than 180 days after the date
16 of enactment of this Act, the Administrator shall transmit
17 a plan for the provision of upgraded and replacement
18 EMUs to the Committee on Science, Space, and Tech-
19 nology of the House of Representatives and the Committee
20 on Commerce, Science, and Transportation of the Senate.

21 **SEC. 226. LOW EARTH ORBIT DEVELOPMENT.**

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

1 ments identified in section 307, following the end of Inter-
2 national Space Station operations.

3 (b) REQUIREMENTS FOR LOW EARTH ORBIT ACTIVI-
4 TIES AND RESEARCH IN SUPPORT OF HUMAN EXPLO-
5 RATION.—The Administrator shall continue to develop
6 and regularly update detailed research, development and
7 associated requirements and capabilities that are needed
8 to support NASA’s human spaceflight and Moon to Mars
9 Program and that must be carried out in low Earth orbit.
10 Requirements and capabilities for NASA human
11 spaceflight and exploration should include—

- 12 (1) human health and performance research;
- 13 (2) crew accommodation and training;
- 14 (3) cargo and crew transportation services;
- 15 (4) technology demonstration and qualification;
- 16 and
- 17 (5) options for how such requirements could be
18 met, including through the use of suborbital launch
19 systems, free flying orbital platforms, and the feasi-
20 bility of and potential risks associated with each op-
21 tion.

22 (c) TRANSMITTAL.—The Administrator shall trans-
23 mit the requirements in subsection (b) to Congress not
24 later than 270 days after the date of enactment of this
25 Act and shall provide annual updates to Congress.

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

8 (e) RESULTS.—The Administrator shall transmit the
9 results of the request for information to the Committee
10 on Science, Space, and Technology of the House of Rep-
11 resentatives and the Committee on Commerce, Science,
12 and Transportation of the Senate not later than 120 days
13 after the date the responses to the request for information
14 are submitted to the Administration.

15 **TITLE III—SCIENCE**

16 **SEC. 301. IMPORTANCE OF A BALANCED SCIENCE PRO-** 17 **GRAM.**

18 It is the sense of Congress that a balanced and ade-
19 quately funded set of activities, consisting of NASA's re-
20 search and analysis grants programs, technology develop-
21 ment, small-, medium-, and large-sized space science mis-
22 sions, and suborbital research activities, continues to con-
23 tribute to a robust and productive science program and
24 serves as a catalyst for innovation.

1 **SEC. 302. REVIEW OF IMPLEMENTATION OF QUALITY AS-**
2 **SURANCE PROGRAM AND PARTS POLICY IN**
3 **SCIENCE MISSION DEVELOPMENT.**

4 (a) REVIEW.—The Comptroller General shall review
5 the implementation of quality assurance program and
6 parts policy, processes, and procedures used in the devel-
7 opment of instrument and spacecraft for space and Earth
8 science missions. The review shall build on prior work car-
9 ried out for the 2011 Government Accountability Office
10 report on “Space and Mission Defense Acquisitions: Peri-
11 odic Assessment Needed to Correct Parts Quality Prob-
12 lems in Major Programs”, released in 2011, and include
13 an assessment of—

14 (1) the extent to which NASA is following es-
15 tablished policy related to the selection, acquisition,
16 traceability, testing, handling, packaging, storage,
17 and application of materials and mechanical and
18 electrical parts and the reasons for any deviations;

19 (2) how NASA conducts surveillance of con-
20 tractor implementation of such policy, processes, and
21 procedures; and

22 (3) the extent to which established policy, proc-
23 esses, and procedures follows Federal government
24 best practices.

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

1 Science, Space, and Technology of the House of Rep-
2 resentatives and the Committee on Commerce, Science,
3 and Transportation of the Senate not later than 1 year
4 after the date of enactment of this Act.

5 **SEC. 303. INDEPENDENT EXTERNAL TECHNICAL, MANAGE-**
6 **MENT, AND COST REVIEWS.**

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

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

21 **SEC. 304. SMALL SATELLITES.**

22 (a) SENSE OF CONGRESS.—It is the sense of Con-
23 gress that small satellites and cubesats are increasingly
24 important elements of NASA’s exploration, scientific, and
25 technology demonstration missions, have produced high-

1 value science, and can contribute, where appropriate, to
2 a balanced science mission portfolio. Cubesat-enabled
3 science missions also provide opportunities for hands-on
4 training and developing project management skills for stu-
5 dents and early career professionals, as noted in the 2016
6 report of the National Academies, “Achieving Science with
7 CubeSats: Thinking Inside the Box”.

8 (b) CONTINUATION.—The Administrator should con-
9 tinue to support the use of small satellite research and
10 development in the space and Earth sciences, where ap-
11 propriate, and for hands-on training and related skills.

12 **SEC. 305. OPTIONS FOR SMALL SATELLITE AND PAYLOAD**

13 **ACCESS TO THE NEAR-SPACE AND SPACE EN-**
14 **VIRONMENT.**

15 Not later than 1 year after the date of enactment
16 of this Act, the Administrator shall transmit to the Com-
17 mittee on Science, Space, and Technology of the House
18 of Representatives and the Committee on Commerce,
19 Science, and Transportation of the Senate a report de-
20 scribing the options for small satellites and payload access
21 to the upper atmospheric, near-space, and space environ-
22 ments, including through suborbital rockets, balloons,
23 hosted payloads, rideshares, dedicated launch vehicles,
24 among any other options. The report shall also identify
25 criteria for the selection of an option for small satellite

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

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

6 Not later than 180 days after the date of enactment
7 of this Act, the Administrator shall transmit a report to
8 the Committee on Science, Space, and Technology of the
9 House of Representatives and the Committee on Com-
10 merce, Science, and Transportation of the Senate on an
11 evaluation of the potential transfer of the Space Life and
12 Physical Sciences Research and Applications activities to
13 the Science Mission Directorate. The study shall identify
14 and consider issues related to the potential establishment
15 of a Space Life and Physical Sciences Research and Appli-
16 cations Division under the Science Mission Directorate,
17 the organization of a potential Division, and the potential
18 scope of a Division's research and activities. The study
19 shall include a recommendation on a potential transfer
20 and identification of follow-on actions, if any, that would
21 be required for implementation.

22 **SEC. 307. SPACE LIFE AND PHYSICAL SCIENCES RESEARCH**
23 **REQUIREMENTS.**

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

1 enter into an arrangement with the National Academies
2 of Sciences, Engineering, and Medicine for the develop-
3 ment of a comprehensive set of requirements to support
4 life and physical sciences research in microgravity fol-
5 lowing the end of International Space Station operations.

6 The study shall include, among other factors—

7 (1) requirements to support basic research, as
8 recommended in the most recent National Academies
9 decadal survey, and requirements for applied re-
10 search and development activities;

11 (2) environmental requirements including ther-
12 mal, vibration, micro-g level, noise, sterility, and
13 cleanliness;

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

16 (4) technology demonstration and qualification;

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

19 (6) power;

20 (7) data storage and transmission;

21 (8) communications;

22 (9) supporting facilities and infrastructure;

23 (10) crew and cargo transportation services, in-
24 cluding pressurized upmass and downmass, to and

1 from low Earth orbit following the end of Inter-
2 national Space Station operations;

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

7 (12) options for governance and management
8 models for non-NASA research and development ac-
9 tivities and recommendations on a governance and
10 management approach.

11 (b) TRANSMITTAL.—The Administrator shall trans-
12 mit the study in subsection (a) to the Committee on
13 Science, Space, and Technology of the House of Rep-
14 resentatives and the Committee on Commerce, Science,
15 and Transportation of the Senate not later than 1 year
16 after the date of enactment of this Act.

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

1 House of Representatives and the Committee on Com-
2 merce, Science, and Transportation of the Senate and
3 acted upon by the Congress.

