THE NASA AUTHORIZATION ACT OF 2013

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

JUNE 19, 2013

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THE NASA AUTHORIZATION ACT OF 2013

WEDNESDAY, JUNE 19, 2013

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Steven Palazzo [Chairman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives
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Subcommittee on Space

"NASA Authorization Act of 2013"

Wednesday, June 19, 2013
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

***Dr. Steven W. Squyres**, Goldwin Smith Professor of Astronomy, Cornell University*

***Mr. A. Thomas Young**, Former Executive Vice President, Lockheed Martin Corporation*

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE

NASA Authorization Act of 2013

Wednesday, June 19, 2013
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Purpose

The purpose of the hearing is to review a discussion draft of the National Aeronautics and Space Administration (NASA) Authorization Act of 2013.

Witness

- Dr. Steven M. Squyres, Goldwin Smith Professor of Astronomy, Cornell University
- Mr. A. Thomas Young, Executive Vice President (retired), Lockheed Martin Corporation

Background

Congress has provided consistent guidance to the Administration through consecutive NASA Authorization Acts, most recently in 2010. That Act (P.L. 111-267) authorized NASA for three years. As the expiration of that authorization nears, the Committee will consider the priorities, funding levels, and authorities granted to NASA contained in the draft legislation.

Attachments

- One Page Summary
- Section by Section
- Discussion Draft

Highlights of the NASA Authorization Act of 2013

This bill authorizes programs and projects at the National Aeronautics and Space Administration for two years. Proposed NASA funding is consistent with the Budget Control Act and FY2013 appropriations--$16,865,200,000. If House-Senate agree to repeal and replace the BCA, then funding would be added to the International Space Station, Space Launch System, and Commercial Crew. NASA continues to be the world's premier space organization. This bill seeks to ensure sustainability of purpose and budget for high-priority programs.

NASA's Mission Objectives

Human Spaceflight: Building on the themes of previous authorizations, this legislation reaffirms Congress's commitment to space exploration, both human and robotic, using a "go-as-we-can-afford-to-pay" strategy toward NASA's missions. This bill makes clear that missions to lunar orbit, the surface of the Moon, and Mars are the goals for NASA's human spaceflight program with quadrennial reports for what progress has been made toward those goals.

In the near-term, the primary objectives for NASA human spaceflight include:

- Realizing the research potential of the International Space Station with an Office of Science & Technology Policy-led strategic plan for all science agencies to conduct research on the Station. NASA will study the feasibility of continuing its operational lifespan beyond 2020.
- Continued commitment to develop the Space Launch System and Orion Crew Vehicle to return to the Moon and beyond, but no funding for an asteroid rendezvous mission. Reiterates Congressional direction that Orion be a backup system to support the Space Station if necessary.
- Building Commercial Crew systems (with NASA funds) to launch American astronauts on American rockets from American soil as soon as possible, so we are no longer reliant on Russia.

Science Programs: Relying on the guidance of National Academy of Sciences Decadal Surveys, this bill restores proper balance to NASA's science portfolio. NASA Earth Science is reduced to 2008 spending levels to provide better balance of funding for NASA's planetary science programs. Thirteen different federal agencies fund $2.5 billion annually in climate science research, but only NASA has space exploration as its primary mission. NASA is still involved in climate change research—spending $1.2 billion annually. NASA must remain focused on building weather satellites for NOAA to meet our nation's urgent weather-monitoring needs, as well as building LANDSAT satellites for the US Geological Survey.

- Maintains launch date of the James Webb Space Telescope by 2018.
- Funds survey for potentially-hazardous Earth-crossing asteroids.
- Continues exciting search for planets around other stars and life on other worlds.

Aeronautics: A robust aeronautics research program is important for the safe integration of unmanned aerial systems into the national airspace as well as NextGen technology for air traffic management.

STEM Education: There's bipartisan agreement that the Administration's proposal to re-organize NASA's STEM education program is questionable. This bill maintains FY 2013 organization and funding level.

NASA Leadership: Witnesses have raised concerns that NASA have been too politicized in recent years, adversely affecting the success of NASA's programs. This bill would make the following changes: Like the National Science Foundation, the NASA Administrator would be appointed to a 6-year term appointment. The NASA Advisory Council would be structured to provide more stakeholder input, with appointments by both the Congress and the President.

Space Act Agreements: The bill provides greater public accountability and transparency on SAAs.

Controlling Costs: Requires NASA to enforce more cost estimating discipline for its programs, while restoring funds set aside for contract termination liability toward development work on high-priority programs.

SECTION BY SECTION – NASA AUTHORIZATION ACT OF 2013

Section 1. Short Title; Table of Contents
This Act may be cited as the National Aeronautics and Space Administration Authorization Act of 2013.

Section 2. Definitions
This section provides relevant definitions within the Act.

TITLE I - AUTHORIZATION OF APPROPRIATIONS

Sec. 101. Fiscal Year 2014.
This section would authorize NASA at levels in line with the Budget Control Act of 2011.

Sec. 102. Fiscal Year 2015.
This section would authorize NASA at levels in line with the Budget Control Act of 2011.

Section 103. Budget Control
This section would state that the amounts authorized are consistent with the Budget Control Act of 2011 (PL 112-25). This section would state that if PL 112-25 is repealed or replaced with an Act that increases allocations, there are authorized to be appropriated such sums, in order of priority: 50% for the International Space Station (ISS); 25% for the Space Launch System (SLS); and 25% for Commercial Crew Development activities.

TITLE II - HUMAN SPACE FLIGHT

Subtitle A – Exploration

Sec. 201 – Space Exploration Policy.
This section would support expanding human presence beyond low-Earth orbit. This section would state that Congress remains committed to ensuring that authorized budgets for the human space flight program maintain NASA's safety standards and shall apply to programs in a cost effective manner. This section would state that exploration deeper into the solar system should be the core mission of NASA. This section would state that Congress strongly supports the development of the SLS and Orion crew capsule (Orion) as enabling elements for human exploration, advanced scientific missions, and national security priorities beyond low-Earth orbit. This section would state that it is the policy of the United States that the development of capabilities and technologies necessary for a human mission to Mars and beyond is the top priority of NASA's human space flight and technology development programs. This section would require the Administrator to establish a program to develop a sustained human presence on the Moon and the surface of Mars. This section would create the milestone of launching the first crewed mission of Orion fully integrated with SLS as close to 2020 as possible. This section would add language to the law creating the milestone of enabling human to land on the Moon. This section would add language to title 51 regarding the acceleration of development of capabilities to enable a human exploration mission to the surface of Mars and beyond through

the prioritization of those technologies and capabilities best suited for such a mission in accordance with the Mars Human Exploration Roadmap. This section would state that non-United States human space flight capabilities only be used as a contingency when no domestic commercial provider is available.

Sec. 202 - Stepping Stone Approach to Exploration.
This section would require the development of a Mars Human Exploration Roadmap defining the capabilities and technologies necessary to extend human presence to the surface of Mars, providing a process for the evolution of the capabilities of the fully integrated Orion with SLS, and describing the capabilities and technologies that could be demonstrated or research data that could be gained through the utilization of the ISS. The roadmap would describe a framework for international cooperation and a process for utilizing private companies. The roadmap must be transmitted the Congress, updated at least every four years, and include an addendum from the NASA Advisory Council with a statement of review.

Sec. 203 – Space Launch System.
This section would require the Administrator to report on the effort and budget required to enable and utilize a cargo variant of the 130 ton SLS configuration.

Sec. 204 - Orion Crew Capsule.
This section would state that the Orion must meet the practical needs and the minimum capability requirements described in law. This section would require a report to Congress detailing those components and systems of Orion which ensure it is in compliance with the law, the expected date that Orion will be available to transport crew and cargo to the ISS, and certifying that the requirements of the law will be met in time for the first crewed test flight in the year 2021.

Subtitle B – Space Operations

Sec. 211 – Findings.
This section would contain findings regarding the importance of ISS and the need to acquire an operational domestic commercial crew transportation service by the year 2017.

Sec. 212 – International Space Station (ISS).
This section would state that it is the policy of the United States that the ISS be utilized to the maximum extent practicable for the development of capabilities and technologies needed for the future of human exploration beyond low-Earth orbit. This section would require the Administrator to take all necessary steps to support the operation and full utilization of the ISS and seek to minimize the operating costs of the ISS. This section would state that reliance on foreign carriers for crew and cargo is unacceptable and the Nation's human space flight program must acquire the capability to launch American astronauts on American rockets from American soil as soon as possible. This section would reaffirm Congress' commitment to development of a commercially developed launch and delivery system to the ISS for crew missions. This section would reaffirm that NASA shall make use of the United States' commercially provided ISS crew transfer and crew rescue services to the maximum extent practicable. This section would

reaffirm that NASA shall pursue means to maximize ISS logistics capabilities, reduce risks to ISS systems sustainability, and minimize United States operations costs relating to the ISS. This section would amend the law to state that it is the policy of the United States to maintain an uninterrupted capability for human space flight and operations in low-Earth orbit and beyond as an essential instrument of national security and the capability to ensure continued United States participation and leadership in the exploration and utilization of space. This section would require the Administrator to submit a report to Congress on the feasibility of extending the operation of the ISS. This section would require the Director of OSTP to develop and transmit to Congress a strategic plan for conducting research in the physical and life sciences and related technologies on the ISS through at least 2020. This section would require the Comptroller General to submit a report to Congress on the progress of the chosen not-for profit entity for management of the National Laboratory.

Sec. 213 - Commercial Crew Report.
This section would require the Administrator to create contingencies in the event that sequestration continues to reduce NASA's budget. This section would require the Administrator to transmit a report with five distinct options for the final stage of the Commercial Crew program: a strategy which assumes an appropriation of $500 million over three years; a strategy which assumes an appropriation of $600 million over three years; a strategy which assumes an appropriation of $700 million over three years; a strategy which assumes an appropriation of $800 million over three years; and a strategy that has yet to be considered previously but that NASA believes could ensure the flight readiness date of 2017 for at least one provider or decrease the program cost. Each strategy shall include the contracting instruments NASA will employ to acquire the services in each phase of development or acquisition, the number of commercial providers NASA will include in the program, and the estimated flight readiness date in each scenario.

Sec. 214 – Flight Readiness Demonstration Deadline.
This section would require NASA to meet a flight readiness demonstration deadline of December 31, 2017. This section would require a quarterly report to Congress providing the status of the Commercial Crew development program and a Statement of Flight Readiness. NASA must notify Congress if a partner misses a milestone. This section would require the Administrator to provide and begin implementation of a new acquisition strategy with the goal of ensuring that one company will be prepared to provide crew transport services by the flight readiness demonstration deadline.

TITLE III – SCIENCE

Subtitle A – General

Sec. 301 - Science Portfolio.
This section would amend the law to state that a balanced and adequately funded set of activities contributes to a robust and productive science program that serves as a catalyst for innovation and discovery (language previously did not contain "discovery"). This section would state that unless otherwise directed by Congress, NASA shall take into account the current decadal surveys from the National Academies when submitting the President's budget request to Congress.

Sec. 302 - Assessment of Science Mission Extensions.
This section would amend the law to require biennial reviews within each of the Science divisions to assess the benefits of extending the date of termination of data collection for missions that exceed their planned mission lifetime. This section would require consultation by relevant agencies for missions with an operational component. This section would state that if a mission is extended by a consultation, the full costs of the extension shall be paid for by the operational agency. This section would require a report to Congress detailing the assessment required.

Sec. 303 – Space Communications.
This section would direct the Administrator to develop a plan for updating NASA's space communications architecture for both low-Earth orbit operations and deep space exploration so that it is capable of meeting NASA's needs over the next twenty years. The plan shall include life-cycle cost estimates, milestones, estimated performance capabilities, and five year funding profits. The plan should include (but is not limited to) a description of: projected Deep Space Network requirements for the next twenty years; upgrades needed to support Deep Space Network requirements; cost estimates for the maintenance of existing Deep Space Network capabilities; projected Tracking and Data Relay Satellite System requirements for the next twenty years; and cost and schedule estimates to maintain and upgrade the Tracking and Data Relay Satellite System to meet projected requirements.

Sec. 305 – Radioisotope Thermoelectric Generators.
This section would require the Administrator conduct and transmit to Congress an analysis of NASA requirements for radioisotope power system material needed to carry out high priority robotic missions in the solar system and other surface exploration activities beyond low-Earth orbit, as well as the risks to NASA missions in meeting those requirements due to a lack of adequate domestic production of radioisotope power system material.

Subtitle B – Astrophysics

Sec. 311 - Decadal Cadence.
This section would state that the Administrator shall ensure a steady cadence of large, medium, and small missions when following the guidance provided by the decadal surveys.

Sec. 312 – Extrasolar Planet Exploration Strategy.
This section would require the Administrator to contract with the National Academies to develop a strategy for the study and exploration of extrasolar planets that would provide a foundation for NASA roadmaps, strategic plans, and activities related to exoplanet research and exploration.

Sec. 313 – James Webb Space Telescope.
This section would state that it is the sense of Congress that the James Webb Space Telescope program is significant to our understanding of the history of the universe and should continue to receive priority of funding in accordance with the recommendations of the most recent decadal survey.

Sec. 314 – Wide-Field Infrared Survey Telescope.
This section would require the Administrator to ensure that the development of the Wide-Field Infrared Survey Telescope continue while the James Webb Space Telescope is completed.

Sec. 315 – National Reconnaissance Office Telescope Donation
This section would require the Administrator to report to Congress on NASA's plan for developing the Wide-Field Infrared Survey Telescope including a plan for the Wide-Field Infrared Survey Telescope 2.4, which includes the donated 2.4-meter aperture National Reconnaissance Office telescope.

Sec. 316 – Public-Private Partnerships
This section would require a report to Congress describing how NASA can use the lessons learned from partnerships with private sector organizations to expand collaborative public-private partnerships to study life's origin, evolution, distribution, and future in the Universe.

Subtitle C –Planetary Science

Sec. 321 – Decadal Cadence.
This section would state that when following the guidance provided by the decadal surveys, the Administrator shall ensure that NASA carries out a balanced set of programs in accordance with the priorities established in the most recent decadal survey, including: a Discovery-class mission every 24 months; a New Frontiers-class mission every 60 months; and a Flagship-class mission at least once every decade thereafter, including a Multiple-Flyby Europa mission.