4 **Subtitle A—Earth Science and**
5 **Applications**

6 **SEC. 311. GOAL.**

7 (a) SENSE OF CONGRESS.—It is the sense of Con-
8 gress that the Administration’s Earth science and applica-
9 tions program are vital for the Nation’s ability to research,
10 understand, and take measures to address the challenge
11 of global climate change and provide increasingly valuable
12 data for applied uses, including on natural resource man-
13 agement, agriculture, forestry, food security, air quality
14 monitoring, among many other application areas. It is the
15 further sense of Congress that a robust and balanced
16 Earth science and applications program contributes sig-
17 nificantly to the Nation’s scientific discovery, economic
18 growth and to supporting the health and safety of Ameri-
19 cans and citizens of the world.

20 (b) REAFFIRMATION.—Congress reaffirms section
21 60501 of title 51, United States Code, on the goal for
22 NASA’s Earth science and applications program, which
23 is that the Administration’s Earth Science program shall
24 be to pursue a program of Earth observations, research,
25 and applications activities to better understand the Earth,

1 how it supports life, and how human activities affect its
2 ability to do so in the future. In pursuit of this goal, the
3 Administration's Earth Science program shall ensure that
4 securing practical benefits for society will be an important
5 measure of its success in addition to securing new knowl-
6 edge about the Earth system and climate change. In fur-
7 ther pursuit of this goal, the Administration shall, to-
8 gether with other relevant agencies, provide United States
9 leadership in developing and carrying out a cooperative
10 international Earth observations-based research program.

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

15 (d) TRANSMITTAL.—The Administrator shall trans-
16 mit the Plan in subsection (c) to the Committee on
17 Science, Space, and Technology of the House of Rep-
18 resentatives and the Committee on Commerce, Science,
19 and Transportation in the Senate not later than 180 days
20 after the date of enactment of this Act.

21 **SEC. 312. APPLIED USES OF EARTH SCIENCE DATA.**

22 (a) SENSE OF CONGRESS.—It is the sense of Con-
23 gress that there are substantive and innovative applica-
24 tions and uses of space-based Earth science observations
25 that are benefitting other Federal Government agencies,

1 State and local government agencies, and the broader user
2 community and society. It is the further sense of Congress
3 that the Administration should continue to seek means,
4 to the extent practicable and in collaboration with other
5 Federal Government agencies, industry, and academia, to
6 expand the applied uses of NASA space-based Earth
7 science observations and data. It is also the sense of Con-
8 gress that quantifying the uses of these observations by
9 other Federal Government agencies is important for un-
10 derstanding the impact and value of the Nation's invest-
11 ments in space-based Earth science observations and data.

12 (b) REPORT.—The Administrator shall prepare a re-
13 port identifying the use of NASA space-based Earth
14 science observations by other civil Federal Government
15 agencies. The report shall, for each Federal agency, iden-
16 tify the extent of space-based Earth science observations
17 used, the type of Earth science observations used, the pur-
18 pose of the data use, and any tools or decision support
19 services developed in the use of the space-based Earth
20 science data for operational or research and development
21 purposes.

22 (c) CONSIDERATION.—The report shall take into ac-
23 count the work of the Satellite Needs Working Group
24 under the U.S. Group on Earth Observations, which iden-
25 tifies high-priority Federal satellite user needs.

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

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

6 (b) TRANSMITTAL.—The Director shall transmit the
7 results of the Survey in subsection (a) to the Committee
8 on Science, Space, and Technology of the House of Rep-
9 resentatives and the Committee on Commerce, Science,
10 and Transportation of the Senate not later than 18
11 months after the date of enactment of this Act.

12 **SEC. 314. COMMERCIAL EARTH OBSERVATION DATA.**

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

20 (b) INCLUSION.—The study in subsection (a) shall in-
21 clude—

22 (1) an assessment of the Administration’s pri-
23 vate sector small satellite constellation pilot pro-
24 gram;

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

4 (3) approaches to ensuring consistency with Ad-
5 ministration data and information policies for Earth
6 observation data obtained or purchased from com-
7 mercial providers;

8 (4) the results of the assessment in paragraph
9 (1);

10 (5) the benefits of using commercially provided
11 data, observations, or services for Earth science re-
12 search;

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

17 (7) recommendations on any other relevant fac-
18 tors and issues regarding the use of commercial
19 Earth observation data for the purposes of con-
20 ducting Earth science research.

21 (c) TRANSMITTAL.—The Administrator shall trans-
22 mit the results of the study to the Committee on Science,
23 Space, and Technology of the House of Representatives
24 and the Committee on Commerce, Science, and Transpor-

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

3 **SEC. 315. PLANKTON, AEROSOL, CLOUD, OCEAN ECO-**
4 **SYSTEM MISSION.**

5 (a) IN GENERAL.—The Administrator shall continue
6 development of the Plankton, Aerosol, Cloud, ocean Eco-
7 system (PACE) mission to advance 2007 National Acad-
8 emies decadal survey priorities for systematic measure-
9 ments on clouds and aerosols and global ocean color meas-
10 urements that extend systematic data records for Earth
11 system and climate science, including on the carbon cycle
12 and ocean biogeochemistry.

13 (b) COST AND SCHEDULE.—In carrying out the de-
14 velopment in subsection (a), the Administrator shall follow
15 all requirements under section 30104 of title 51, United
16 States Code.

17 **SEC. 316. CLARREO PATHFINDER.**

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

1 (b) COST AND SCHEDULE.—In carrying out the de-
2 velopment in subsection (a), the Administrator shall follow
3 all requirements under section 30104 of title 51, United
4 States Code.

5 **Subtitle B—Astrophysics**

6 **SEC. 321. WIDE FIELD INFRARED SURVEY TELESCOPE.**

7 (a) IN GENERAL.—The Administrator shall continue
8 development of the Wide Field Infrared Survey Telescope
9 (WFIRST), in the configuration established through pre-
10 liminary design review, to meet the objectives prioritized
11 in the 2010 decadal survey of astronomy and astrophysics
12 of the National Academies of Sciences, Engineering, and
13 Medicine.

14 (b) COST AND SCHEDULE.—In carrying out the de-
15 velopment in subsection (a), the Administrator shall follow
16 all requirements under section 30104 of title 51, United
17 States Code.

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

1 cost and schedule reserves levels, consistent with NASA
2 policy.

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

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

14 (f) COMPTROLLER GENERAL REVIEW.—The Comp-
15 troller General shall provide to the Committee on Science,
16 Space, and Technology of the House of Representatives
17 and the Committee on Commerce, Science, and Transpor-
18 tation of the Senate an annual review of the performance
19 and progress of the WFIRST development under sub-
20 sections (a) through (c). The review shall examine the Ad-
21 ministration's performance in meeting cost, schedule, and
22 technical objectives and overall management of the
23 project's development.

1 **SEC. 322. STRATOSPHERIC OBSERVATORY FOR INFRARED**
2 **ASTRONOMY.**

3 Not later than 270 days after the date of enactment
4 of this Act, the Administrator shall submit to the Com-
5 mittee on Science, Space, and Technology of the House
6 of Representatives and the Committee on Commerce,
7 Science, and Transportation of the Senate a report on the
8 scientific program and operations of the Stratospheric Ob-
9 servatory for Infrared Astronomy. The report shall pro-
10 vide—

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

13 (A) their current operating status;

14 (B) operating costs;

15 (C) anticipated operational lifetimes; and

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

18 (2) a description of the scientific instruments
19 are planned to be flown on the observatory, includ-
20 ing the—

21 (A) development status;

22 (B) estimated development costs;

23 (C) anticipated launch date;

24 (D) the anticipated operational lifetime;

25 and

1 (E) the anticipated scientific impact of the
2 instrument.

3 **SEC. 323. RESEARCH ON TECHNOSIGNATURES.**

4 (a) SENSE OF CONGRESS.—It is the sense of Con-
5 gress that the search for life in the universe is an integral
6 component of the Administration’s space science program
7 and that the search for life in the universe has increasingly
8 encompassed a multi- and interdisciplinary approach. It
9 is the further sense of Congress that research related to
10 the search for life has encompassed nongovernment fund-
11 ed research on and searches for intelligent life. Those ef-
12 forts include searches for signatures of advanced tech-
13 nologies that could be used to indicate the existence of
14 intelligent life beyond Earth, or what is referred to as
15 “technosignatures”.