Sec. 322 – Near Earth Objects.
This section would require the Administrator to continue to discover, track, catalogue, and characterize the physical characteristic of near-Earth objects equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to Earth. It shall be the goal of the survey to achieve 90 percent completion of its near-earth object catalogue by 2020. This section would reaffirm the policy in title 51 relating to detecting, tracking, cataloguing, and characterizing asteroids and comets. This section would require the Administrator to transmit to Congress an initial report that provides a recommended option and proposed budget to carry out the Survey program; and analysis of possible options NASA could employ to divert an object on a likely collision course with Earth; and a description of the status of efforts to coordinate and cooperate with other countries to discover hazardous asteroids and comets, plan a mitigation strategy, and implement that strategy. This section would require the Administrator to transmit an annual report that provides a summary of all activities and expenditures taken with regards to the Survey since the enactment of this act.

Sec. 323 – Astrobiology Strategy.
This section would require the Administrator to contract with the National Academies to develop a science strategy for astrobiology to guide NASA roadmaps, strategic plans and other activities.

Subtitle D –Heliophysics

Sec. 331 - Decadal Cadence.
This section would state that the Administrator shall ensure a steady cadence of large, medium, and small heliophysics missions when following the guidance provided by the decadal surveys.

Sec. 332 – Review of Space Weather.
This section would require the Director of OSTP to contract with the National Academies to provide a comprehensive study that reviews planned space weather monitoring requirements and capabilities to inform future space weather monitoring.

Sec. 333 – Deep Space Climate Observatory
This section would prohibit the Administrator from integrating or funding the development of any sensor on the Deep Space Climate Observatory not aligned with the spacecraft's original space weather mission requirements. This section would prohibit NASA from developing or implementing algorithms or any other application or product that are not aligned with the Deep Space Climate Observatory mission's intended space weather requirements, or to enable the "Earth at noon" images from the spacecraft.

Subtitle E – Earth Science

Sec. 341 – Goal
This section would state that the Administrator shall continue to develop first of a kind instruments that can be transitioned to other agencies for operations. This section would require the Administrator to conduct research and development on new sensors and instruments that will mitigate the risks associated with the development of operational systems and long term data continuity requirements by other agencies. This section would also add language stating that NASA is not responsible for long term data continuity or the development of operational systems, including satellite, sensor, or instrument development, acquisition, and operations, as well as product development and data analysis, unless such work is conducted on a reimbursable basis that accounts for the full cost of the work and that NASA shall use the existing Joint Agency Satellite Division structure to manage this process on a fully reimbursable basis.

Sec. 342– Decadal Cadence.
This section would state that the Administrator shall ensure a steady cadence of large, medium, and small Earth Science missions when following the guidance provided by the decadal surveys.

Sec. 343 – Research to Operations.
This section would prevent the transfer of operational responsibility of science and space weather mission or sensors to NASA without authorization by Congress.

Sec. 344 – Interagency Coordination.
This section would amend the law to require coordination with the US Geological Survey in addition to NOAA.

Sec. 345 – Joint Polar Satellite System Climate Sensors.
This section would state that NASA shall not be responsible for the development of Joint Polar Satellite System climate sensors, and that any effort by NASA related to this work will be

conducted on a fully-reimbursable basis, and executed by NASA's Joint Agency Satellite Division.

Sec. 346 – Land Imaging.
This section would require the Director of OSTP to take steps to ensure the continuous collection of space-based medium-resolution observations of the Earth's land cover with the data made available so as to facilitate the widest possible use. This section would prevent the Administrator from initiating the definition of land imaging capabilities unless this work is conducted on a fully-reimbursable basis, and executed by NASA's Joint Agency Satellite Division.

Sec. 347 – Sources of Earth Science Data.
This section would direct the Administrator to acquire space-based and airborne Earth remote sensing data, services, distribution, and applications from a commercial provider. This section would require that acquisition be carried out in accordance with applicable laws and regulations. This section would require a report to Congress on NASA's efforts to utilize this authority.

TITLE IV- AERONAUTICS

Sec. 401 - Sense of Congress.
This section would state that it is the sense of Congress that a robust aeronautics research portfolio will help maintain the United States' status as a leader in aviation. This section would state that aeronautics research is essential to NASA's mission and that the Administrator should coordinate with other stakeholders to minimize duplication and leverage resources.

Sec. 402 - Unmanned Aerial Systems Research and Development.
This section would require the Administrator to direct research and technological development to facilitate the safe integration of unmanned aerial systems into the National Airspace System. This section would require the Administrator to update and transmit to Congress a roadmap for unmanned aerial systems research and development. This section would require that operational flight data from specified cooperative agreements be made available to NASA and the FAA for the development of regulatory standards.

Sec. 403 - Research Program On Composite Materials Used In Aeronautics.
This section would state that the Administrator, in overseeing NASA's Integrated Systems Research Program's work on composite materials, shall consult with the FAA Administrator and partners in industry to accelerate safe development and certification processes for new composite materials and design methods while maintaining rigorous inspection of new composite materials. This section would require the Administrator to transmit to Congress a report detailing NASA and FAA's work on new composite materials and the coordination efforts between agencies.

Sec. 404 - Hypersonic Research.
This section would require the Administrator to develop and transmit to Congress a roadmap for hypersonic aircraft research.

Sec. 405 – Supersonic Research.

This section would require the Administrator to develop and transmit to Congress a roadmap for supersonic transport research and development with the goal of developing and demonstrating, in a relevant environment, airframe and propulsion technologies to minimize the environmental impact of overland flight of supersonic civil transport aircraft in an efficient and economical manner.

Sec. 406 - Research On NextGen Airspace Management Concepts And Tools.
This section would require the Administrator, in consultation with the Director of FAA's Joint Planning and Development Office, to review NASA's research and development activities in support of NextGen and make any necessary adjustments to NASA's research and development activities in support of NextGen. This section would require the Administrator to report to Congress regarding the progress of NASA's research and development activities in support of the NextGen airspace management modernization initiative, including details of coordination with the FAA and any adjustments made to research activities.

Sec. 407 - Rotorcraft Research.
This section would require the Administrator to prepare and transmit to Congress a plan for research relating to rotorcraft and other runway-independent air vehicles. The plan must include specific goals for the research, a timeline for implementation, metrics for success, and guidelines for collaboration and coordination with industry and other Federal agencies.

TITLE V - SPACE TECHNOLOGY

Sec. 501 - Space Technology Program.
This section would create a Space Technology Program within the office of the Administrator to pursue the development of technologies that enable exploration that supports human missions to the surface of the Moon, the surface of Mars, and beyond. This section would state that the Space Technology program may manage cross-cutting development projects within the various elements of NASA that have specific applications to such purpose. This section would state that the Administrator shall organize and manage NASA's Small Business Innovation Research program and Small Business Technology Transfer program within the space technology program. This section would require the Administrator to certify that no project within the Space Technology program is also under development in any established mission directorate.

TITLE VI - EDUCATION AND OUTREACH

Sec. 601- Education.
This section would state that NASA must continue its education and outreach efforts to: increase student interest and participation in STEM education; improve public literacy in STEM; employ proven strategies for improving student learning and teaching; provide curriculum support materials; and create and support opportunities for professional development for STEM teachers. This section would require NASA to continue its STEM education and outreach activities within the Missions Directorates. This section would require that funds for education and public outreach be maintained in the Directorates, and prohibit their consolidations into the Education Directorate. This section would prohibit NASA from implementing any proposed STEM education and outreach related changes proposed in the budget for FY 2014.

TITLE VII- Other Provisions

Sec. 701 – Asteroid Retrieval Mission.
This section would prohibit the Administrator from funding the development of any asteroid retrieval mission to send a robotic spacecraft to a near-Earth asteroid for rendezvous, retrieval, and redirection of that asteroid to lunar orbit for exploration by astronauts. This section would prohibit the Administrator from pursuing a program to search for asteroids of 20 meters or less in diameter until the survey program described in section 322 is at least 90 percent complete. This section would require the Administrator to report to Congress on the proposed Asteroid Retrieval Mission including a detailed budget profile, a detailed technical plan, a description of the technologies and capabilities anticipated to be gained that will enable future missions to Mars which could not be gained by lunar missions, and a review by the Small Bodies Assessment Group and the NASA Advisory Council.

Sec. 702 - Termination Liability
This section would direct funds set aside for contract termination liability toward development work.

Sec. 703 - Indemnification Extension.
This section would extend indemnification for the space launches until December 31, 2018.

Sec. 704 - Baseline and Cost Controls.
This section would amend requirements associated with Baseline and Cost Controls to make the reporting more timely.

Sec. 705 - Project and Program Reserves.
This section would require the Administrator to report to Congress on NASA's criteria for establishing the amount of reserves at the project and program levels and how such criteria complement NASA's policy of budgeting at a 70 percent confidence level.

Sec. 706 - Independent Reviews.
This section would require the Administrator to report to Congress on NASA's procedure for independent reviews of projects and programs at lifecycle milestones and how NASA ensures the independence of the individuals conducting those reviews.

Sec. 707 - Space Act Agreements.
This section would set the following conditions for Space Act Agreements:

- Funds provided by the government under a Space Act Agreement should not exceed the total amount provided by other parties to the agreement or other transaction;
- A Space Act Agreement may be used for a research project only when the use of a standard contract, grant, or cooperative agreement for such a project is not feasible or appropriate;
- The Administrator shall publically disclose on NASA's website and make available in a searchable format all Space Act Agreements with appropriate redactions for proprietary information in a timely manner;

- Space Act Agreements must be available for public notice and comment prior to agreement;
- The Administrator shall not enter into any funded Space Act Agreements in excess of $50 million unless such an agreement has been specifically authorized by law;
- The Administrator must submit to Congress an annual report on the use of Space Act Agreement authority by NASA during the previous fiscal year. The report must also include a list of anticipated agreements for the upcoming fiscal year.

Sec. 708 - Human Spaceflight Accident Investigations.
This section would add vehicles being used by the Federal Government pursuant to a contract or Space Act Agreement to the list of vehicles covered by the investigative provision.

Sec. 709 - Commercial Technology Transfer program.
This section would add "protecting national security" to the considerations used in evaluating technology transfer.

Sec. 710 - Orbital Debris
This section would require the Administrator to report to Congress on efforts to coordinate with countries within the Inter-Agency Space Debris Coordination Committee to mitigate the effects of orbital debris as required by law. This section would require the Director of OSTP to report to Congress on the status of the orbital debris mitigation strategy required by law.

Sec. 711 – NASA Leadership
This section would state that the Administrator shall serve a six year term and may be reappointed, and that in the Administrator's absence, the Deputy Administrator shall not act as Administrator for a period of more than 45 days. After 45 days, the Associate Administrator shall exercise the powers of Administrator until a new Administrator is confirmed.

Sec. 712 – NASA Advisory Council
This section would establish the NASA Advisory Council and set guidelines for appointing its members. This section would establish criteria for membership on the Council, set the terms of membership, set requirements for meetings of the Council, and describe its internal leadership. This section would require the Administrator to provide the Council with staff. This section would state that the functions of the Council are: to review the Administration's budget proposal and provide advice to the President, to advise the Congress on the budget, and to report their findings, advice, and recommendations to the President and Congress on matters of policy interested on space exploration and aeronautics.

Sec. 713 – Cost Estimation
This section would require a report to Congress on the implementation of more effective cost estimation practices.

[DISCUSSION DRAFT]

JUNE 12, 2013

113TH CONGRESS
1ST SESSION

H. R. _____

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

IN THE HOUSE OF REPRESENTATIVES

M__. _____ introduced the following bill; which was referred to the Committee on _____

A BILL

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

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

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "National Aeronautics and Space Administration Authorization Act of 2013".

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

SEC. 2. DEFINITIONS.

In this Act:

(1) ADMINISTRATION.—The term "Administration" means the National Aeronautics and Space Administration.

(2) ADMINISTRATOR.—The term "Administrator" means the Administrator of the Administration.

(3) ORION CREW CAPSULE.—The term "Orion crew capsule" refers to the multi-purpose crew vehicle described in section 303 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18323).

(4) SPACE ACT AGREEMENT.—The term "Space Act Agreement" means an agreement created under the authority to enter into "other transactions" under section 20113(e) of title 51, United States Code.

(5) SPACE LAUNCH SYSTEM.—The term "Space Launch System" refers to the follow-on Government-owned civil launch system developed, managed, and operated by the Administration to serve as a key component to expand human presence beyond low-Earth orbit, as described in section 302 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18322).

TITLE I—AUTHORIZATION OF APPROPRIATIONS

SEC. 101. FISCAL YEAR 2014.

There are authorized to be appropriated to the Administration for fiscal year 2014, $16,865,200,000 as follows:

(1) For Space Exploration $4,007,400,000, of which—

(A) $1,454,200,000 shall be for the Space Launch System;

(B) $318,000,000 shall be for Exploration Ground Systems;

(C) $1,200,000,000 shall be for the Orion Crew Capsule;

(D) $305,000,000 shall be for Exploration Research and Development; and

(E) $700,000,000 shall be for Commercial Crew Development activities.

(2) For Space Operations $3,817,900,000, of which—

(A) $2,984,100,000 shall be for the International Space Station (ISS) Program; and

(B) $833,800,000 shall be for Space and Flight Support.

(3) For Science $4,626,900,000, of which—

(A) $1,200,000,000 shall be for Earth Science;

(B) $1,500,000,000 shall be for Planetary Science;

(C) $642,300,000 shall be for Astrophysics;

(D) $658,200,000 shall be for the James Webb Space Telescope; and

(E) $626,400,000 shall be for Heliophysics.

(4) For Aeronautics $565,700,000.

(5) For Space Technology $500,000,000.

(6) For Education $125,000,000.

(7) For Cross-Agency Support $2,600,000,000, of which—

(A) $2,000,000,000 shall be for Center Management and Operations; and

(B) $600,000,000 shall be for Agency Management and Operations.

(8) For Construction and Environmental Compliance and Restoration $587,000,000, of which—

(A) $542,000,000 shall be for Construction and Facilities; and

(B) $45,000,000 shall be for Environmental Compliance and Restoration.

(9) For Inspector General $35,300,000.

SEC. 102. FISCAL YEAR 2015.

There are authorized to be appropriated to the Administration for fiscal year 2015, $16,865,200,000 as follows:

(1) For Space Exploration $4,007,400,000, of which—

(A) $1,454,200,000 shall be for the Space Launch System;

(B) $318,000,000 shall be for Exploration Ground Systems;

(C) $1,200,000,000 shall be for the Orion Crew Capsule;

(D) $305,000,000 shall be for Exploration Research and Development; and

(E) $700,000,000 shall be for Commercial Crew Development activities.

(2) For Space Operations $3,817,900,000, of which—

(A) $2,984,100,000 shall be for the International Space Station (ISS) Program; and

(B) $833,800,000 shall be for Space and Flight Support.

(3) For Science $4,626,900,000, of which—

(A) $1,200,000,000 shall be for Earth Science;

(B) $1,500,000,000 shall be for Planetary Science;

(C) $642,300,000 shall be for Astrophysics;

(D) $658,200,000 shall be for the James Webb Space Telescope; and

(E) $626,400,000 shall be for Heliophysics.

(4) For Aeronautics $565,700,000.

(5) For Space Technology $500,000,000.

(6) For Education $125,000,000.

(7) For Cross-Agency Support $2,600,000,000, of which—

(A) $2,000,000,000 shall be for Center Management and Operations; and

(B) $600,000,000 shall be for Agency Management and Operations.

(8) For Construction and Environmental Compliance and Restoration $587,000,000, of which—

(A) $542,000,000 shall be for Construction and Facilities; and

(B) $45,000,000 shall be for Environmental Compliance and Restoration.

(9) For Inspector General $35,300,000.

SEC. 103. BUDGET CONTROL.

The amounts authorized to be appropriated to the Administration for fiscal years 2014 and 2015 are consistent with the Public Law 112–25, the Budget Control Act of 2011. If Public Law 112–25 is repealed or replaced

with an Act that increases allocations, there are authorized to be appropriated to the Administration such sums as that increase allows, with increases for the following programs in order of priority—

(1) 50 percent of such increase for the International Space Station Program.

(2) 25 percent of such increase for the Space Launch System.

(3) 25 percent of such increase for Commercial Crew Development activities.

TITLE II—HUMAN SPACE FLIGHT

Subtitle A—Exploration

SEC. 201. SPACE EXPLORATION POLICY.

(a) FINDINGS.—The finds the following:

(1) Congress supports a human exploration program that is not critically dependent on the achievement of milestones by fixed dates and an exploration technology development program to enable lunar human and robotic operations, as described in paragraphs (1) and (2) of section 70502 of title 51, United States Code.

(2) Congress supports the expansion of permanent human presence beyond low-Earth orbit, in a manner involving international partners where practical.

(3) Congress remains committed to ensuring that authorized budgets for the human space flight program shall maintain the Administration's high safety standards and shall apply to programs in a cost effective manner.

(4) Exploration deeper into the solar system should be the core mission of the Administration.

(5) Congress strongly supports the development of the Space Launch System and the Orion crew capsule as the enabling elements for human exploration, advanced scientific missions, and national security priorities beyond low-Earth orbit.

(b) POLICY.—It is the policy of the United States that the development of capabilities and technologies necessary for human missions to lunar orbit, the surface of the Moon, the surface of Mars, and beyond shall be the goals of the Administration's human space flight program.

(c) VISION FOR SPACE EXPLORATION.—Section 20302 of title 51, United States Code, is amended—

(1) by striking subsection (a) and inserting the following:

"(a) IN GENERAL.—The Administrator shall establish a program to develop a sustained human presence on the Moon and the surface of Mars, including a robust precursor program that follows the stepping stone plan re-

quired in section 70504 to promote exploration, science, commerce, and United States preeminence in space. The Administrator is further authorized to develop and conduct appropriate international collaborations in pursuit of such program, but the absence of an international partner may not be justification for failure to pursue such program in a timely manner.";

(2) in subsection (b)—

(A) by striking paragraph (1) and inserting the following:

"(1) Returning Americans to the Moon.";

(B) by striking paragraph (2) and inserting the following:

"(2) Launching the first crewed mission of the fully integrated Orion crew capsule with the Space Launch System as close to 2020 as possible."; and

(C) in paragraph (4), by striking "from Mars and" and inserting "from the Moon, Mars, and"; and

(3) by adding at the end the following:

"(e) DEFINITIONS.—In this section:

"(1) ORION CREW CAPSULE.—The term 'Orion crew capsule' refers to the multi-purpose crew vehicle described in section 303 of the National Aero-

nautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18323).

"(2) SPACE LAUNCH SYSTEM.—The term 'Space Launch System' refers to the follow-on Government-owned civil launch system developed, managed, and operated by the Administration to serve as a key component to expand human presence beyond low-Earth orbit, as described in section 302 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18322).".

(d) KEY OBJECTIVES.—Section 202(b) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18312(b)) is amended—

(1) in paragraph (3), by striking "and" after the semicolon;

(2) in paragraph (4), by striking the period at the end and inserting "; and"; and

(3) by adding at the end the following:

"(5) to accelerate the development of capabilities to enable a human exploration mission to the surface of Mars and beyond through the prioritization of those technologies and capabilities best suited for such a mission in accordance with the Mars Human Exploration Roadmap under section 70504 of title 51, United States Code.".

(e) USE OF NON-UNITED STATES HUMAN SPACE FLIGHT TRANSPORTATION CAPABILITIES.—Section 201(a) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18311(a)) is amended to read as follows:

"(a) USE OF NON-UNITED STATES HUMAN SPACE FLIGHT TRANSPORTATION CAPABILITIES.—

"(1) IN GENERAL.—NASA may not obtain non-United States human space flight capabilities unless no domestic commercial provider is available to provide such capabilities.

"(2) DEFINITION.—For purposes of this subsection, the term 'domestic commercial provider' means a person providing space transportation services or other space-related activities, the majority control of which is held by persons other than a Federal, State, local, or foreign government, foreign company, or foreign national.".

(f) REPEAL OF SPACE SHUTTLE CAPABILITY ASSURANCE.—Section 203 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18313) is amended—

(1) by striking subsection (b);

(2) in subsection (d), by striking "subsection (c)" and inserting "subsection (b)"; and

(3) by redesignating subsections (c) and (d) as subsections (b) and (c), respectively.

SEC. 202. STEPPING STONE APPROACH TO EXPLORATION.

(a) IN GENERAL.—Section 70504 of title 51, United States Code, is amended to read as follows:

"§ 70504. Stepping stone approach to exploration

"(a) IN GENERAL.—In order to maximize the cost-effectiveness of the long-term space exploration and utilization activities of the United States, the Administrator shall direct the Human Exploration and Operations Mission Directorate to develop a Mars Human Exploration Roadmap to define the specific capabilities and technologies necessary to extend human presence to the surface of Mars and the mission sets required to demonstrate these capabilities and technologies.

"(b) ROADMAP REQUIREMENTS.—In developing the Mars Human Exploration Roadmap, the Administrator shall—

"(1) include the specific set of capabilities and technologies required to extend human presence to the surface of Mars and the mission sets necessary to demonstrate the proficiency of these capabilities and technologies with an emphasis on using the International Space Station, lunar landings, cis-lunar space, trans-lunar space, Lagrangian points,

and the natural satellites of Mars, Phobos and Deimos, as testbeds, as necessary, and shall include the most appropriate process for developing such capabilities and technologies;

"(2) provide a specific process for the evolution of the capabilities of the fully integrated Orion crew capsule with the Space Launch System and how these systems demonstrate the capabilities and technologies described in paragraph (1);

"(3) provide a description of the capabilities and technologies that could be demonstrated or research data that could be gained through the utilization of the International Space Station, and the status of the development of such capabilities and technologies;

"(4) describe a framework for international cooperation in the development of all technologies and capabilities required in this section, as well as an assessment of the risks posed by relying on international partners for capabilities and technologies on the critical path of development;

"(5) describe a process for utilizing non-governmental entities for future human exploration beyond trans-lunar space and specify what, if any, synergy could be gained from—

"(A) partnerships using Space Act Agreements (as defined in section 2 of the National Aeronautics and Space Administration Authorization Act of 2013); or

"(B) other acquisition instruments;

"(6) update such Roadmap at least every 4 years and include it in the budget for that fiscal year transmitted to Congress under section 1105(a) of title 31, and describe—

"(A) the achievements and goals reached in the process of developing such capabilities and technologies during the 4-year period prior to the submission of the Roadmap to Congress; and

"(B) the expected goals and achievements in the following 4-year period; and

"(7) include in the Roadmap an addendum from the NASA Advisory Council with a statement of review of the Roadmap that shall include—

"(A) subjects of agreement;

"(B) areas of concern; and

"(C) recommendations.

"(c) DEFINITIONS.—The terms 'Orion crew capsule' and 'Space Launch System' have the meanings given such terms in section 20302.".

(b) REPORT.—

(1) IN GENERAL.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit a copy of the Mars Human Exploration Roadmap developed under section 70504 of title 51, United States Code, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

(2) UPDATES.—The Administrator shall transmit a copy of each updated Mars Human Exploration Roadmap to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 7 days after such Roadmap is updated under section 70504(b)(6) of such title.

SEC. 203. SPACE LAUNCH SYSTEM.

(a) FINDINGS.—Congress finds that the Space Launch System is the most practical approach to reaching the Moon, Mars, and beyond, and reaffirms the policy and minimum capability requirements contained in such section.

(b) REPORT.—Working with the Secretary of Defense and the Director of National Intelligence, the Adminis-

trator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 180 days after the date of enactment of this Act that addresses the effort and budget required to enable and utilize a cargo variant of the 130 ton Space Launch System configuration described in section 302(c) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18322(c)). This report shall also include consideration of the technical requirements of the scientific and national security communities related to such Space Launch System and shall directly assess the utility and estimated cost savings obtained by using such Space Launch System for national security and space science missions.

SEC. 204. ORION CREW CAPSULE.

(a) IN GENERAL.—The Orion crew capsule shall meet the practical needs and the minimum capability requirements described in section 303 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18323).

(b) REPORT.—Not later than 60 days after the date of enactment of this Act, the Administrator shall transmit a report to the Committee on Science, Space, and Tech-

nology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate—

(1) detailing those components and systems of the Orion crew capsule that ensure it is in compliance with section 303(b) of such Act (42 U.S.C. 18323(b));

(2) detailing the expected date that the Orion crew capsule will be available to transport crew and cargo to the International Space Station; and

(3) certifying that the requirements of section 303(b)(3) of such Act (42 U.S.C. 18323(b)(3)) will be met by the Administration in time for the first crewed test flight in 2021.

Subtitle B—Space Operations

SEC. 211. FINDINGS.

Congress finds the following:

(1) The International Space Station is the ideal short-term testbed for future exploration systems development, including long-duration space travel.

(2) The use of the private market to provide cargo and crew transportation services is currently the most expeditious process to restore domestic access to the International Space Station and low-Earth orbit.

(3) Government assured access to low-Earth orbit is paramount to the continued success of the International Space Station and National Laboratory.

(4) Acquiring and maintaining an operational domestic commercial crew transportation service by the year 2017 is of the utmost importance for the future viability of the International Space Station and National Laboratory.

SEC. 212. INTERNATIONAL SPACE STATION.

(a) IN GENERAL.—The following is the policy of the United States:

(1) The International Space Station shall be utilized to the maximum extent practicable for the development of capabilities and technologies needed for the future of human exploration beyond low-Earth orbit.

(2) The Administrator shall, in consultation with the International Space Station partners—

(A) take all necessary measures to support the operation and full utilization of the International Space Station; and

(B) seek to minimize, to the extent practicable, the operating costs of the International Space Station.

(3) Reliance on foreign carriers for crew transfer is unacceptable, and the Nation's human space flight program must acquire the capability to launch United States astronauts on United States rockets from United States soil as soon as is safe and practically possible whether on Government-owned and operated space transportation systems or privately owned systems that have been certified for flight by the appropriate Federal agencies.

(b) REAFFIRMATION OF POLICY.—Congress reaffirms—

(1) its commitment to the development of a commercially developed launch and delivery system to the International Space Station for crew missions as expressed in the National Aeronautics and Space Administration Authorization Act of 2005 (Public Law 109–155), the National Aeronautics and Space Administration Authorization Act of 2008 (Public Law 110–422), and the National Aeronautics and Space Administration Authorization Act of 2010 (Public Law 111–267);

(2) that the Administration shall make use of United States commercially provided International Space Station crew transfer and crew rescue services to the maximum extent practicable; and

(3) the policy in section 501(b) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18351(b)) that the Administration shall pursue international, commercial, and intragovernmental means to maximize International Space Station logistics supply, maintenance, and operational capabilities, reduce risks to International Space Station systems sustainability, and offset and minimize United States operations costs relating to the International Space Station.

(c) ASSURED ACCESS TO LOW-EARTH ORBIT.—Section 70501(a) of title 51, United States Code, is amended to read as follows:

"(a) POLICY STATEMENT.—It is the policy of the United States to maintain an uninterrupted capability for human space flight and operations in low-Earth orbit, and beyond, as an essential instrument of national security and the capability to ensure continued United States participation and leadership in the exploration and utilization of space.".

(d) REPEALS.—

(1) USE OF SPACE SHUTTLE OR ALTERNATIVES.—Chapter 701 of title 51, United States Code, and the item relating to such chapter in the table of chapters for such title, is repealed.

(2) SHUTTLE PRICING POLICY FOR COMMERCIAL AND FOREIGN USERS.—Chapter 703 of title 51, United States Code, and the item relating to such chapter in the table of chapters for such title, is repealed.

(3) SHUTTLE PRIVATIZATION.—Section 50133 of title 51, United States Code, and the item relating to such section in the table of sections for chapter 501 of such title, is repealed.

(e) EXTENSION CRITERIA REPORT.—Not later than 1 year after the date of enactment of this Act, the Administrator shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the feasibility of extending the operation of the International Space Station that includes—

(1) criteria for defining the International Space Station as a research success;

(2) cost estimates for operating the International Space Station to achieve the criteria in paragraph (1);

(3) cost estimates for extending operations to 2020, 2025, and 2030; and

(4) an assessment of how the defined criteria under paragraph (1) respond to the National Acad-

emies Decadal Survey on Biological and Physical Sciences in Space.

(f) STRATEGIC PLAN FOR INTERNATIONAL SPACE STATION RESEARCH.—

(1) IN GENERAL.—The Director of the Office of Science and Technology Policy, in consultation with the Administrator, academia, other Federal agencies, the International Space Station National Laboratory Advisory Committee, and other potential stakeholders, shall develop and transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a strategic plan for conducting competitive, peer-reviewed research in physical and life sciences and related technologies on the International Space Station through at least 2020.