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

19 **Subtitle C—Planetary Science**

20 **SEC. 331. MARS COMMUNICATIONS INFRASTRUCTURE.**

21 (a) REQUIREMENTS.—The Administrator shall de-
22 velop an estimate of the Administration’s communication
23 requirements, including bandwidth and communications
24 needs, to serve current and future robotic orbiter, lander,
25 rover and human missions to Mars into the 2040s.

1 (b) ASSESSMENT.—The Administrator shall prepare
2 an assessment of the existing Mars communication infra-
3 structure and its capabilities to meet the Administration’s
4 requirements in subsection (a), including the risk of poten-
5 tial gaps in communications relays between Mars space-
6 craft and Earth within the next 5 years.

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

11 (d) INCLUSION.—The Plan in subsection (c) shall in-
12 clude—

13 (1) options for a Mars communication infra-
14 structure that meets the estimated requirements in
15 subsection (a), options for mitigating any risks iden-
16 tified in the Assessment in subsection (b), and a pre-
17 liminary estimate of the potential costs of each op-
18 tion, including—

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

23 (B) an identification of any technology,
24 software, and cybersecurity developments antici-
25 pated to become available in the next 2–5 years

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

4 (2) options for acquisition approaches for a
5 Mars communications infrastructure, including part-
6 nerships with international or commercial partners.

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

13 **SEC. 332. MARS SAMPLE RETURN STRATEGY AND PLAN.**

14 (a) SENSE OF CONGRESS.—It is the sense of Con-
15 gress that the 2011 National Academies decadal survey,
16 “Vision and Voyages for Planetary Science in the Decade
17 2013-2022” states that “The Mars community . . . was
18 emphatic in their view that a sample return mission is the
19 next step in Mars exploration. Mars science has reached
20 a level of sophistication such that fundamental advances
21 in addressing the important questions . . . will come only
22 from analysis of returned samples.”. It is the further sense
23 of Congress that the decadal survey recommended a Mars
24 sample return mission as the highest priority large mis-
25 sion, and that in addition to advancing high priority

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

4 (b) STRATEGY.—The Administrator shall develop a
5 strategy, including options, for returning samples that are
6 planned to be cached by the Mars 2020 rover to Earth
7 for terrestrial laboratory study. The strategy shall iden-
8 tify—

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

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

15 (3) opportunities for potential international
16 partnership; and

17 (4) a recommended mission option, and an esti-
18 mated cost.

19 (c) IMPLEMENTATION PLAN.—Not later than 180
20 days after the date of enactment of this Act, the Adminis-
21 trator shall transmit a plan for implementing the strategy
22 in subsection (a), including a timeline and a list of key
23 milestones, to the Committee on Science, Space, and Tech-
24 nology of the House of Representatives and the Committee
25 on Commerce, Science, and Transportation of the Senate.

1 (d) EARLY TECHNOLOGY DEVELOPMENT.—The Ad-
2 ministrator shall continue early technology development
3 work in preparation for a Mars sample return mission.

4 **SEC. 333. COMMERCIAL LUNAR PAYLOAD SERVICES.**

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

9 (b) RELATIONSHIP TO OTHER MISSION DIREC-
10 TORATES.—Any lander demonstrations, services, instru-
11 ments, or payloads, and the commercial lunar payload
12 services required to deliver those payloads or instruments
13 to the lunar surface or lunar vicinity, that are not carried
14 out for the purposes established in subsection (a) or that
15 are carried out for the Human Exploration and Oper-
16 ations Mission Directorate or the Space Technology Mis-
17 sion Directorate shall be funded from the Mission Direc-
18 torate sponsoring the use of the program established in
19 subsection (a).

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

1 (d) ASSESSMENT.—The Administrator shall carry
2 out an assessment of the Commercial Lunar Payload Serv-
3 ices program to identify lessons learned, ongoing chal-
4 lenges, and approaches to addressing the challenges. The
5 study shall be transmitted to the Committee on Science,
6 Space, and Technology of the House of Representatives
7 and the Committee on Commerce, Science, and Transpor-
8 tation of the Senate not later than 3 years after the date
9 of enactment of this Act.

10 **SEC. 334. EUROPA CLIPPER LAUNCH VEHICLE.**

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

18 (1) an analysis of the marginal cost, schedule,
19 risk, and benefits associated with launching the Eu-
20 ropa Clipper mission on a Space Launch System as
21 compared to an alternative launch vehicle, including
22 any additional cost, schedule, and risk incurred from
23 spacecraft design changes due to alternative inter-
24 planetary trajectories; and

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

7 (b) AUTHORIZATION.—The Administrator is author-
8 ized, based on the results of the assessment in subsection
9 (a), to select the launch vehicle for the Europa Clipper
10 mission taking into account the probability of mission suc-
11 cess and based on cost, schedule, vehicle availability, and
12 impact on science requirements.

13 (c) REPORT.—Not later than 15 days after com-
14 pleting the assessment in subsection (a), the Adminis-
15 trator shall provide to the Committee on Science, Space,
16 and Technology of the House of Representatives and the
17 Committee on Commerce, Science, and Transportation of
18 the Senate a report including the complete assessment of
19 launch vehicle options in subsection (a), the Administra-
20 tor’s selection of the Europa Clipper launch vehicle as au-
21 thorized in subsection (b), and the estimated cost of the
22 selected launch option.

23 **SEC. 335. DEDICATED SURVEY MISSION.**

24 (a) DEDICATED SURVEY MISSION.—The Adminis-
25 trator shall develop a dedicated space-based infrared sur-

1 vey telescope mission, as soon as is practicable, for the
2 purpose of accomplishing the objectives of the George E.
3 Brown, Jr. Near-Earth Object Survey Act, and consistent
4 with section 71101 of title 51, United States Code. The
5 mission design shall take into account the recommenda-
6 tions of the National Academies of Sciences, Engineering,
7 and Medicine’s report, “Finding Hazardous Asteroids
8 Using Infrared and Visible Wavelength Telescopes”.

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

16 **SEC. 336. NEAR-EARTH OBJECT AND PLANETARY DEFENSE**
17 **ROADMAP.**

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

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

4 (b) NASA RESPONSIBILITIES.—In carrying out sub-
5 section (a), NASA shall, in cooperation with relevant Fed-
6 eral agencies and international partners—

7 (1) lead activities that—

8 (A) enhance national capabilities for near-
9 Earth object detection, tracking, and character-
10 ization; and

11 (B) seek to develop technologies for fast-
12 response near-Earth object deflection and dis-
13 ruption; and

14 (2) participate in activities that—

15 (A) seek to improve national capabilities
16 for potentially hazardous near-Earth object
17 modeling, predictions, and information integra-
18 tion; and

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

21 **SEC. 337. ASSESSMENT OF REQUIREMENTS FOR CATA-**
22 **LOGUING AND ARCHIVING NEAR-EARTH OB-**
23 **JECT DATA.**

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

1 Sciences, Engineering, and Medicine to carry out an as-
2 sessment to identify the requirements and capabilities
3 needed for the cataloguing, archiving, and maintaining ob-
4 servational space-based and ground-based data of near-
5 Earth objects through 2030, including data from the
6 Large Synoptic Survey Telescope.

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

9 (1) the extent to which the existing facilities,
10 including the Minor Planet Center, can accommo-
11 date the identified needs;

12 (2) and any additional facilities, equipment, and
13 capabilities needed to catalogue, archive, and main-
14 tain near-Earth object data anticipated to be col-
15 lected through 2030;

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

19 (4) an estimated timeline and budget required
20 to support the requirements and capabilities identi-
21 fied in paragraphs (1) through (3).

22 (c) TRANSMITTAL.—The Administrator shall trans-
23 mit the results of the assessment to the Committee on
24 Science, Space, and Technology of the House of Rep-
25 resentatives and the Committee on Commerce, Science,

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

3 **SEC. 338. INTERNATIONAL CONFIDENCE AND CAPACITY**
4 **BUILDING FOR NEAR-EARTH OBJECT IMPACT**
5 **MITIGATION.**

6 (a) IN GENERAL.—The Administrator shall expand
7 efforts being carried out with international entities, in-
8 cluding the Space Missions Planning Advisory Group of
9 the Working Group on near-Earth Objects of the Sci-
10 entific and Technical Subcommittee of the United Nations
11 Committee on the Peaceful Uses of Outer Space, to sup-
12 port confidence-building and capacity-building activities
13 related to near-Earth object impact mitigation techniques,
14 such the use of a kinetic impactor, gravity tractor, and
15 nuclear explosive device.

16 (b) CONFIDENCE AND CAPACITY-BUILDING.—The
17 Administrator may carry out workshops, technical ex-
18 changes of information, training, or other means, as ap-
19 propriate, with international entities for building con-
20 fidence, and developing technical understanding and
21 awareness of in-space near-Earth object deflection or im-
22 pact mitigation techniques.

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

1 Space, and Technology of the House of Representatives
2 and the Committee on Commerce, Science, and Transpor-
3 tation of the Senate on plans for carrying out the activities
4 in subsections (a) and (b).

5 **SEC. 339. CLOSE PASSING NEAR-EARTH OBJECTS.**

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

13 **Subtitle D—Heliophysics and**
14 **Space Weather Research**

15 **SEC. 341. IMPORTANCE OF HELIOPHYSICS RESEARCH TO**
16 **UNDERSTANDING SPACE WEATHER.**

17 It is the sense of Congress that—

18 (1) NASA’s Heliophysics Division is a key con-
19 tributor to a greater understanding of the Sun, solar
20 activity, and the space environment of Earth and
21 other planets;

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

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

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

8 **SEC. 342. SPACE WEATHER RESEARCH AND APPLICATIONS**
9 **PROGRAM.**

10 (a) **ESTABLISHMENT.**—The Administrator, in col-
11 laboration with other relevant Federal Government agen-
12 cies, shall establish within the Heliophysics Division a
13 Space Weather Research and Applications Program to
14 support the transition of scientific research to operations
15 and to carry out competitively selected applied research
16 for the purposes of improving the modeling, forecasting,
17 and prediction of space weather phenomena. In carrying
18 out the Program established in this subsection, the Ad-
19 ministrator shall, to the extent practicable, partner with
20 relevant Federal Government agencies, academia, indus-
21 try, and the space weather user community.

22 (b) **COMMUNITY COORDINATED MODELING CEN-**
23 **TER.**—The Administrator, in collaboration with relevant
24 Federal Government agencies and stakeholders, shall lead
25 the coordination of space weather model development,

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

4 (1) take steps to support the integration of ad-
5 ditional data sources (including international, aca-
6 demic, and commercial) that could improve space
7 weather models, predictive capabilities, and fore-
8 casts; and

9 (2) increase efforts to coordinate the Commu-
10 nity Coordinated Modeling Center activities with
11 academia, industry, international, and other space
12 weather modeling and forecasting entities.

13 (c) OBSERVATIONS.—The Administrator should con-
14 tinue to consider, to the extent practicable, the use of
15 small spacecraft to expand space weather observations and
16 enhance research related to space weather model develop-
17 ment.

18 **Subtitle E—Data Science and** 19 **Management**

20 **SEC. 361. DATA SCIENCE AND MANAGEMENT.**

21 It is the sense of Congress that the Administrator
22 should take steps to establish a data science and manage-
23 ment initiative to expand data analytic capabilities, such
24 as cloud computing, in the management of the Adminis-
25 tration’s scientific databases that can enable the pursuit

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

4 **SEC. 362. WORKSHOP ON DATA ANALYTICS FOR EARTH**
5 **SCIENCE RESEARCH.**

6 (a) **WORKSHOP.**—The Administrator shall enter into
7 an arrangement with the National Academies of Sciences,
8 Engineering, and Medicine for a workshop on the scientific
9 opportunities related to the use of advanced data analytics
10 and modeling techniques in Earth science research and ap-
11 plications. The workshop should identify—

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

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

19 (3) potential areas of interdisciplinary Earth
20 science and applications research that could be en-
21 abled by advanced data analytics and modeling tech-
22 niques.

23 (b) **TRANSMITTAL.**—The Administrator shall provide
24 a report on the Workshop in subsection (a) not later than
25 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);

1 (8) the extent to which there is an established
2 means for prioritizing investments and how such in-
3 vestments are balanced between sustaining existing
4 operations, upgrading systems, and undertaking new
5 developments;

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

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

14 (c) TRANSMITTAL.—The review in subsection (a)
15 shall be transmitted to the Committee on Science, Space,
16 and Technology of the House of Representatives and the
17 Committee on Commerce, Science, and Transportation of
18 the Senate not later than 1 year after the date of enact-
19 ment of this Act.

20 **TITLE V—AERONAUTICS**

21 **SEC. 501. RESEARCH EFFORT TO ADVANCE SUSTAINABLE** 22 **AVIATION.**

23 (a) IN GENERAL.—The Administrator, in consulta-
24 tion with other relevant Federal agencies, industry, and
25 academia, shall conduct research and development efforts

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

5 (b) RESEARCH EFFORT.—The research effort in sub-
6 section (a) shall include research, development, and dem-
7 onstration projects on—

8 (1) subsonic aircraft and engine design and
9 technology;

10 (2) sustainable aviation fuels;

11 (3) electric and hybrid-electric propulsion; and

12 (4) other efforts that contribute to a sustain-
13 able future for aviation.

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

16 (1) two percent annual fuel efficiency improve-
17 ment through 2050; and

18 (2) carbon neutral growth.

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

1 **SEC. 502. WORKSHOP ON RESEARCH AND DEVELOPMENT**
2 **ON NOISE.**

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

12 (b) PARTICIPANTS.—The Workshop described in sub-
13 section (a) shall include participants from relevant Federal
14 government agencies, industry, academia, and nongovern-
15 mental organizations.

16 (c) REPORT.—The Administrator shall transmit a re-
17 port on the results of the workshop to the Committee on
18 Science, Space, and Technology of the House of Rep-
19 resentatives and the Committee on Commerce, Science,
20 and Transportation of the Senate not later than 18
21 months after the date of enactment of this Act.

22 **SEC. 503. AERONAUTICS RESEARCH AND TECHNOLOGY**
23 **ROUNDTABLE.**

24 It is the sense of Congress that the National Acad-
25 emies Aeronautics Research and Technology Round Table
26 has been a valuable forum for industry, academia, and

1 government to share knowledge, define strategic issues,
2 identify research topics of interest, and provide input into
3 NASA's Aeronautics Research Mission Directorate's agen-
4 da. It is the further sense of Congress, that the Adminis-
5 trator should continue to support the Roundtable to facili-
6 tate continuing partnerships in United States aeronautics
7 research going forward.

8 **SEC. 504. EXPERIMENTAL AIRCRAFT DEMONSTRATIONS.**

9 (a) IN GENERAL.—The Administrator shall study,
10 develop, and carry out large-scale testing and demonstra-
11 tions in relevant environments that are needed to under-
12 stand complex, transformational flight systems, including
13 structures, aerodynamics, propulsion, controls and flight
14 dynamics interactions, and advanced technologies and sys-
15 tems for their transition into aircraft and airspace systems
16 by the aviation community.

17 (b) EXPERIMENTAL AIRCRAFT DEMONSTRATIONS.—
18 In meeting the objectives established in subsection (a), the
19 Administrator shall carry out experimental aircraft dem-
20 onstrations, including a—

21 (1) subsonic demonstrator to demonstrate the
22 performance and feasibility of advanced, ultra-effi-
23 cient subsonic flight demonstrator configurations;

24 (2) low-boom flight demonstrator to validate de-
25 sign tools and technologies that can be applied to

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

4 (3) hybrid wing body demonstrator to dem-
5 onstrate the performance and feasibility of an ultra-
6 efficient hybrid wing body configuration.