(2) PLAN REQUIREMENTS.—The strategic plan shall—

(A) be consistent with the priorities and recommendations established by the National Academies in its Decadal Survey on Biological and Physical Sciences in Space;

(B) provide a research timeline and identify resource requirements for its implementa-

tion, including the facilities and instrumentation necessary for the conduct of such research; and

(C) identify—

(i) criteria for the proposed research, including—

(I) a justification for the research to be carried out in the space microgravity environment;

(II) the use of model systems;

(III) the testing of flight hardware to understand and ensure its functioning in the microgravity environment;

(IV) the use of controls to help distinguish among the direct and indirect effects of microgravity, among other effects of the flight or space environment;

(V) approaches for facilitating data collection, analysis, and interpretation;

(VI) procedures to ensure repetition of experiments, as needed;

(VII) support for timely presentation of the peer-reviewed results of the research; and

(VIII) defined metrics for the success of each study;

(ii) instrumentation required to support the measurements and analysis of the research to be carried out under the strategic plan;

(iii) the capabilities needed to support direct, real-time communications between astronauts working on research experiments onboard the International Space Station and the principal investigator on the ground;

(iv) a process for involving the external user community in research planning, including planning for relevant flight hardware and instrumentation, and for utilization of the International Space Station, free flyers, or other research platforms; and

(v) defined metrics for success for the research plan.

(3) REPORT.—

(A) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Comptroller General of the United States shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the progress of the organization chosen for the management of the International Space Station National Laboratory as directed in section 504 of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18354).

(B) SPECIFIC REQUIREMENTS.—The report shall assess the management, organization, and performance of such organization and shall include a review of the status of each of the 7 required activities listed in section 504(c) of such Act (42 U.S.C. 18354(c)).

SEC. 213. COMMERCIAL CREW REPORT.

(a) IN GENERAL.—The Administration shall consider the ramifications of and create contingencies as the sequestration adopted in the Budget Control Act of 2011 (Public Law 112–25) continues to reduce the Administration's overall budget.

(b) REPORT.—

(1) IN GENERAL.—Not later than 60 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report containing 5 distinct options for the final stages of the commercial crew program.

(2) REQUIREMENTS.—These options shall include—

(A) a strategy that assumes an appropriation of $500,000,000 over the next 3 fiscal years;

(B) a strategy that assumes an appropriation of $600,000,000 over the next 3 fiscal years

(C) a strategy that assumes an appropriation of $700,000,000 over the next 3 fiscal years;

(D) a strategy that assumes an appropriation of $800,000,000 over the next 3 fiscal years; and

(E) a strategy that has yet to be considered previously in any budget submission but

that the Administration believes could ensure the flight readiness date of 2017 for at least one provider or significantly decreases the overall program life cycle cost.

(3) INCLUSIONS.—Each strategy shall include the contracting instruments the Administration will employ to acquire the services in each phase of development or acquisition, the number of commercial providers the Administration will include in the program, and the estimated flight readiness date in each scenario.

SEC. 214. FLIGHT READINESS DEMONSTRATION DEADLINE.

(a) IN GENERAL.—

(1) DEADLINE.—The Administration shall meet a flight readiness demonstration deadline of December 31, 2017.

(2) DEFINITION.—For purposes of this section, the term "flight readiness demonstration deadline" means the date by which one or more commercial crew partner companies shall have successfully transported American astronauts to the International Space Station.

(b) REPORT.—Not later than 180 days after the date of enactment of this Act and every 90 days thereafter until the Administration meets the flight readiness demonstra-

tion deadline, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report—

(1) describing the current status of the Commercial Crew program, including all funding paid to any partner company throughout the life of the program detailed by specific dollar amounts provided for each milestone completed for each partner company;

(2) specifying the accomplishments and milestones completed in the 90 days prior to the date of transmission of the report under any phase of the program and all dollar amounts provided for each of those milestones;

(3) identifying those accomplishments and milestones that were expected to be completed in the 90 days prior to the date of transmission of such report under any phase of the program but that were not completed in that timeframe;

(4) setting forth the accomplishments and milestones that are expected to be completed in the 90-day period following the transmission of such report under any phase of the program; and

(5) containing a statement of flight readiness under subsection (c).

(c) STATEMENT OF FLIGHT READINESS.—The statement of flight readiness required in subsection (b)(5) shall include either—

(1) a certification by the Administrator that the Administration is on schedule to comply with the flight readiness demonstration deadline; or

(2) an explanation as to why the Administration is not on schedule to comply with the flight readiness demonstration deadline and why the Administration did not develop an acquisition strategy based on existing budget authority.

(d) AUTHORIZATION OF FUNDS.—Not later than 60 days after the issuance of the explanation described in subsection (c)(2), the Administrator shall provide, and begin implementation of, a new acquisition strategy that ensures that at least 1 company will be prepared to provide crew transport services by the flight readiness demonstration deadline.

TITLE III—SCIENCE

Subtitle A—General

SEC. 301. SCIENCE PORTFOLIO.

(a) BALANCED AND ADEQUATELY FUNDED ACTIVITIES.—Section 803 of the National Aeronautics and Space

Administration Authorization Act of 2010 (124 Stat. 2832) is amended to read as follows:

"SEC. 803. OVERALL SCIENCE PORTFOLIO; SENSE OF THE CONGRESS.

"Congress reaffirms its sense, expressed in section 803 of the National Aeronautics and Space Administration Authorization Act of 2010, that a balanced and adequately funded set of activities, consisting of research and analysis grants programs, technology development, small, medium, and large space missions, and suborbital research activities, contributes to a robust and productive science program and serves as a catalyst for innovation and discovery.".

(b) DECADAL SURVEYS.—In proposing the funding of programs and activities for the National Aeronautics and Space Administration for each fiscal year, the Administrator shall, to the greatest extent practicable, follow guidance provided in the current decadal surveys from the National Academies' Space Studies Board.

SEC. 302. ASSESSMENT OF SCIENCE MISSION EXTENSIONS.

Section 30504 of title 51, United States Code, is amended to read as follows:

"§ 30504. Assessment of science mission extensions

"(a) ASSESSMENT.—The Administrator shall carry out biennial reviews within each of the Science divisions

to assess the cost and benefits of extending the date of the termination of data collection for those missions that exceed their planned mission lifetime. The assessment shall take into consideration the impact on delaying the start of future missions in order to extend existing missions.

"(b) CONSULTATION AND CONSIDERATION OF POTENTIAL BENEFITS OF INSTRUMENTS ON MISSIONS.—When deciding whether to extend a mission that has an operational component, the Administrator shall consult with the National Oceanic and Atmospheric Administration, the United States Geological Survey, or any other affected agency, and shall take into account the potential benefits of instruments on missions that are beyond their planned mission lifetime.

"(c) COSTS.—If a mission is extended based on consultation required under subsection (b), the full costs of the extension shall be paid for by the operational agency or agencies.

"(d) REPORT.—The Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate, at the same time as the submission to Congress of the President's annual budget request, a report detailing any as-

sessment required by subsection (a) that was carried out during the previous year.".

SEC. 303. SPACE COMMUNICATIONS.

(a) PLAN.—The Administrator shall develop a plan, in consultation with relevant Federal agencies, for updating the Administration's space communications architecture for both low-Earth orbital operations and deep space exploration so that it is capable of meeting the Administration's needs over the next 20 years. The plan shall include life-cycle cost estimates, milestones, estimated performance capabilities, and 5-year funding profiles. The plan shall also include an estimate of the amounts of any reimbursements the Administration is likely to receive from other Federal agencies during the expected life of the upgrades described in the plan. At a minimum, the plan shall include a description of the following:

(1) Projected Deep Space Network requirements for the next 20 years, including those in support of human space exploration missions.

(2) Upgrades needed to support Deep Space Network requirements, including cost estimates and schedules.

(3) Cost estimates for the maintenance of existing Deep Space Network capabilities.

(4) Projected Tracking and Data Relay Satellite System requirements for the next 20 years, including those in support of other relevant Federal agencies.

(5) Cost and schedule estimates to maintain and upgrade the Tracking and Data Relay Satellite System to meet projected requirements.

(b) SCHEDULE.—The Administrator shall transmit the plan developed under this section to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than one year after the date of enactment of this Act.

SEC. 304. RADIOISOTOPE THERMOELECTRIC GENERATORS.

(a) ANALYSIS OF REQUIREMENTS AND RISKS.—The Administrator, in consultation with other Federal agencies, shall conduct an analysis of—

(1) the requirements of the Administration for radioisotope power system material which is needed to carry out planned, high priority robotic missions in the solar system and other surface exploration activities beyond low-Earth orbit; and

(2) the risks to missions of the Administration in meeting those requirements, or any additional re-

quirements, due to a lack of adequate radioisotope power system material.

(b) CONTENTS OF ANALYSIS.—The analysis conducted under subsection (a) shall—

(1) detail the Administration's current projected mission requirements and associated timeframes for radioisotope power system material;

(2) explain the assumptions used to determine the Administration's requirements for the material, including—

(A) the planned use of Advanced Stirling Radioisotope Generator technology;

(B) the status of and timeline for completing development and demonstration of the Advanced Stirling Radioisotope Generator technology, including the development of flight readiness requirements; and

(C) the risks, implications, and contingencies for the Administration's mission plans of any delays or unanticipated technical challenges related to the anticipated use of Advanced Stirling Radioisotope Generator technology;

(3) assess the risk to the Administration's programs of any potential delays in achieving the sched-

ule and milestones for planned domestic production of radioisotope power system material;

(4) outline a process for meeting any additional Administration requirements for the material;

(5) estimate the incremental costs required to increase the amount of material produced each year, if such an increase is needed to support additional Administration requirements for the material;

(6) detail how the Administration and the Department of Energy will manage, operate, and fund production facilities and the design and development of all radioisotope power systems used by the Administration and other government entities as necessary;

(7) specify the steps the Administration will take, in consultation with the Department of Energy, to preserve the infrastructure and workforce necessary for production of radioisotope power systems; and

(8) detail how the Administration has implemented or rejected the recommendations from the National Research Council's 2009 report titled "Radioisotope Power Systems: An Imperative for Maintaining U.S. Leadership in Space Exploration".

(c) TRANSMITTAL.—Not later than 180 days after the date of enactment of this Act, the Administrator shall transmit the results of the analysis to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate.

Subtitle B—Astrophysics

SEC. 311. DECADAL CADENCE.

In carrying out section 301(b), the Administrator shall ensure a steady cadence of large, medium, and small astrophysics missions.

SEC. 312. EXTRASOLAR PLANET EXPLORATION STRATEGY.

(a) STRATEGY.—The Administrator shall enter into an arrangement with the National Academies to develop a science strategy for the study and exploration of extrasolar planets that would—

(1) outline key scientific questions;

(2) identify the most promising research in the field;

(3) indicate the extent to which the mission priorities in existing decadal surveys address key extrasolar planet research goals; and

(4) make recommendations with respect to optimal coordination with international partners.

(b) USE OF STRATEGY.—The Administrator shall use the strategy to inform roadmaps, strategic plans, and other activities of the Administration as they relate to extrasolar planet research and exploration, and to provide a foundation for future activities and initiatives.

(c) REPORT TO CONGRESS.—Not later than 2 years after the date of enactment of this Act, the National Academies shall transmit a report to the Administrator, and to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate, containing the strategy developed under subsection (a).

SEC. 313. JAMES WEBB SPACE TELESCOPE.

It is the sense of Congress that the James Webb Space Telescope program is significant to our understanding of the history of the universe, including galaxies, stars, and planetary systems, and should continue to receive priority of funding in accord with the recommendation of the National Academies' Space Studies Board most recent decadal survey for Astronomy and Astrophysics.

SEC. 314. WIDE-FIELD INFRARED SURVEY TELESCOPE.

The Administrator shall ensure that the development of the Wide-Field Infrared Survey Telescope continues while the James Webb Space Telescope is completed.

SEC. 315. NATIONAL RECONNAISSANCE OFFICE TELESCOPE DONATION.

Not later than 90 days after the date of enactment of this Act, the Administrator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate outlining the cost of the Administration's potential plan for developing the Wide-Field Infrared Survey Telescope as described in the most recent astronomy and astrophysics decadal survey, including an alternative plan for the Wide-Field Infrared Survey Telescope 2.4, which includes the donated 2.4-meter aperture National Reconnaissance Office telescope. Due to the budget constraints on the Administration's science programs, this report shall include—

(1) an assessment of affordable approaches to develop the Wide-Field Infrared Survey Telescope;

(2) a comparison to the development of mission concepts that exclude the utilization of the donated asset;

(3) an assessment of how the Administration's existing science missions will be affected by the utilization of the donated asset described in this section; and

(4) a description of the cost associated with storing and maintaining the donated asset.

SEC. 316. PUBLIC-PRIVATE PARTNERSHIPS.

Not later than 180 days after the date of enactment of the Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report describing how the Administration can use the lessons learned from partnerships with private sector organizations to expand collaborative public-private partnerships to the study life's origin, evolution, distribution, and future in the Universe.

Subtitle C—Planetary Science

SEC. 321. DECADAL CADENCE.

In carrying out section 301(b), the Administrator shall ensure, to the greatest extent practicable, that the Administration carries out a balanced set of planetary science programs in accordance with the priorities established in the most recent decadal survey for planetary science. Such programs shall include, at a minimum—

(1) a Discovery-class mission at least once every 24 months;

(2) a New Frontiers-class mission at least once every 60 months; and

(3) a Flagship-class mission at least once every decade thereafter, including the Multiple-Flyby Europa mission, as recommended by the 2012 Europa Study and initiated through the Science Appropriations Act, 2013 (127 Stat. 261).

SEC. 322. NEAR-EARTH OBJECTS.

(a) FINDINGS.—The Congress makes the following findings:

(1) Near-Earth objects pose a serious and credible threat to humankind, as many scientists believe that a major asteroid or comet was responsible for the mass extinction of the majority of the Earth's species, including the dinosaurs, nearly 65,000,000 years ago.

(2) Similar objects have struck the Earth or passed through the Earth's atmosphere several times in the Earth's history and pose a similar threat in the future.

(3) Several such near-Earth objects have only been discovered within days of the objects' closest approach to Earth, and recent discoveries of such large objects indicate that many large near-Earth objects remain to be discovered.

(4) The efforts taken to date by the Administration for detecting and characterizing the hazards

of near-Earth objects must continue to fully determine the threat posed by such objects to cause widespread destruction and loss of life.

(b) DEFINITION.—For purposes of this section the term "near-Earth object" means an asteroid or comet with a perihelion distance of less than 1.3 Astronomical Units from the Sun.

(c) NEAR-EARTH OBJECT SURVEY.—The Administrator shall continue to discover, track, catalogue, and characterize the physical characteristics of near-Earth objects equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth, pursuant to the George E. Brown, Jr. Near-Earth Object Survey Act (42 U.S.C. 16691). It shall be the goal of the Survey program to achieve 90 percent completion of its near-Earth object catalogue (based on statistically predicted populations of near-Earth objects) by 2020.

(d) WARNING AND MITIGATION OF POTENTIAL HAZARDS OF NEAR-EARTH OBJECTS.—Congress reaffirms the policy set forth in section 20102(g) of title 51, United States Code (relating to detecting, tracking, cataloguing, and characterizing asteroids and comets).

(e) PROGRAM REPORT.—The Administrator shall transmit to the Committee on Science, Space, and Tech-

nology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate, not later than 1 year after the date of enactment of this Act, an initial report that provides—

(1) a recommended option and proposed budget to carry out the Survey program pursuant to the recommended option;

(2) analysis of possible options that the Administration could employ to divert an object on a likely collision course with Earth; and

(3) a description of the status of efforts to coordinate and cooperate with other countries to discover hazardous asteroids and comets, plan a mitigation strategy, and implement that strategy in the event of the discovery of an object on a likely collision course with Earth.

(f) ANNUAL REPORTS.—The Administrator shall annually transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report that provides—

(1) a summary of all activities taken pursuant to subsection (c) since the date of enactment of this Act; and

(2) a summary of expenditures for all activities pursuant to subsection (c) since the date of enactment of this Act.

SEC. 323. ASTROBIOLOGY STRATEGY.

(a) STRATEGY.—The Administrator shall enter into an arrangement with the National Academies to develop a science strategy for astrobiology that would outline key scientific questions, identify the most promising research in the field, and indicate the extent to which the mission priorities in existing decadal surveys address the search for life's origin, evolution, distribution, and future in the Universe.

(b) USE OF STRATEGY.—The Administrator shall use the strategy developed under subsection (a) in planning and funding research and other activities and initiatives in the field of astrobiology. The strategy shall include recommendations for coordination with international partners.

(c) REPORT TO CONGRESS.—Not later than 2 years after the date of enactment of this Act, the National Academies shall transmit a report to the Administrator, and to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate, containing the strategy developed under subsection (a).

Subtitle D—Heliophysics

SEC. 331. DECADAL CADENCE.

In carrying out section 301(b), the Administrator shall ensure a steady cadence of large, medium, and small heliophysics missions.

SEC. 332. REVIEW OF SPACE WEATHER.

(a) REVIEW.—The Director of the Office of Science and Technology Policy, with cooperation from the Administrator, the Administrator of the National Oceanic and Atmospheric Administration, the Director of the National Science Foundation, the Secretary of Defense, the Secretary of Energy, and the Secretary of Homeland Security, shall enter into an arrangement with the National Academies to provide a comprehensive study that reviews current and planned space weather monitoring requirements and capabilities. The study shall inform the process of identifying national needs for future space weather monitoring and mitigation. The National Academies shall give consideration to international and private sector efforts and collaboration. The study shall also review the current state of research capabilities in observing, modeling, and prediction and provide recommendations to ensure future advancement of predictive capability.

(b) REPORT TO CONGRESS.—Not later than 1 year after the date of enactment of this Act, the National Acad-

emies shall transmit a report to the Administrator, and to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate, containing the results of the study provided under subsection (a).

SEC. 333. DEEP SPACE CLIMATE OBSERVATORY.

(a) INTEGRATING SENSORS.—The Administrator shall not integrate or fund the development of any sensor on the Deep Space Climate Observatory (DSCOVR) that is not aligned with the spacecraft's original space weather mission requirements.

(b) ALGORITHMS.—The Administration shall not develop or implement algorithms, or any other application or product, that are not aligned with the Deep Space Climate Observatory mission's intended space weather requirements, or to enable "Earth at noon" images from the spacecraft.

Subtitle E—Earth Science

SEC. 341. GOAL.

(a) IN GENERAL.—Recognizing the contributions that Earth science and remote sensing have made to society over the last 50 years, the Administration shall continue to develop first-of-a-kind instruments that, once

proved, can be transitioned to other agencies for operations.

(b) AMENDMENT.—Section 60501 of title 51, United States Code, is amended by inserting "In order to accomplish this goal, the Administrator shall conduct research and development on new sensors and instruments that will mitigate the risks associated with the development of operational systems and long term data continuity requirements by other agencies. The Administration shall not be responsible for the development of operational Earth science systems, including satellite, sensor, or instrument development, acquisition, and operations, as well as product development and data analysis, unless such work is conducted on a reimbursable basis that accounts for the full cost of the work. The Administrator shall use the Joint Agency Satellite Division structure, or a direct successor thereto, to manage this process on a fully reimbursable basis." after "Earth observations-based research program.".

SEC. 342. DECADAL CADENCE.

In carrying out section 301(b), the Administrator shall ensure a steady cadence of large, medium, and small Earth science missions.

SEC. 343. RESEARCH TO OPERATIONS.

Section 60502(a) of title 51, United States Code, is amended by inserting "Operational responsibility for Earth science or space weather missions or sensors shall not be transferred from any other Federal agency to the Administration, except as specifically authorized by law." after "execute the transitions.".

SEC. 344. INTERAGENCY COORDINATION.

Section 60505 of title 51, United States Code, is amended—

(1) in the section heading, by inserting "**and the United States Geological Survey**" after "**Atmospheric Administration**";

(2) in subsection (a)—

(A) by striking "and the Administrator of the National Oceanic and Atmospheric Administration" and inserting ", the Administrator of the National Oceanic and Atmospheric Administration, and the Director of the United States Geological Survey"; and

(B) by striking "two agencies" and inserting "3 agencies";

(3) in subsection (b)—

(A) by striking "and the Administrator of the National Oceanic and Atmospheric Administration" both places it appears and inserting

", the Administrator of the National Oceanic and Atmospheric Administration, and the Director of the United States Geological Survey"; and

(B) by striking "Committee on Science and Technology" and inserting "Committee on Science, Space, and Technology";

(4) in subsection (c), by inserting "and the Director of the United States Geological Survey," after "Atmospheric Administration"; and

(5) in subsection (d), by striking "Administration Earth science mission" and all that follows through the period and inserting "Earth science mission or Earth observing system to or from the National Oceanic and Atmospheric Administration, the United States Geological Survey, or the Administration, or to or from other stakeholders, until the plans required under subsection (c) have been approved by the Administrator, the Administrator of the National Oceanic and Atmospheric Administration, and the Director of the United States Geological Survey, and until financial resources have been identified to support the transition or transfer in the President's annual budget request for the National Oceanic and Atmospheric Administration, the Ad-

ministration, the United States Geological Survey, or other relevant agencies. Operational responsibility for Earth science programs shall not be transferred from any other Federal agency to the Administration, except as specifically authorized by law.".

SEC. 345. JOINT POLAR SATELLITE SYSTEM CLIMATE SENSORS.

The Administration shall not be responsible for the development of Joint Polar Satellite System climate sensors, including the Total Solar Irradiance Sensor (TSIS-2), the Ozone Mapping and Profiler Suite–Limb (OMPS-L), or the Clouds and Earth Radiant Energy System (CERES-C). Any effort by the Administration related to this work shall be conducted on a fully-reimbursable basis, and executed by the Administration's Joint Agency Satellite Division or a direct successor thereto.

SEC. 346. LAND IMAGING.

(a) REAFFIRMATION OF POLICY.—The Congress reaffirms the finding in section 2(1) of the Land Remote Sensing Policy Act of 1992 (15 U.S.C. 5601(1)) which states that "The continuous collection and utilization of land remote sensing data from space are of major benefit in studying and understanding human impacts on the global environment, in managing the Earth's natural resources, in carrying out national security functions, and

in planning and conducting many other activities of scientific, economic, and social importance.".

(b) CONTINUOUS LAND REMOTE SENSING DATA COLLECTION.—The Director of Office of Science and Technology Policy shall take steps in consultation with other relevant Federal agencies to ensure, to the maximum extent practicable, the continuous collection of space-based medium-resolution observations of the Earth's land cover, and to ensure that the data are made available in such ways as to facilitate the widest possible use.

(c) DEFINITION OF LAND IMAGING CAPABILITIES.—The Administrator shall not initiate the definition of land imaging capabilities, including the system design, flight system implementation, and launch of future mission, unless this work is conducted on a fully-reimbursable basis, and executed by the Administrations's Joint Agency Satellite Division or a direct successor thereto.

SEC. 347. SOURCES OF EARTH SCIENCE DATA.

(a) ACQUISITION.—The Administrator shall, to the extent possible and while satisfying the scientific or educational requirements of the Administration, and, where appropriate, of other Federal agencies and scientific researchers, acquire, where cost-effective, space-based and airborne Earth remote sensing data, services, distribution, and applications from a commercial provider.

(b) TREATMENT AS COMMERCIAL ITEM UNDER ACQUISITION LAWS.—Acquisitions by the Administrator of the data, services, distribution, and applications referred to in subsection (a) shall be carried out in accordance with applicable acquisition laws and regulations (including chapters 137 and 140 of title 10, United States Code). For purposes of such law and regulations, such data, services, distribution, and applications shall be considered to be a commercial item. Nothing in this subsection shall be construed to preclude the United States from acquiring, through contracts with commercial providers, sufficient rights in data to meet the needs of the scientific and educational community or the needs of other government activities.

(c) SAFETY STANDARDS.—Nothing in this section shall be construed to prohibit the Federal Government from requiring compliance with applicable safety standards.

(d) REPORT.—Not later than 180 days after the date of enactment of the Act, the Administrator shall submit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate on the Administration's efforts to carry out this section.

TITLE IV—AERONAUTICS

SEC. 401. SENSE OF CONGRESS.

It is the sense of Congress that—

(1) a robust aeronautics research portfolio will help maintain the United States status as a leader in aviation;

(2) aeronautics research is essential to the Administration's mission; and

(3) the Administrator should coordinate and consult with relevant Federal agencies and the private sector to minimize duplication and leverage resources.

SEC. 402. UNMANNED AERIAL SYSTEMS RESEARCH AND DEVELOPMENT.

(a) IN GENERAL.—The Administrator, in consultation with the Administrator of the Federal Aviation Administration and other Federal agencies, shall direct research and technological development to facilitate the safe integration of unmanned aerial systems into the National Airspace System, including—

(1) positioning and navigation systems;

(2) sense and avoid capabilities;

(3) secure data and communication links;

(4) flight recovery systems; and

(5) human systems integration.

(b) ROADMAP.—The Administrator shall update a roadmap for unmanned aerial systems research and development and transmit this roadmap to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate not later than 90 days after the date of enactment of this Act.

(c) COOPERATIVE UNMANNED AERIAL VEHICLE ACTIVITIES.—Section 31504 of title 51, United States Code, is amended by inserting "Operational flight data derived from these cooperative agreements shall be made available, in appropriate and usable formats, to the Administration and the Federal Aviation Administration for the development of regulatory standards." after "in remote areas.".

SEC. 403. RESEARCH PROGRAM ON COMPOSITE MATERIALS USED IN AERONAUTICS.

(a) CONSULTATION.—The Administrator, in overseeing the Administration's Integrated Systems Research Program's work on composite materials, shall consult with the Administrator of the Federal Aviation Administration and partners in industry to accelerate safe development and certification processes for new composite materials and design methods while maintaining rigorous inspection of new composite materials.

(b) REPORT.—Not later than 1 year after the date of enactment of this Act, the Administrator shall transmit a report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate detailing the Administration's and the Federal Aviation Administration's work on new composite materials and the coordination efforts between the agencies.

SEC. 404. HYPERSONIC RESEARCH.

Not later than 1 year after the date of enactment of this Act, the Administrator, in consultation with other Federal agencies, shall develop and transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a research and development roadmap for hypersonic aircraft research with the objective of exploring the science and technology of hypersonic flight using air-breathing propulsion concepts, through a mix of theoretical work, basic and applied research, and development of flight research demonstration vehicles. The roadmap shall prescribe appropriate agency contributions, coordination efforts, and technology milestones.

SEC. 405. SUPERSONIC RESEARCH.

Not later than 1 year after the date of enactment of this Act, the Administrator shall develop and transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a roadmap, that allows for flexible funding profiles, for supersonic transport research and development with the objective of developing and demonstrating, in a relevant environment, airframe and propulsion technologies to minimize the environmental impact, including noise, of overland flight of supersonic civil transport aircraft in an efficient and economical manner. The roadmap shall include—

(1) a status report on the Administration's existing research on supersonic flight;

(2) a list of specific technological, environmental, and other challenges that must be overcome to minimize the environmental impact, including noise, of supersonic overland flight of civil transport;

(3) a research plan to address these challenges, as well as a project timeline for accomplishing relevant research goals; and

(4) a plan for coordination with stakeholders, including relevant government agencies and industry.

SEC. 406. RESEARCH ON NEXTGEN AIRSPACE MANAGEMENT CONCEPTS AND TOOLS.

(a) IN GENERAL.—The Administrator shall, in consultation with the Director of the Joint Planning and Development Office of the Federal Aviation Administration, review at least annually the alignment and timing of the Administration's research and development activities in support of the NextGen airspace management modernization initiative, and shall make any necessary adjustments by reprioritizing or retargeting the Administration's research and development activities in support of the NextGen initiative.

(b) ANNUAL REPORTS.—The Administrator shall report to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate annually regarding the progress of the Administration's research and development activities in support of the NextGen airspace management modernization initiative, including details of coordination with the Federal Aviation Administration and any adjustments made to research activities.

SEC. 407. ROTORCRAFT RESEARCH.

Not later than 1 year after the date of enactment of this Act, the Administrator, in coordination with other Federal agencies, shall prepare and transmit to the Com-

mittee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a plan for research relating to rotorcraft and other runway-independent air vehicles, with the objective of developing and demonstrating improved safety, noise, and environmental impact in a relevant environment. The plan shall include specific goals for the research, a timeline for implementation, metrics for success, and guidelines for collaboration and coordination with industry and other Federal agencies.

TITLE V—SPACE TECHNOLOGY

SEC. 501. SPACE TECHNOLOGY.

(a) FINDINGS.—Congress finds the following:

(1) The Space Technology Mission Directorate created by the Administration is lacking an organic statutory authorization and in need of congressional direction.