7 (c) COLLABORATION WITH INDUSTRY AND ACA-
8 DEMIA.—The Administration shall seek means to increase
9 collaboration with industry and academia in basic re-
10 search, technology development, and experimental aircraft
11 demonstration activities.

12 **SEC. 505. REVIEW OF RESEARCH ROADMAP ON**
13 **HYPERSONICS.**

14 (a) IN GENERAL.—The Administrator shall enter
15 into an arrangement with the National Academies of
16 Sciences, Engineering, and Medicine to review the Road-
17 map for Hypersonic Research directed in section 603 of
18 the NASA Transition Authorization Act of 2017. The re-
19 view shall take into account research activities of the De-
20 partment of Defense. The review shall identify and
21 prioritize critical basic and applied research to be carried
22 out by the Administration in the near-term (within 6
23 months to 3 years), mid-term (within 3 to 6 years), and
24 long-term (within 6 to 10 years), and shall identify the
25 flight demonstration vehicles and demonstrations, capa-

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

3 (b) TRANSMITTAL.—The Administrator shall trans-
4 mit the review in subsection (a) to the Committee on
5 Science, Space, and Technology of the House of Rep-
6 resentatives and the Committee on Commerce, Science,
7 and Transportation of the Senate not later than 1 year
8 after the date of enactment of this Act.

9 **SEC. 506. SUPERSONIC FLIGHT.**

10 (a) SENSE OF CONGRESS.—It is the sense of Con-
11 gress that the development of low-boom commercial super-
12 sonic transport that is efficient, cost-effective, and safe for
13 the environment will be transformative for the aviation in-
14 dustry and will help ensure continued United States lead-
15 ership in enabling new transportation capabilities. It is the
16 further sense of Congress that NASA, in its work on a
17 low-boom flight demonstrator aircraft, should continue
18 consulting with the Federal Aviation Administration
19 (FAA), the International Civil Aviation Organization
20 (ICAO), other international aeronautics research organi-
21 zations.

22 (b) CONTINUED RESEARCH.—The Administrator
23 shall continue to conduct research and development activi-
24 ties to enable the development and operational use of low-
25 boom supersonic aircraft.

1 **SEC. 507. URBAN AIR MOBILITY.**

2 (a) STRATEGY.—The Administrator shall develop a
3 strategy, including goals and objectives, for the Adminis-
4 tration’s research and development activities on urban air
5 mobility. The strategy shall—

6 (1) take into account the Administration’s work
7 on uncrewed aviation systems;

8 (2) consider relevant National Academies re-
9 ports on the feasibility of a safe and efficient urban
10 air mobility system;

11 (3) provide a description of the Administra-
12 tion’s “Grand Challenges” for urban air mobility
13 and how it contributes to achieving the goals and ob-
14 jectives identified in the strategy;

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

17 (5) identify the means of partnering with the
18 other relevant Federal agencies, academia, and in-
19 dustry on urban air mobility research and develop-
20 ment.

21 (b) TRANSMITTAL.—The Administrator shall trans-
22 mit the strategy to the Committee on Science, Space, and
23 Technology of the House of Representatives and the Com-
24 mittee on Commerce, Science, and Transportation of the
25 Senate not later than 270 days after the date of enactment
26 of this Act.

1 **SEC. 508. AERONAUTICS WORKFORCE AND MODELING AND**
2 **TEST FACILITIES.**

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

7 (1) the Nation’s aeronautics workforce and
8 skills-base; and

9 (2) the status of NASA’s aeronautical modeling
10 and test facilities.

11 The review shall make prioritized recommendations on ac-
12 tions needed to align the workforce with research objec-
13 tives, strategic goals, and commercial aeronautics opportu-
14 nities and on the improvements and additions to modeling
15 capabilities and test facilities needed to meet the Nation’s
16 aeronautics strategic goals and objectives.

17 (b) TRANSMITTAL.—The Administrator shall trans-
18 mit the results of the review not later than 15 months
19 after the date of enactment of this Act to the Committee
20 on Science, Space, and Technology of the House of Rep-
21 resentatives and the Committee on Commerce, Science,
22 and Transportation of the Senate.

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

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

4 **SEC. 509. UNIVERSITY LEADERSHIP INITIATIVE.**

5 (a) SENSE OF CONGRESS.—It is the sense of Con-
6 gress that United States leadership in aeronautics will de-
7 pend, in part, on infusing innovation into the Nation’s
8 aeronautical research and development programs and in
9 transferring the proven capabilities and technologies es-
10 tablished through research and development into commer-
11 cial aviation. It is the further sense of Congress that the
12 University Leadership Initiative is encouraging innovation
13 by successfully engaging multidisciplinary teams, includ-
14 ing academia and industry, in compelling research activi-
15 ties that address the Aeronautics Research Mission Direc-
16 torate’s strategic research goals while also energizing the
17 aeronautics research enterprise. The Administrator should
18 continue to support the University Leadership Initiative.

19 (b) REVIEW.—The Administrator shall arrange for
20 an external review of the University Leadership Initiative
21 for the purposes of considering the Initiative’s progress
22 toward meeting the program’s objectives, identifying op-
23 tions and recommendations for strengthening the pro-
24 gram, and evaluating the project’s efforts to increase the

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

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

8 **TITLE VI—SPACE TECHNOLOGY**

9 **SEC. 601. SPACE NUCLEAR SYSTEMS.**

10 It is the sense of Congress that:

11 (1) Space nuclear technology development, in-
12 cluding nuclear propulsion and surface power reac-
13 tors, is critical for enabling Moon and Mars mis-
14 sions. Nuclear propulsion technologies can reduce
15 transit times to Mars, particularly making possible
16 opposition class missions. Surface power would en-
17 able robotic and human exploration. It is important
18 that the United States lead in developing the safe
19 and sustainable use of space nuclear power.

20 (2) NASA should continue to develop tech-
21 nologies that rely on low enriched uranium fuel and
22 continue partnerships on such concepts with the
23 commercial sector. Where feasible, the use of low en-
24 riched uranium should be prioritized.

1 **SEC. 602. NUCLEAR THERMAL PROPULSION.**

2 (a) IN GENERAL.—The Administrator shall carry out
3 nuclear thermal propulsion research and development ac-
4 tivities, including for systems based on the use of low-en-
5 riched uranium, for the purposes of developing an in-space
6 propulsion system to support crewed missions to Mars.

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

11 (c) TRANSMITTAL.—The Administrator shall trans-
12 mit the plan to the Committee on Science, Space, and
13 Technology of the House of Representatives and the Com-
14 mittee on Commerce, Science, and Transportation of the
15 Senate not later than 12 months after the date of enact-
16 ment of this Act.

17 **SEC. 603. NUCLEAR SURFACE POWER.**

18 (a) SENSE OF CONGRESS.—Developing lightweight
19 fission reactors systems is critical for generating sufficient
20 power to run systems that enable long-term presence,
21 robotic or human, in space. It is the sense of Congress
22 that NASA should continue developing kilowatt tech-
23 nology.

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

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

5 (d) TRANSMITTAL.—The Administrator shall trans-
6 mit plan to the Committee on Science, Space, and Tech-
7 nology of the House of Representatives and the Committee
8 on Commerce, Science, and Transportation of the Senate
9 not later than 12 months after the date of enactment of
10 this Act.

11 **SEC. 604. REVIEW OF FLIGHT OPPORTUNITIES PROGRAM.**

12 (a) REVIEW.—The Comptroller General shall carry
13 out a review of the Flight Opportunities Program to as-
14 sess—

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

17 (2) the extent to which the program goals and
18 objectives have changed over time since the estab-
19 lishment of the program, and the rationale for such
20 changes;

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

24 (4) the activities conducted and level of re-
25 sources provided to date toward meeting the goals;

1 (5) the basis for the resource requirements;

2 (6) the extent to which NASA is using the re-
3 sults of the flight opportunities research activities to
4 advance the agency's strategic goals;

5 (7) the challenges in achieving program objec-
6 tives; and

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

12 (b) TRANSMITTAL.—The report in subsection (a)
13 shall be transmitted to the Committee on Science, Space,
14 and Technology of the House of Representatives and the
15 Committee on Commerce, Science, and Transportation of
16 the Senate not later than 1 year after the date of enact-
17 ment of this Act.

18 **SEC. 605. SENSE OF CONGRESS ON OPTICAL COMMUNICA-**
19 **TIONS.**

20 It is the sense of Congress that advances in interplan-
21 etary communications are an essential enabler for future
22 robotic and human exploration, and that optical commu-
23 nications can provide increased bandwidth at farther dis-
24 tances with greater accuracy and speed than radio fre-
25 quency transmissions. Optical communications involve op-

1 portunities and challenges that can transform scientific in-
2 vestigations in space and support deep space human explo-
3 ration operations that will require broadband communica-
4 tions with Earth. In addition, optical communications sys-
5 tems are lighter, more compact and use less power than
6 radio frequency communications, and the Government's
7 investment in advancing optical communications also has
8 the potential to offer significant benefits to the private sec-
9 tor and future space commerce.

10 **SEC. 606. PROPULSION TESTING FACILITIES.**

11 (a) SENSE OF CONGRESS.—It is the sense of Con-
12 gress that the Administration's development of next gen-
13 eration in-space and electric propulsion will help enable
14 the Nation's goal of sending humans to Mars, especially
15 for use in emplacing the cargo and infrastructure nec-
16 essary to support human activities at Mars. It is the fur-
17 ther sense of Congress that additional testing capabilities
18 may be needed to support research and development on
19 in-space propulsion and that such facilities could serve
20 government, industry, and university work on maturing
21 in-space propulsion development work.

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

1 electric propulsion devices and ground-based testing of a
2 full-scale, full-power nuclear thermal engine. The assess-
3 ment should consider the potential development of facili-
4 ties that will support long-term research and development
5 of in-space propulsion systems.

6 (c) TRANSMITTAL.—The Administrator shall trans-
7 mit the results of the assessment to the Committee on
8 Science, Space, and Technology of the House of Rep-
9 resentatives and the Committee on Commerce, Science,
10 and Transportation of the Senate not later than 1 year
11 after the date of enactment of this Act.

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

13 (a) RESTORE-L.—The Administrator shall continue
14 development of RESTORE-L technologies and capabilities
15 for a planned on-orbit demonstration to refuel the Landsat
16 7 spacecraft.

17 (b) ASSESSMENT.—The Administrator shall carry out
18 an assessment of in-space assembly and servicing tech-
19 nologies, the potential uses of those technologies, and re-
20 lated issues. The assessment shall include—

21 (1) the capabilities, technological readiness lev-
22 els, and relevant applications of the Administration’s
23 existing in-space servicing and assembly technology
24 across directorates and divisions;

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

5 (3) the potential advantages of incorporating
6 in-space assembly and servicing into spacecraft de-
7 sign, construction, and operations;

8 (4) a determination of any areas of overlap or
9 alignment among Administration directorates and
10 divisions of current capabilities and potential ena-
11 bling technologies for in-space servicing and assem-
12 bly;

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

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

23 (7) a description of ways in which the Adminis-
24 tration could partner with the private sector or oth-

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

3 (8) a description of the approaches the Admin-
4 istration is taking to ensure that the project under
5 subsection (a) does not involve competition with the
6 private sector and does not preclude the development
7 of commercial capabilities for in-space satellite serv-
8 icing and assembly.

9 (c) TRANSMITTAL.—The results of the Assessment in
10 subsection (c) shall be transmitted to the Committee on
11 Science, Space, and Technology of the House of Rep-
12 resentatives and the Committee on Commerce, Science,
13 and Transportation of the Senate not later than 1 year
14 after the date of enactment of this Act.

15 **SEC. 608. PARACHUTE SYSTEMS RESEARCH AND DEVELOP-**
16 **MENT.**

17 It is the sense of Congress that parachute design, de-
18 velopment, and performance is essential for the safety and
19 success of both robotic and human spaceflight systems, in-
20 cluding the Orion crew vehicle, capsules being developed
21 under the Commercial Crew Program, as well as some
22 robotic spacecraft that are to be landed on solar system
23 bodies. It is the further sense of Congress that the risks
24 and complexities involved in parachute systems warrant
25 additional research and development that could benefit

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

7 **TITLE VII—SCIENCE, TECH-**
8 **NOLOGY, ENGINEERING, AND**
9 **MATHEMATICS EDUCATION**

10 **SEC. 701. OFFICE OF STEM ENGAGEMENT.**

11 (a) SENSE OF THE CONGRESS.—It is the sense of the
12 Congress that NASA’s inspiring mission, specialized facili-
13 ties, skilled engineering and scientific workforce, and re-
14 search activities present unique opportunities for inspiring
15 public engagement in STEM and increasing the number
16 of students pursuing STEM degrees and careers.

17 (b) IN GENERAL.—The Administrator shall establish
18 an Office of STEM Engagement for the purpose of ad-
19 vancing progress toward the Nation’s Federal STEM edu-
20 cation goals for enhancing STEM literacy, increasing di-
21 versity, equity, and inclusion in STEM, and preparing the
22 STEM workforce for the future.

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

1 formal education programs, research experiences, and re-
2 lated activities among organizations across the agency, in-
3 cluding NASA headquarters, Mission Directorates, and
4 Centers, to administer and support evidence-based formal
5 and informal education programs, research experiences,
6 and related activities designed to—

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

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

12 (3) strengthen public understanding of science
13 by enabling connections to NASA’s mission and
14 work.

15 (d) PORTFOLIO.—The Office shall coordinate and ad-
16 minister—

17 (1) the National Space Grant College and Fel-
18 lowship Program;

19 (2) the Established Program to Stimulate Com-
20 petitive Research;

21 (3) the Minority University Research and Edu-
22 cation Project;

23 (4) the NextGen STEM Project; and

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

1 **SEC. 702. INDEPENDENT REVIEW OF SPACE GRANT.**

2 (a) REVIEW.—The Administrator shall make ar-
3 rangements for an independent external review of the Na-
4 tional Space Grant College and Fellowship Program to
5 evaluate its management, accomplishments, and respon-
6 siveness to the purposes and goals defined in Chapter 403
7 of title 51, United States Code.

8 (b) REPORT.—Not later than 1 year after the date
9 of enactment of this Act, the Administrator shall transmit
10 a report on the independent external review of the Na-
11 tional Space Grant College and Fellowship Program de-
12 scribed in subsection (a) to the Committee on Science,
13 Space, and Technology of the House of Representatives
14 and the Committee on Commerce, Science, and Transpor-
15 tation of the Senate.

16 **TITLE VIII—SAFETY, SUPPORT,**
17 **AND MISSION SERVICES**

18 **SEC. 801. POLICY AND PROCEDURE.**

19 (a) POLICY AND PROCEDURE.—The Administrator
20 shall develop an Administration policy and procedure for
21 assessment every 3 to 5 years of the Administration’s stra-
22 tegic capabilities, including infrastructure and facilities,
23 and workforce skills and capabilities. The policy and pro-
24 cedure shall include acquiring data and support for Ad-
25 ministration decisions and recommendations on strategic
26 capabilities, including on infrastructure and facilities, and

1 workforce skills and capabilities needed to support the Ad-
2 ministration's goals and objectives through 2040.

3 (b) TRANSMITTAL.—The Administrator shall trans-
4 mit the policy and procedure in subsection (a) to the Com-
5 mittee on Science, Space, and Technology of the House
6 of Representatives and the Committee on Commerce,
7 Science, and Transportation of the Senate not later than
8 1 year after the date of enactment of this Act.