(2) In order to appropriately prioritize the Administration's resources to accomplish its goals and purposes, the Space Technology Mission Directorate needs to be reorganized as provided in the amendments made by this section.

(b) EXPLORATION TECHNOLOGY RESEARCH.—Section 70506 of title 51, United States Code, is amended

by striking "The Administrator" and inserting "Within the Human Exploration and Operations Mission Directorate, the Administrator".

(c) SPACE TECHNOLOGY PROGRAM.—

(1) AMENDMENT.—Section 70507 of title 51, United States Code, is amended to read as follows:

"§ 70507. Space Technology Program authorized

"(a) PROGRAM AUTHORIZED.—The Administrator shall establish, within the office of the Administrator, a Space Technology Program, to pursue the development of technologies that enable exploration that supports human missions to the surface of the Moon, the surface of Mars, and beyond.

"(b) CROSS-CUTTING DEVELOPMENT PROJECTS.—In carrying out its purpose under subsection (a), the Space Technology Program may manage cross-cutting development projects within the various elements of the Administration that have specific applications to such purpose.

"(c) SMALL BUSINESS PROGRAMS.—The Administrator shall organize and manage the Administration's Small Business Innovation Research program and Small Business Technology Transfer program within the Space Technology Program.

"(d) NONDUPLICATION CERTIFICATION.—The Administrator shall include in the budget for each fiscal year,

as transmitted to Congress under section 1105(a) of title 31, a certification that no project, program, or mission undertaken by the Space Technology Program is independently under development by any other office or directorate of the Administration.".

(2) TABLE OF SECTIONS AMENDMENT.—The item relating to section 70507 in the table of sections for chapter 705 of title 51, United States Code, is amended to read as follows:

"70507. Space Technology Program authorized.".

TITLE VI—EDUCATION

SEC. 601. EDUCATION.

(a) IN GENERAL.—The Administration shall continue its education and outreach efforts to—

(1) increase student interest and participation in Science, Technology, Engineering, and Mathematics ("STEM") education;

(2) improve public literacy in STEM;

(3) employ proven strategies for improving student learning and teaching;

(4) provide curriculum support materials; and

(5) create and support opportunities for professional development for STEM teachers.

(b) ORGANIZATION.—In order to ensure the inspiration and engagement of children and the general public, the Administration shall continue its STEM education and

outreach activities within the Science, Aeronautics Research, Space Operations, and Exploration Mission Directorates. Funds devoted to education and public outreach shall be maintained in the Directorates, and the consolidation of these activities into the Education Directorate is prohibited.

(c) PROHIBITION.—The Administration may not implement any proposed STEM education and outreach-related changes proposed in the budget for fiscal year 2014 transmitted to Congress under section 1105(a) of title 31, United States Code.

TITLE VII—POLICY PROVISIONS

SEC. 701. ASTEROID RETRIEVAL MISSION.

(a) IN GENERAL.—Consistent with the policy stated in section 201(b), the Administrator shall not fund the development of an asteroid retrieval mission to send a robotic spacecraft to a near-Earth asteroid for rendezvous, retrieval, and redirection of that asteroid to lunar orbit for exploration by astronauts.

(b) ASTEROID SURVEY.—The Administration shall not pursue a program to search for asteroids of 20 meters or less in diameter unless the survey program described in section 322(c) is at least 90 percent complete.

(c) REPORT.—Not later than 180 days after the date of enactment of this Act, the Administrator shall provide

to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the proposed Asteroid Retrieval Mission. Such report shall include—

(1) a detailed budget profile, including cost estimates for the development of all necessary technologies and spacecraft required for the mission;

(2) a detailed technical plan that includes milestones and a specific schedule;

(3) a description of the technologies and capabilities anticipated to be gained from the proposed mission that will enable future human missions to Mars which could not be gained by lunar missions; and

(4) a complete review by the Small Bodies Assessment Group and the NASA Advisory Council that includes a recommendation to Congress on the feasibility of the mission as proposed by the Administration.

SEC. 702. TERMINATION LIABILITY.

(a) FINDINGS.—The Congress makes the following findings:

(1) The International Space Station and the Space Launch System will enable the Nation to con-

tinue operations in low-Earth orbit and to send its astronauts to deep space. As a result of their unique capabilities and their critical contribution to the future of space exploration, these systems have been designated by the Congress and the National Aeronautics and Space Administration as priority investments.

(2) While the Space Launch System, currently under development, has made significant progress, it has not been funded at levels authorized, and as a result congressionally-authorized milestones will be delayed by several years.

(3) In addition, contractors are currently holding program funding, estimated to be in the hundreds of millions of dollars, to cover the potential termination liability should the Government choose to terminate a program for convenience. As a result, hundreds of millions of taxpayer dollars are unavailable for meaningful work on these programs.

(4) According to the Government Accountability Office, the National Aeronautics and Space Administration procures most of its goods and services through contracts, and it terminates very few of them. In fiscal year 2010, the agency terminated 28

of 16,343 active contracts and orders—a termination rate of about 0.17 percent.

(5) Providing processes requiring Congressional action on termination of these high-priority programs and requiring a supplemental appropriation for termination liability would enable contractors to apply the full appropriation of taxpayer dollars to making maximum progress in meeting the established goals and milestones of these programs.

(b) NASA TERMINATION LIABILITY.—

(1) GENERAL RULE.—Termination liability costs for a covered program shall be provided only pursuant to this subsection.

(2) PROHIBITION ON RESERVING FUNDS.—The Administrator shall not reserve funds from amounts appropriated for a covered program, and shall direct prime contractors not to reserve funds, for potential termination liability costs with respect to a covered program.

(3) VOID CONTRACTUAL PROVISIONS.—Any provision in a prime contract entered into before the date of enactment of this Act that provides for the payment of termination liability costs through any means other than as provided in this subsection is hereby declared to be void and unenforceable.

(4) CONGRESSIONAL ACTION; NOTICE.—

(A) TERMINATION FOR CONVENIENCE.—The Administrator shall not initiate termination for the convenience of the Government of a prime contract on a covered program unless such program termination is authorized or required by a law enacted after the date of enactment of this Act.

(B) TERMINATION FOR CAUSE.—The Administrator shall notify the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate before initiating termination for cause of a prime contract on a covered program.

(5) SUPPLEMENTAL APPROPRIATION REQUEST.—

(A) REQUEST.—If the Administrator decides to terminate a prime contract on a covered program and sufficient unobligated appropriations are not available to cover termination liability costs in the appropriations account that is funding the prime contract being terminated, the Administrator shall provide to Congress a supplemental appropriation request not later

than 120 days in advance of the contract termination settlement for the covered program.

(B) INTENT OF CONGRESS.—It is the intent of Congress to provide such additional appropriations as may be necessary to pay termination liability costs on prime contracts for covered programs.

(6) DEFINITIONS.—For purposes of this section:

(A) COVERED PROGRAM.—The term "covered program" means the International Space Station and the Space Launch System.

(B) PRIME CONTRACTOR.—The term "prime contractor" means a person or entity contracting directly with the Federal Government on a covered program.

(C) TERMINATION LIABILITY COSTS.—The term "termination liability costs" means any costs incurred by a prime contractor, or by any subcontractor of a prime contractor, for which the Federal Government is liable as a result of termination of a prime contract by the Administrator.

(c) REPORTING.—Not later than 6 months after the date of enactment of this Act, and every 6 months there-

after for the duration of the prime contracts on covered programs, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report that provides—

(1) the estimated termination liability costs for each of the prime contracts; and

(2) the basis for how the estimate was determined.

SEC. 703. INDEMNIFICATION EXTENSION.

Section 50915(f) of title 51, United States Code, is amended by striking "December 31, 2013" and inserting "December 31, 2018".

SEC. 704. BASELINE AND COST CONTROLS.

Section 30104 of title 51, United States Code, is amended—

(1) in subsection (a), by striking "Procedural Requirements 7120.5c, dated March 22, 2005" and inserting "Procedural Requirements 7120.5E, dated August 14, 2012"; and

(2) in subsection (f), by striking "beginning 18 months after the date the Administrator transmits a report under subsection (e)(1)(A)" and inserting

"beginning 18 months after the Administrator makes such determination".

SEC. 705. PROJECT AND PROGRAM RESERVES.

To ensure that the establishment, maintenance, and allotment of project and program reserves contribute to prudent management, not later than 180 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report describing the Administration's criteria for establishing the amount of reserves at the project and program levels and how such criteria complement the Administration's policy of budgeting at a 70 percent confidence level.

SEC. 706. INDEPENDENT REVIEWS.

Not later than 270 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report describing the Administration's procedures for conducting independent reviews of projects and programs at lifecycle milestones and how the Administration ensures the independence of the individuals who conduct those reviews prior to their assignment.

SEC. 707. SPACE ACT AGREEMENTS.

(a) COST-SHARING.—To the extent that the Administrator determines practicable, the funds provided by the Government under a Space Act Agreement shall not exceed the total amount provided by other parties to the Space Act Agreement.

(b) NEED.—A Space Act Agreement may be used for a research project only when the use of a standard contract, grant, or cooperative agreement for such project is not feasible or appropriate.

(c) TRANSPARENCY.—The Administrator shall publically disclose on the Administration's website and make available in a searchable format all Space Act Agreements, with appropriate redactions for proprietary, sensitive, or classified information, in a timely manner.

(d) PUBLIC NOTICE AND COMMENT.—The Administrator shall make available for public notice and comment each proposed Space Act Agreement before entering into such agreement.

(e) AUTHORIZATION.—The Administrator shall not enter into a funded Space Act Agreement for an amount in excess of $50,000,000 unless such agreement has been specifically authorized by law.

(f) ANNUAL REPORT.—

(1) REQUIREMENT.—Not later than 90 days after the end of each fiscal year, the Administrator

shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on the use of Space Act Agreement authority by the Administration during the previous fiscal year.

(2) CONTENTS.—The report shall include for each Space Act Agreement in effect at the time of the report—

(A) an indication of whether the agreement is a reimbursable, nonreimbursable, or funded Space Act Agreement;

(B) a description of—

(i) the subject and terms;

(ii) the parties;

(iii) the responsible mission directorate, center, or headquarters element;

(iv) the value;

(v) the extent of the cost-sharing among Federal Government and non-Federal sources;

(vi) the time period or schedule; and

(vii) all milestones; and

(C) an indication of whether the agreement was renewed during the previous fiscal year.

(3) ANTICIPATED AGREEMENTS.—The report shall also include a list of all anticipated reimbursable, nonreimbursable, and funded Space Act Agreements for the upcoming fiscal year.

(4) CUMULATIVE PROGRAM BENEFITS.—The report shall also include, with respect to the Space Act Agreements covered by the report, a summary of—

(A) the technology areas in which research projects were conducted under such agreements;

(B) the extent to which the use of the Space Act Agreements—

(i) has contributed to a broadening of the technology and industrial base available for meeting Administration needs; and

(ii) has fostered within the technology and industrial base new relationships and practices that support the United States; and

(C) the total amount of value received by the Federal Government during the fiscal year pursuant to such Space Act Agreements.

SEC. 708. HUMAN SPACEFLIGHT ACCIDENT INVESTIGATIONS.

Section 70702 of title 51, United States Code, is amended by striking paragraph (3) and inserting the following:

"(3) any other space vehicle carrying humans that is owned by the Federal Government or that is being used pursuant to a contract or Space Act Agreement, as defined in section 2 of the National Aeronautics and Space Administration Authorization Act of 2013 with the Federal Government; or".

SEC. 709. COMMERCIAL TECHNOLOGY TRANSFER PROGRAM.

Section 50116(a) of title 51, United States Code, is amended by inserting ", while protecting national security" after "research community".

SEC. 710. ORBITAL DEBRIS.

(a) FINDING.—Congress finds that orbital debris poses serious risks to the operational space capabilities of the United States and that an international consensus and strategic plan is needed to mitigate the growth of orbital debris wherever possible.

(b) REPORTS.—

(1) COORDINATION.—Not later than 90 days after the date of enactment of this Act, the Administrator shall provide the Committee on Science,

Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate with a report on the status of efforts to coordinate with countries within the Inter-Agency Space Debris Coordination Committee to mitigate the effects and growth of orbital debris as required by section 1202(b)(1) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18441(b)(1)).

(2) MITIGATION STRATEGY.—Not later than 90 days after the date of enactment of this Act, the Director of the Office of Science and Technology Policy shall provide the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate with a report on the status of the orbital debris mitigation strategy required under section 1202(b)(2) of the National Aeronautics and Space Administration Authorization Act of 2010 (42 U.S.C. 18441(b)(2)).

SEC. 711. NASA LEADERSHIP.

Section 20111 of title 51, United States Code, is amended—

(1) in subsection (a), by inserting "The Administrator shall serve for a term of 6 years, and may

be reappointed for additional terms." after "and activities thereof."; and

(2) in subsection (b)—

(A) by inserting "The Deputy Administrator shall not act for, and exercise the powers of, the Administrator for a period in excess of 45 days. After 45 days, the Associate Administrator shall exercise the powers of Administrator until a new Administrator is appointed and confirmed by the Senate." after "absence or disability."; and

(B) by striking "from civilian life".

SEC. 712. NASA ADVISORY COUNCIL.

(a) ESTABLISHMENT.—Subchapter II of chapter 201 of title 51, United States Code, is amended by adding at the end the following new section:

"§ 20118. NASA Advisory Council

"(a) ESTABLISHMENT.—There shall be established a NASA Advisory Council (in this section referred to as 'the Council') for the Administration in accordance with this section, not later than 9 months after the date of enactment of this section.

"(b) MEMBERSHIP AND APPOINTMENT.—The Council shall consist of 11 members to be appointed as follows:

"(1) 3 members shall be appointed by the President.

"(2) 3 members shall be appointed by the president pro tempore of the Senate.

"(3) 1 member shall be appointed by the minority leader of the Senate.

"(4) 3 members shall be appointed by the Speaker of the House of Representatives.

"(5) 1 member shall be appointed by the minority leader of the House of Representatives.

In addition to the members appointed under paragraphs (1) through (5), the Administrator shall be an ex officio, nonvoting member of the Council. Members of the Council must comply with laws and regulations for Federal advisory committees and ethics in government.

"(c) QUALIFICATIONS.—The persons appointed as members of the Council shall be—

"(1) former astronauts or scientists or engineers eminent in the fields of human spaceflight, planetary science, space science, Earth science, or aeronautics, or other scientific, engineering, business, and disciplines related to space exploration and aeronautics;

"(2) selected on the basis of established records of distinguished service; and

"(3) so selected as to provide representation of the views of engineering, science, and aerospace leaders in all areas of the Nation.