9 **SEC. 802. MONITORING MILLIMETER-SIZED ORBITAL DE-**
10 **BRIS.**

11 (a) REPORT.—Not later than 270 days after the date
12 of enactment of this Act, the Administrator shall transmit
13 a report to the Committee on Science, Space, and Tech-
14 nology of the House of Representatives and the Committee
15 on Commerce, Science, and Transportation of the Senate
16 on—

17 (1) the risks of millimeter-sized and larger or-
18 bital debris objects to NASA orbiting assets and
19 space activities; and

20 (2) the gaps in monitoring of millimeter-sized
21 orbital debris data, orbital debris object sizes of 2–
22 10 centimeters, and orbital debris objects larger
23 than 10 centimeters;

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

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

3 **SEC. 803. PLANETARY PROTECTION STRATEGIC PLAN.**

4 (a) STRATEGIC PLAN.—The Administrator shall de-
5 velop a strategic plan for the Administration’s planetary
6 protection policy, research, and development activities.

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

9 (1) managing planetary protection policy imple-
10 mentation;

11 (2) organizing and receiving input from inde-
12 pendent, external experts on planetary protection;

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

15 (4) setting planetary protection research and
16 technology investment priorities, including on plan-
17 etary protection techniques and measures for
18 verifying compliance with planetary protection guide-
19 lines; and

20 (5) coordinating the strategic plan and any
21 planetary protection issues related to sample return
22 and human missions to Mars in the Administration’s
23 robotic and human solar system exploration activi-
24 ties, as informed by the National Academies report,

1 “Review and Assessment of Planetary Protection
2 Policy Development Processes”.

3 (c) TRANSMITTAL.—Not later than 1 year after the
4 date of enactment of this Act, the Administrator shall
5 transmit the results of the Strategic Plan in subsection
6 (a) and to the Committee on Science, Space, and Tech-
7 nology of the House of Representatives and the Committee
8 on Commerce, Science, and Transportation of the Senate.

9 **TITLE IX—CONSTRUCTION AND**
10 **ENVIRONMENTAL COMPLI-**
11 **ANCE AND RESTORATION**

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

15 (a) DATA COLLECTION.—The Administrator shall es-
16 tablish and follow a means to collect quantitative data
17 on—

18 (1) the annual and cumulative number of en-
19 hanced-use leases entered into;

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

24 (3) other quantifiable benefits to the Adminis-
25 tration of the use of enhanced-use leasing authority.

1 (b) INCLUSION.—The data collected in subsection (a)
2 shall be included the annual report required under section
3 20145(f) of title 51, United States Code.

4 **SEC. 902. REPORT ON ENHANCED-USE LEASING REQUIRE-**
5 **MENTS.**

6 Not later than 270 days after the date of enactment
7 of this Act, the Administrator shall prepare and transmit
8 a report to the Committee on Science, Space, and Tech-
9 nology of the House of Representatives and the Committee
10 on Commerce, Science, and Transportation of the Senate
11 on requirements for enhanced-use leasing applicants, in-
12 cluding requirements related to the involvement of foreign
13 entities, foreign entity ownership, and foreign entity in-
14 vestment in the entities applying for enhanced-use leases.

15 **SEC. 903. REPORT ON CURRENT AND ANTICIPATED EF-**
16 **FFECTS OF CLIMATE CHANGE AND EXTREME**
17 **WEATHER ON AGENCY INFRASTRUCTURE**
18 **AND FACILITIES.**

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

25 (b) CONTENTS.—The assessment shall include—

1 (1) an identification of existing facilities and in-
2 frastructure vulnerable to climate change and ex-
3 treme weather events based on the effects of sea
4 level rise, increased flooding, drought,
5 desertification, wildfires, thawing permafrost, in-
6 creases in heavy precipitation events, and any other
7 categories the Administrator deems necessary;

8 (2) a description of the potential impacts to fa-
9 cilities and infrastructure identified in paragraph
10 (1);

11 (3) an overview of measures that may be nec-
12 essary to ensure the continued operational viability
13 and to increase the resiliency of the identified vul-
14 nerable facilities and infrastructure and the cost of
15 such measures; and

16 (4) considerations and recommendations for
17 policies and practices for future Administration fa-
18 cilities and infrastructure design, construction, and
19 operation that would promote resilience to changing
20 environmental conditions and extreme weather
21 events.

22 (c) CONSIDERATION AND INCORPORATION OF RELI-
23 ABLE AND AUTHORIZED SOURCES.—In conducting the as-
24 sessment, the Administrator shall consider and incor-
25 porate climate change impacts, projections and analyses

1 from reliable and authorized sources, such as the National
2 Academies of Sciences, the United States Geological Sur-
3 vey, the U.S. Global Change Research Office and National
4 Climate Assessment, and the Administration’s Earth
5 Science Division.

6 **TITLE X—GENERAL PROVISIONS**

7 **SEC. 1001. SPACE SITUATIONAL AWARENESS AND ORBITAL** 8 **DEBRIS MITIGATION.**

9 (a) IN GENERAL.—The Administrator is authorized
10 to carry out activities, including research and develop-
11 ment, orbital debris measurement, tracking, modeling,
12 mitigation, remediation, conjunction analysis, and collision
13 avoidance, for the purposes of maintaining the safety of
14 the Administration’s human spaceflight crew and space-
15 craft operations and for advancing the understanding of
16 practical approaches to ensuring the sustainability of the
17 space environment for the future of civil and commercial
18 activities in space.

19 (b) RESEARCH AND TECHNOLOGY STRATEGY.—The
20 Administrator, in collaboration with other relevant Fed-
21 eral agencies, academia, and industry, shall develop a re-
22 search and technology strategy for advancing the Nation’s
23 capability for conducting space situational awareness and
24 orbital debris mitigation activities. The strategy shall iden-
25 tify and prioritize—

1 (1) basic and applied research to improve object
2 identification, orbit determination, object character-
3 ization, data cataloguing, and orbit propagation
4 tracking and prediction;

5 (2) technology development and demonstrations
6 needed to further the activities identified in sub-
7 section (a);

8 (3) specific research and technology activities
9 regarding small satellite constellations, projections
10 for debris production by small satellite constella-
11 tions, and potential means for the prevention of de-
12 bris by such constellations;

13 (4) other relevant research and technology ac-
14 tivities that have the potential to materially improve
15 the Nation's understanding and capabilities in space
16 situational awareness and orbital debris mitigation;

17 (5) mechanisms to coordinate and transition
18 basic and applied research on space situational
19 awareness into space situational awareness oper-
20 ations; and

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

24 (c) TRANSMITTAL.—The Administrator shall trans-
25 mit the Strategy in subsection (b) to the Committee on

1 Science, Space, and Technology of the House of Rep-
2 resentatives and the Committee on Commerce, Science,
3 and Transportation of the Senate not later than 270 days
4 after the date of enactment of this Act.

5 **SEC. 1002. INTERNATIONAL FRAMEWORK ON ACTIVE OR-**
6 **BITAL DEBRIS REMOVAL.**

7 (a) IN GENERAL.—The Administrator, in consulta-
8 tion with other relevant Federal agencies, shall carry out
9 international discussions and capacity-building activities
10 on orbital debris removal, including active satellite debris
11 removal, for the purposes of making progress toward
12 international guidelines on orbital debris removal, includ-
13 ing active satellite debris removal.

14 (b) INCLUSION.—The international discussions and
15 capacity-building activities in subsection (a) shall iden-
16 tify—

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

19 (2) legal issues related to international respon-
20 sibilities for orbital debris removal, including active
21 satellite debris removal; and

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

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

1 a report to the Committee on Science, Space, and Tech-
2 nology of the House of Representatives and the Committee
3 on Commerce, Science, and Transportation of the Senate
4 on the status of international discussions and capacity-
5 building activities in subsection (a), including the status
6 of progress toward the development of international guide-
7 lines under subsection (a).