"(e) TERMS.—The term of office of each member of the Council shall be 6 years.

"(f) MEETINGS.—The Council shall meet two times annually at minimum and at such other times as the Chairman may determine, but the Chairman shall also call a meeting whenever one-third of the members so request in writing. The Council shall adopt procedures governing the conduct of its meetings, including delivery of notice and a definition of a quorum, which in no case shall be less than one-half plus one of the members of the Council.

"(g) CHAIRMAN AND VICE CHAIRMAN.—The Chairman and Vice Chairman of the Council shall be elected by a majority vote of the Council for a two-year term. A Member may serve as Chairman and Vice Chairman for up to three terms. The Vice Chairman shall perform the duties of the Chairman in his absence. In case a vacancy occurs in the chairmanship or vice chairmanship, the Council shall elect a member to fill such vacancy.

"(h) STAFF.—The Administrator shall support the Council with professional staff to provide for the performance of such duties as may be prescribed by the Council.

"(i) COMMITTEES.—The Council is authorized to appoint from among its members such committees as it deems necessary, and to assign to committees so appointed such survey and advisory functions as the Council deems appropriate to assist it in exercising its powers and functions.

"(j) FUNCTIONS.—

"(1) BUDGET PROPOSAL.—

"(A) REVIEW OF PROPOSAL.—Not later than October 15 of each year, the Council shall have reviewed the Administration's proposed budget for the next fiscal year and provide to the President their advice based on the best professional judgment of a majority of members. Portions of Council meetings in which the Council considers the budget proposal for the next fiscal year may be closed to the public until the Council submits the proposal to the President and the Congress.

"(B) ADVICE TO CONGRESSIONAL COMMITTEES.—Not later than 14 days following the President's budget submittal to the Congress for the next fiscal year, the Council shall provide to the Committee on Science, Space, and Technology of the House of Representatives

and the Committee on Commerce, Science, and Transportation of the Senate their advice based on the best professional judgment of a majority of members.

"(2) ADVICE TO THE PRESIDENT AND CONGRESS.—The Council shall report their findings, advice, and recommendations to the President and the Congress on matters of particular policy interest on space exploration and aeronautics based on the best professional judgment of a majority of members.".

(b) TABLE OF SECTIONS.—The table of sections for chapter 201 of title 51, United States Code, is amended by adding at the end of the items for subchapter II the following new item:

"20118. NASA Advisory Council.".

(c) CONSULTATION AND ADVICE.—Section 20113(g) of title 51, United States Code, is amended by inserting "and Congress" after "advice to the Administration".

SEC. 713. COST ESTIMATION.

(a) REPORT.—Not later than 90 days after the date of enactment of this Act, the Administrator shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Commerce, Science, and Transportation of the Senate a report on current and continuing efforts to implement more effective cost estimation practices.

(b) ELEMENTS.—The report required under subsection (a) shall include—

(1) a list of steps the Administration is undertaking to advance consistent implementation of the joint cost and schedule level (JCL) process; and

(2) a description of mechanisms the Administration is using and will continue to use to ensure that adequate resources are dedicated to cost estimation.

Chairman PALAZZO. The Subcommittee on Space will come to order.

Good morning. Welcome to today's hearing titled "The NASA Authorization Act of 2013." In front of you are packets containing the written testimonies, biographies and required Truth in Testimony disclosures for today's witnesses. I recognize myself for five minutes for an opening statement.

The discussion draft of the National Aeronautics and Space Administration Act of 2013 before us today is the result of input from a wide variety of interests throughout the science and space communities. The outreach efforts of this Committee have been unprecedented, and I am proud of the draft we have put together. My goal for this hearing is to ensure that all of our Members have an opportunity to ask questions, raise concerns and debate important topics. I expect the tenor of today's hearing to be respectful. We are all here because we care about NASA and want it to succeed.

The draft bill includes a top line budget of over $16.8 billion and authorizes the agency for two years. This budget is consistent with the requirements of the Budget Control Act.

In regards to sequestration, I want to take a moment to point out that I and several of my colleagues sitting here in this room worked extremely hard to avoid getting to this point. We have offered solid solutions and replacements for these damaging cuts, and we stand ready to work with the Senate and the Administration to replace the sequester with responsible, strategic cuts. This authorization bill reflects a sincere effort to maximize return to the taxpayer while working to protect America's role as the world leader in space exploration.

It is realistic and reflective of the hard choices we must make as a Nation and provides support for agreed-upon priorities. The stark reality is that if we fail to reform mandatory spending, discretionary funding for space, science and research will continue to shrink.

The Administration must focus on core programs such as the Space Launch System and Orion crew capsule, the International Space Station, the James Webb Space Telescope and the Commercial Crew program. The Space Launch System is authorized at over $1.7 billion and the Orion crew capsule at $1.2 billion. The SLS and Orion will take our astronauts deeper into space than ever before. I am committed to the success of these assets and ensuring their continued on-time development and appropriate prioritization moving forward.

The Commercial Crew program is authorized at $700 million, but let me be clear: this is not a blank check for the Administration. The bill includes several accountability measures and a flight readiness deadline of December 31, 2017. This deadline is not negotiable. NASA must do whatever is necessary in its acquisition model to meet this deadline, even if that means radically altering their current plans.

The International Space Station is authorized at over $2.9 billion, and the bill includes a framework for NASA to use for determining the future life of the Station. This Committee intends to ensure the ISS is utilized to the greatest extent possible and that every dollar is efficiently allocated with a priority placed on micro-

gravity research. The $4.62 billion authorized for the Science Mission Directorate ensures critical programs will continue on schedule including the James Webb Space Telescope and Planetary Science missions. Over the last five years, the Earth Science program has grown by more than 40 percent at the expense of other critical missions within the Science Mission Directorate and elsewhere in NASA.

There are 13 agencies throughout the Federal Government that currently fund over $2.5 billion in climate science research, but only one agency does space exploration and space science. This bill ensures a balanced portfolio of science mission programs by simply moderating the increases that Earth Science has received over the last five years.

The Aeronautics Mission Directorate promotes technology sharing among government agencies and infuses critical research and data into the commercial market. It is authorized at $565 million with requirements for interagency roadmaps for various technology areas.

This bill authorizes $500 million for the Space Technology program. This investment in game-changing technology development is crucial for future exploration mission, both robotic and human. We also recognize the role this program can play in finding innovative solutions to tough problems.

The President's budget request this year included a major structural change to STEM programs at NASA. The full Science Committee held a hearing that revealed significant bipartisan concerns about this plan. While the Committee generally supports consolidation of government programs to ensure efficiencies, this change was poorly conceived and is not ready for implementation. For this reason, the bill prohibits NASA from implementing those changes.

Another request in the President's budget was an Asteroid Retrieval Mission, or ARM. While the Committee supports the Administration's efforts to study near-Earth objects, this proposal lacks in details, a justification or support from the NASA's own advisory bodies. Because the mission appears to be a costly and complex distraction, this bill prohibits NASA from doing any work on the project, and we will work with appropriators to ensure the agency complies with this directive.

In addition to authorizing funding and giving direction to the agency for critical missions, the Committee has included several measures to ensure good government practices and transparency within NASA including reform for the use of Space Act Agreements, changes to termination liability requirements and stricter cost growth controls.

As people in our districts and across the Nation continue to struggle to find jobs and put food on the table, we must ensure that every single dollar appropriated to NASA is spent effectively and efficiently. This bill provides commonsense guidance and prioritizes those most critical NASA missions.

[The prepared statement of Mr. Palazzo follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON SPACE CHAIRMAN STEVEN PALAZZO

The discussion draft of the National Aeronautics and Space Administration Act of 2013 before us today is the result of input from a wide variety of interests

throughout the science and space communities. The outreach efforts of this Committee have been unprecedented and I am proud of the draft we have put together. My goal for this hearing is to ensure that all of our Members have an opportunity to ask questions, raise concerns and debate important topics. I expect the tenor of today's hearing to be respectful. We are all here because we care about NASA and want it to succeed.

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The Administration must focus on core programs such as the Space Launch System and Orion crew capsule, the International Space Station, the James Webb Space Telescope and the Commercial Crew Program. The Space Launch System is authorized at over $1.77 billion and the Orion crew capsule at $1.2 billion. The SLS and Orion will take our astronauts deeper into space than ever before. I am committed to the success of these assets and ensuring their continued on-time development and appropriate prioritization moving forward. The Commercial Crew program is authorized at $700 million, but let me be clear; this is not a blank check for the Administration. The bill includes several accountability measures and a flight readiness deadline of December 31, 2017. This deadline is not negotiable. NASA must do whatever is necessary in its acquisition model to meet this deadline, even if that means radically altering their current plans.

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Agreements, changes to termination liability requirements and stricter cost growth controls.

As people in our districts and across the nation continue to struggle to find jobs and put food on the table, we must ensure that every single dollar appropriated to NASA is spent effectively and efficiently. This bill provides common sense guidance and prioritizes those most critical NASA missions.

Chairman PALAZZO. I now recognize the Ranking Member, the gentlelady from Maryland, Ms. Edwards, for an opening statement.

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you for calling this hearing to discuss a draft of the proposed NASA authorization bill.

NASA has been and should continue to be the Nation's crown jewel for spurring innovation, highly skilled and good-paying jobs, and inspiring the next generation of scientists. It is vital that any new NASA Authorization match that same standard.

I think we both agree that a strong NASA is critical to the Nation and that this authorization is vitally important, and it is an important opportunity to set the policy direction and authorized funding needed to ensure America's global leadership in space. It is my hope that we can work together to ensure that NASA's mission is clear, establish expectations that will inspire the public and the workforce, and then provide the level of resources needed to enable the agency to be successful. Doing otherwise would not only be a disservice to the men and women at NASA, its contractor workforce and the American people, but would effectively set the agency on a path to failure. I know that Members of this Committee want to see NASA thrive, and we must have an authorization bill that ensures that.

Mr. Chairman, we are not, nor should we be, the scientists and engineers who devise the programs and projects to meet the high-level goals set for the agency. That should be left to the capable experts at NASA.

I was pleased to see that the draft bill contains a number of reporting requirements and other provisions taken from the 2010 House version of the NASA Authorization Act of 2010, since those were not included in the enacted law because Members only voted on the Senate bill in 2010.

Developing a plan or a roadmap for human exploration to Mars and seeking criteria for evaluating the potential extension of ISS operations beyond 2020 are just a few of the key areas where I see the potential to build consensus.

I am concerned however, with several aspects of this draft bill, and I question whether, in the end, this draft will serve to ensure our Nation's hard-earned leadership in space and all the inspiration, discovery, international standing and economic benefits that such leadership brings.

First, the draft bill would appear to shift the emphasis of NASA's core mission to human exploration. This is counter to the policy of NASA's organic Act, the National Aeronautics and Space Act of 1958, as well as to the policy statements of multiple NASA authorizations that have seen NASA as a multi-mission agency with significant activities in science, aeronautics and human spaceflight and exploration, and technology development

Another key concern is the level of funding that is authorized. The proposed bill would slash NASA's budget by almost a billion dollars relative to both the President's proposal for Fiscal Year 2014 and the pre-sequester funding approved by Congress in Fiscal Year 2012, and it would maintain that cut over each of the years of the Majority's authorization bill.

The severe cuts to NASA's top line are manifested throughout the draft bill. For example, Earth Science would be cut by almost $650 million relative to the Fiscal Year 2014 request, meaning the Earth Science account is cut by one-third. Cuts to Earth Science would not only result in gaps in the data needed to understand changes in our Earth system, it would also impact on the data needed for water monitoring, forest and timber productivity forecasting, improving gas and electric utilities load forecasting, and assessing the impact of sea-level rise in coastal communities. These uses and societal benefits are exactly what we hope for when we make Federal investments in research and technology. To stop them would be irresponsible.

And the bill appears to shift all Space Technology activities to support only exploration-related technology development. More importantly, the proposed reduction in funding for Space Technology will not keep NASA on a path aligned with 21st century innovation and job creation. Plans to pursue new technologies such as in-space propulsion and cryogenic fuel storage may suffer. The impact of making these reductions was not discussed in preceding hearings, as they should have been.

Compounding these things, the bill establishes aggressive milestones and activities that run contrary to proposed downsized levels without any real regard for safety and schedule. These are exactly the pressures of the lessons that we learned from both Challenger and Columbia, and we can't afford to repeat those tragedies. We cannot expect NASA to develop a sustainable and inspiring space program under these circumstances, and Mr. Chairman, the Subcommittee has historically done best for NASA when we move legislation in a bipartisan manner.

As a minimum, now that the draft bill is open for discussion and before we begin considering markup, we should first take the time to hold hearings with valued experts and stakeholders impacted by the bill's provisions, especially in areas such as Earth Science, Space Technology, and Commercial Crew safety.

As we will hear from one of the witnesses today, one way of counteracting the high cost of human space exploration may be in the form of expanded international partnerships. This is an idea that needs to be considered as the journey to Mars will be long, yet rewarding for the future of humankind.

Thank you, and I look forward to hearing from our witnesses today.

[The prepared statement of Ms. Edwards follows:]

PREPARED STATEMENT OF SUBCOMMITTEE RANKING MINORITY MEMBER DONNA EDWARDS

Mr. Chairman, thank you for calling this hearing to discuss a draft of the proposed NASA authorization bill.

NASA has been and should continue to be the Nation's crown jewel for spurring innovation, highly-skilled and good paying jobs, and inspiring the next generation of scientists. It is vital that any new NASA Authorization match that standard.

I think we both agree that a strong NASA is critical to the nation and that this Authorization is a vitally important opportunity to set the policy direction and authorize funding needed to ensure America's global leadership in space.

It is my hope that we can work together to ensure that NASA's mission is clear, establish expectations that will inspire the public and workforce, and then provide the level of resources needed to enable the agency to be successful.

Doing otherwise would not only be a disservice to the men and women at NASA, its contractor workforce, and the American people, but would effectively set the Agency on a path to failure. I know that Members of this Committee want to see NASA thrive; we must have an Authorization bill that ensures that.

Mr. Chairman, we are not, nor should we be, the scientists and engineers who devise the programs and projects to meet the high-level goals of the Agency. That should be left to the capable experts at NASA.

I was pleased to see that the draft bill contains a number of reporting requirements and other provisions taken from the 2010 House version of the NASA Authorization Act of 2010, since those were not included in the enacted law because Members only voted on the Senate bill in 2010.