8 **SEC. 1003. SAFETY AND TECHNICAL RISKS OF ACTIVE DE-**
9 **BRIS REMOVAL.**

10 (a) REPORT.—The Administrator shall identify safe-
11 ty and technical risks associated with active debris re-
12 moval that would need to be addressed in active debris
13 removal operations of the Administration’s assets and pro-
14 vide report on the identified safety and technical risks to
15 the Committee on Science, Space, and Technology of the
16 House of Representatives and the Committee on Com-
17 merce, Science, and Transportation of the Senate not later
18 than 1 year after the date of enactment of this Act.

19 **SEC. 1004. INDEPENDENT PROGRAM ANALYSIS AND EVAL-**
20 **UATION OFFICE.**

21 (a) IN GENERAL.—The Administrator shall establish
22 within NASA an independent program analysis and eval-
23 uation capability for the purposes of independently assess-
24 ing program performance, making programmatic, tech-
25 nical risk mitigation and institutional recommendations,

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

3 (b) ESTABLISHMENT.—The Administrator shall es-
4 tablish an Independent Program Analysis and Evaluation
5 Office to carry out the functions in subsection (a). The
6 Office shall remain independent of any Program, and shall
7 have no programmatic responsibilities so as to maintain
8 its independent assessment integrity.

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

15 (d) MOON TO MARS PROGRAM.—The Office estab-
16 lished in subsection (b) shall maintain an ongoing, focused
17 effort to assess the goals, objectives, requirements, archi-
18 tectural approach, cost and schedule, and progress of the
19 Moon to Mars Program established under section 202.

20 **SEC. 1005. REPORT ON USE OF THE TERM “COMMERCIAL”**
21 **IN NASA ACTIVITIES.**

22 Not later than 90 days after the date of enactment
23 of this Act, the Administrator shall transmit to the Com-
24 mittee on Science, Space, and Technology of the House
25 of Representatives and the Committee on Commerce,

1 Science, and Transportation of the Senate a report on the
2 definitions of “commercial” being used across the Admin-
3 istration.

4 **SEC. 1006. SUPPLY CHAIN AND SUPPLIER BASE.**

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

13 (b) TRANSMITTAL.—Not later than 1 year after the
14 date of enactment of this Act, the Administrator shall
15 transmit the results of the review, including any rec-
16 ommended actions in response to the review, to the Com-
17 mittee on Science, Space, and Technology of the House
18 of Representatives and the Committee on Commerce,
19 Science, and Transportation of the Senate.

20 **SEC. 1007. USE OF OPERATIONAL COMMERCIAL SUB-**
21 **ORBITAL VEHICLES FOR RESEARCH, DEVEL-**
22 **OPMENT, AND EDUCATION.**

23 (a) ASSESSMENT.—The Administrator shall conduct
24 an assessment of the issues and risks related to the poten-
25 tial use of operational commercial reusable suborbital

1 flight vehicles for carrying out potential NASA-sponsored
2 science and engineering investigations, technology dem-
3 onstrations, and educational activities involving NASA-
4 sponsored researchers. The report shall—

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

9 (2) identify and describe the United States
10 Government and space flight operator responsibil-
11 ities for liability and indemnification with respect to
12 commercial suborbital vehicle flights that involve
13 NASA-sponsored payloads or activities, potential
14 NASA-supported space flight participants, or other
15 NASA-related contributions; and

16 (3) identify any statutory provisions that may
17 be required to authorize and enforce the liability and
18 indemnification responsibilities described in para-
19 graph (2).

20 (b) TRANSMITTAL.—Not later than 1 year after the
21 date of enactment of this Act, the Administrator shall
22 transmit the plan and assessment described in subsections
23 (a) and (b) to the Committee on Science, Space, and Tech-
24 nology of the House of Representatives and the Committee
25 on Commerce, Science, and Transportation of the Senate.

1 **SEC. 1008. THE SPACE CAPABILITIES OF THE PEOPLE'S RE-**
2 **PUBLIC OF CHINA.**

3 (a) REPORT.—Not later than 1 year after the date
4 of enactment of this Act, the National Space Council shall
5 coordinate an interagency assessment of the space explo-
6 ration capabilities of the People's Republic of China, in-
7 cluding any threats to United States assets in space as
8 well as the impact of cooperation and participation of the
9 People's Republic of China with other nations on space
10 activities.

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

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

17 **SEC. 1009. SPECTRUM INTERFERENCE.**

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

22 (b) TRANSMITTAL.—The assessment conducted in
23 subsection (a) shall be delivered to the Committee on
24 Science, Space, and Technology of the House of Rep-
25 resentatives and the Committee on Commerce, Science,

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

3 **SEC. 1010. REPORTS TO CONGRESS.**

4 (a) IN GENERAL.—Chapter 301 of title 51, United
5 States Code, is amended by adding at the end the fol-
6 lowing:

7 **“SEC. 30105. REPORTS TO CONGRESS.**

8 “Any report or notification provided to Congress by
9 NASA, including on the status of balances of funding at
10 the account level and on cost increases of 10 percent or
11 more, shall be provided the Committee on Science, Space,
12 and Technology of the House of Representatives and the
13 Committee on Commerce, Science, and Transportation of
14 the Senate concurrently with its delivery to any other com-
15 mittee or office.”.

16 (b) CONFORMING AMENDMENT.—The table of sec-
17 tions for chapter 301 of title 51, United States Code, is
18 amended by adding after the item relating to section
19 30104 the following:

“30105. Reports to Congress.”.

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

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

1 “(4) GAO REPORT.—The GAO shall issue an
2 annual report on the status of large-scale the Na-
3 tional Aeronautics and Space Administration’s major
4 programs, programs, projects and activities.

5 “(5) SCHEDULE.—The report directed in this
6 subsection shall be delivered to the Congress annu-
7 ally and in advance of the annual budget submission
8 of the President.

9 “(6) ACCESS.—The Administrator is directed to
10 cooperate fully and to provide timely program anal-
11 ysis, evaluation data and relevant information to the
12 GAO so that it can conduct this review and meet the
13 annual schedule. Such information includes, but is
14 not limited to, copies of preliminary cost estimates,
15 access to relevant online agency applications, data-
16 bases, and web portals, and access to information
17 from contractor and agency personnel.”.

18 **SEC. 1012. NASA INSTITUTES.**

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

21 (1) by striking “and” at the end of paragraph

22 (5);

23 (2) by redesignating paragraph (6) as para-
24 graph (7); and

1 (3) by inserting after paragraph (5) the fol-
2 lowing:

3 “(6) the budget for each NASA-funded insti-
4 tute; and”.

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

11 **SEC. 1013. SURVEYS ON THE INDUSTRIAL BASE OF THE**
12 **UNITED STATES.**

13 (a) IN GENERAL.—Chapter 315 of title 51, United
14 States Code, is amended by adding at the end the fol-
15 lowing:

16 **“SEC. 30506. INDUSTRIAL BASE SURVEYS.**

17 “No funds may be obligated or expended by the Ad-
18 ministrator of NASA for the purpose of carrying out a
19 Bureau of Industry and Security survey with respect to
20 the United States space and aerospace industrial base
21 until the date that is 90 days after the date on which the
22 Administrator submits to the Committee on Science,
23 Space, and Technology of the House of Representatives
24 and the Committee on Commerce, Science, and Transpor-
25 tation of the Senate a written notification that includes—

1 “(1) the proposed subject matter of such sur-
2 vey;

3 “(2) a description of the information to be re-
4 quired of survey respondents; and

5 “(3) any penalties to be assessed against re-
6 spondents for noncompliance with survey require-
7 ments.”.

8 (b) CONFORMING AMENDMENT.—The table of sec-
9 tions for chapter 315 of title 51, United States Code, is
10 amended by adding after the item relating to section
11 30505 the following:

 “30506. Industrial base surveys.”.

12 **SEC. 1014. BUDGETS.**

13 Section 30103(a)(1)(A) of title 51, United States
14 Code, is amended by striking “space shuttle” and insert-
15 ing “Commercial Crew and Commercial Cargo”.

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