Developing a plan or roadmap for human exploration to Mars and seeking criteria for evaluating the potential extension of ISS operations beyond 2020 are just a few of the key areas where I see the potential to build consensus.

I am concerned however, with several aspects of this draft bill, and I question whether, in the end, this draft will serve to ensure our nation's hard-earned leadership in space and all the inspiration, discovery, international standing, and economic benefits that such leadership brings.

First, the draft bill would appear to shift the emphasis of NASA's core mission to human exploration. This is counter to the policy of NASA's organic Act, the National Aeronautics and Space Act of 1958, as well as to the policy statements of multiple NASA Authorizations that have seen NASA as a multi-mission agency with significant activities in science, aeronautics, and human spaceflight and exploration, and technology development.

Another key concern is the level of funding that is authorized. The proposed bill would slash NASA's budget by almost a billion dollars relative to both the President's proposal for FY 14 and the pre-sequester funding approved by Congress in FY 12, and it would maintain that cut over each of the years of the Majority's Authorization bill. The severe cuts to NASA's top line are manifested throughout the draft bill.

For example, Earth Science would be cut by almost $650 million relative to the FY 14 request, meaning the Earth Science account is cut by 1/3.

Cuts to Earth Science would not only result in gaps in the data needed to understand changes in our Earth system, it would also impact on the data needed for water monitoring, forest and timber productivity forecasting, improving gas and electric utilities load forecasting, and assessing the impact of sea level rise in coastal communities.

These uses and societal benefits are exactly what we hope for when we make federal investments in research and technology. To stop them would not be responsible. And the bill appears to shift all Space Technology activities to support only exploration-related technology development.

More importantly, the proposed reduction in funding for Space Technology will not keep NASA on a path aligned with 21st century innovation and job creation. Plans to pursue new technologies such as in-space propulsion and cryogenic fuel storage may suffer.

The impact of making these reductions was not discussed in preceding hearings, as they should have been. Compounding things, the bill establishes aggressive milestones and activities that run contrary to proposed downsized levels.

We cannot expect NASA to develop a sustainable and inspiring space program under these circumstances. Mr. Chairman, this Subcommittee has historically done best for NASA when we have moved legislation in a bipartisan manner.

As a minimum, now that the draft bill is open for discussion and before we consider moving to markup, we should first take the time to hold other hearings with valued experts and stakeholders impacted by the draft bill's provisions, especially in areas such as Earth science, space technology, and commercial crew safety.

As we will hear from one of the witnesses today, one way of counteracting the high cost of human space exploration may be in the form of expanded international partnerships. This is an idea that needs to be considered as the journey to Mars will be long, yet rewarding for the future of humankind.

Chairman PALAZZO. Thank you, Ms. Edwards.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point. Oh, I apologize, Ms. Johnson. Our Ranking Member is present. I now recognize the Ranking Member of the full Committee for her remarks.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and good morning, and I would like to join you in welcoming our witnesses to this morning's hearing. You both have offered valuable counsel to our Committee in the past, and I am certain that you will do that again today.

As the Chairman has indicated, we are here today to begin our review of the Majority's discussion draft of the NASA Authorization Act of 2013. Those who know me know that I consider NASA to be a critical part of the Nation's innovation infrastructure, a driver of technological and scientific progress, a positive symbol of the United States throughout the world, and most importantly, a source of inspiration for successive generations of our young people. I strongly believe that any NASA authorization bill that comes out of this Committee should reflect these realities.

Unfortunately, the draft bill that we are starting to examine today doesn't do that. It doesn't contain funding commensurate with the tasks NASA has been asked to undertake. In fact, it gives NASA additional unfunded mandates while maintaining deep sequestration cuts over the life of the bill. It contains policy direction that I fear will do long-term damage to the agency. And, I regret to say that if enacted, it would not help NASA meet the challenges facing the agency. In short, it is a missed opportunity to position NASA for excellence, and it is a bill that if enacted would lead to the erosion of the capabilities that have made NASA such a positive force for progress.

Why do I say that? Well, I have already mentioned the deep and sustained cuts this bill makes to NASA's overall budget at a time when we should be investing more in NASA, not putting it on a path to mediocrity. It also cuts NASA's Earth Science budget by one-third, which I find very baffling. Certainly the Committee has held no hearings on NASA's Earth Science program in this Congress nor the 112th Congress, so it is hard to see any justification for those cuts. It makes equally damaging cuts and changes to NASA's Space Technology program, again without explanation. And despite on the one hand putting NASA's budget on a path of declining purchasing power for the foreseeable future, it on the other hand directs NASA to establish major new programs, not just goals, for sustained human presence on both the Moon and Mars.

Moreover, in addition to imposing other unfunded and underfunded mandates on numerous NASA programs, it also sets an arbitrary deadline by when NASA will have had to carry out a successful commercial crew flight to the International Space Station, a deadline that I fear will lead to the kind of schedule pressure the Columbia Accident Investigation Board warned against a decade ago after the tragic loss of the Space Shuttle Columbia.

Mr. Chairman, there are other areas of this draft legislation that I fundamentally disagree with, but I think you have a sense of my overall view. This is not a bill ready for markup. This is a flawed

draft, starting from its funding assumptions, and I cannot support it in the present form. I can also predict that if passed by our Committee, this bill would be DOA in the Senate, DOA meaning dead on arrival.

Rather than moving directly to an unproductive markup, I hope that the Majority will take a step back and at a minimum hold additional legislative hearings so we can hear from the affected parties what the impacts of the proposed cuts and changes to Earth Science and Space Technology will be. We also need to hear from the congressionally established Aerospace Safety Advisory Panel on its views of this legislation, because I know that no member of this Committee will want to do anything that would jeopardize safety.

In closing, NASA is an investment in our future. The women and men who work at NASA are some of our best and brightest. We owe it to them and to our children and grandchildren to take the time to produce a NASA Authorization Act worthy of this Committee.

I thank you, Mr. Chairman. I yield back the balance of my time.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF COMMITTEE RANKING MEMBER EDDIE BERNICE JOHNSON

Good morning. I'd like to join the Chairman in welcoming our witnesses to this morning's hearing. You both have provided valuable counsel to our Committee in the past, and I am certain that you will do so again today.

As the Chairman has indicated, we are here today to begin our review of the Majority's Discussion Draft of the NASA Authorization Act of 2013. Those who know me know that I consider NASA to be a critical part of the nation's innovation infrastructure, a driver of technological and scientific progress, a positive symbol of the United States throughout the world, and most importantly, a source of inspiration for successive generations of our young people. I strongly believe that any NASA Authorization bill that comes out of this Committee should reflect those realities.

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Why do I say that? Well, I have already mentioned the deep and sustained cuts this bill makes to NASA's overall budget—at a time when we should be investing more in NASA, not putting it on a path to mediocrity. It also cuts NASA's Earth Science budget by one-third, which I find baffling. Certainly the Committee has held no hearings on NASA's Earth Science program in this or the 112th Congress, so it's hard to see any justification for those cuts. It makes equally damaging cuts and changes to NASA's Space Technology program—again without explanation.

And despite on the one hand putting NASA's budget on a path of declining purchasing power for the foreseeable future, it on the other hand directs NASA to establish major new programs—not just goals—for sustained human presences on both the Moon and Mars.

Moreover, in addition to imposing other unfunded and underfunded mandates on numerous NASA programs, it also sets an arbitrary deadline by when NASA will have had to carry out a successful commercial crew flight to the International Space Station—a deadline that I fear will lead to the kind of schedule pressure the Columbia Accident Investigation Board warned against a decade ago after the tragic loss of the Space Shuttle Columbia.

Mr. Chairman, there are other areas of the draft legislation that I fundamentally disagree with, but I think you have a sense of my overall view. This is not a bill ready for markup. This is a flawed draft, starting from its funding assumptions, and

I cannot support it in its present form. I can also predict that if passed by our Committee, this bill would be DOA in the Senate.

Rather than moving directly to an unproductive markup, I hope that the Majority will take a step back and at a minimum hold additional legislative hearings so we can hear from the affected parties what the impacts of the proposed cuts and changes to Earth Science and Space Technology will be. We also need to hear from the congressionally established Aerospace Safety Advisory Panel on its views of this legislation, because I know that no Member on this Committee will want to do anything that would jeopardize safety.

In closing, NASA is an investment in our future. The women and men who work at NASA are some of our best and brightest. We owe it to them and to our children and grandchildren to take the time to produce a NASA Authorization Act worthy of this Committee.

Chairman PALAZZO. Thank you, Ms. Johnson. Again, the purpose of this Committee to hear our Members' concerns, issues and questions and also have some debate on those issues.

If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time I would like to introduce our panel of witnesses. Our first witness is Dr. Steven Squyres, the Goldwin Smith Professor of Astronomy at Cornell University, and Chair of the NASA Advisory Council. Our second witness is Mr. Thomas Young, former Executive Vice President of Lockheed Martin Corporation.

As our witnesses should know, spoken testimony is limited to five minutes each, after which Members of the Committee have five minutes each to ask questions. Your written testimony will be included in the record of the hearing.

I now recognize our first witness, Dr. Squyres, for five minutes.

TESTIMONY OF STEVEN SQUYRES
GOLDWIN SMITH PROFESSOR OF ASTRONOMY,
CORNELL UNIVERSITY

Dr. SQUYRES. Mr. Chairman and Members of the Committee, thank you for the opportunity to appear today.

Three themes run through my testimony. First, NASA needs a clear and compelling long-term goal. In my opinion, that goal should be to send human explorers to Mars. Second, NASA is being asked to do too much with too little. Unless program content can be matched to budget, the result will be wasted effort and delay. Third, our Nation's civil space program will be best served by having high-level policies set by the Administration and Congress, and implementation details recommended by NASA engineers, scientists and managers.

I recently testified at a hearing before this Committee entitled "Next Steps in Human Exploration to Mars and Beyond." An underlying assumption of that hearing was that a crucial future goal for NASA should be to send human explorers to the surface of Mars. I argued then and I reiterate now that sending human explorers to Mars to learn whether or not life ever emerged there is a goal worthy of a great national space agency. It should be NASA's number one long-range priority.

To make progress towards the goal, the draft Authorization Act wisely calls for NASA to develop a Mars human exploration roadmap, but then, with little technical justification, the draft legislation also dictates what some of the key elements of that roadmap

should or should not be. Specifically, it directs NASA to establish a program to develop a sustained human presence on the moon and forbids NASA to fund the development of an Asteroid Retrieval Mission. I believe that it would be unwise for Congress to either prescribe or proscribe any key milestone in NASA's Mars exploration roadmap at this time. Personally, I agree with the draft Authorization Act's position on the Asteroid Retrieval Mission, and I disagree with its position on a sustained lunar presence, but my personal views are not the point.

In the 1960s, the government set the high-level goal of sending humans to the Moon and then left it to the engineers and the scientists and managers of NASA to find the right program architecture to achieve this goal. I believe that a similar approach should be taken to achieving the goal of getting humans to Mars. I urge that milestones not be dictated either by the Administration or the Congress without allowing NASA to develop a technically sound roadmap first. The objective of this roadmap should be to achieve the goal of human exploration of Mars as quickly and efficiently as possible, and then once a viable roadmap has been generated, the additional technologies, vehicles and milestones that are needed to make it a reality will become clear.

Moving on to Space Science, this program has been one of NASA's major success stories for many years. Priorities across the full sweep of Space Science have been recommended by the National Research Council's Decadal Surveys. I am pleased that the draft Authorization Act places particular emphasis on assuring that NASA's Space Science program follows decadal priorities.

Unfortunately, tight budgets and mission cost overruns have put NASA's Space Science program under pressure. Recent Administration budget requests have funded most Space Science disciplines adequately but have included cuts to Planetary Exploration that were so deep as to appear punitive. The draft Authorization Act, in contrast, restores funding for Planetary Exploration but introduces alarmingly deep cuts to Earth Science. I feel it is important that cuts be driven by science priorities as outlined in the Decadal Surveys and that they be distributed sensibly across disciplines. So I urge this Committee to strive for balance in the Space Science portfolio rather than singling out Earth Science or any other discipline for disproportionate cuts.

The draft Authorization Act would reorganize the Space Technology program by moving much of the responsibility for technology development to the Human Exploration and Operations Mission Directorate. Unfortunately, when budgets are tight, it is tempting for mission directorates to use technology funds to solve today's problems rather than enabling tomorrow's missions. So I favor a more distributed approach in which only technology funding for specific near- and medium-term needs of a mission directorate resides within that directorate. I feel that longer-term and more broadly applicable exploration technology funding is better maintained in a separate technology organization helping protect it from being used to solve immediate mission problems.

Returning to my opening themes, I believe that the mismatch between the agency's aspirations and its budget is the most serious problem facing NASA. Unless a solution is found, some very hard

choices may have to be made soon. Specifically, a choice is looming, I believe, regarding whether the focus of human spaceflight should be ISS utilization or moving beyond low-Earth orbit. At projected budget levels, I fear that NASA will not be able to do both of these safely and well.

Part of the solution may be international partnerships. If no major funding increase for NASA is forthcoming, then I believe that the agency should aggressively seek out international partners for human exploration beyond low-Earth orbit. If capable partners who are willing to shoulder a substantial fraction of the cost of deep space exploration can be found, then it may be possible for NASA to maintain something like its current portfolio of activities. Otherwise I fear that a painful reduction in program content may lie ahead.

Despite the challenges that it faces, NASA is one of our Nation's greatest assets and a source of pride for all Americans. An Authorization Act that enunciates a clear and compelling long-term goal for the agency, that matches program content to budget and that lets NASA formulate the implementation details of national civil space policy will allow it to remain so.

Again, thank you for the opportunity to appear today.

[The prepared statement of Dr. Squyres follows:]

Statement of Steven W. Squyres
Goldwin Smith Professor of Astronomy
Cornell University

Before the Subcommittee on Space
United States House of Representatives

June 19, 2013

Mr. Chairman and Members of the Committee, thank you for the opportunity to appear today. My name is Steven W. Squyres, and my title is Goldwin Smith Professor of Astronomy at Cornell University. I have participated for the past thirty years in a number of NASA solar system exploration missions. Recently I chaired the planetary decadal survey for the National Research Council, and I am currently the Chairman of the NASA Advisory Council. The views that I express today are my own, and do not represent the opinions of the National Research Council, the NASA Advisory Council, or any other organization.

The subject of today's hearing is the NASA Authorization Act of 2013. The draft legislation is long and detailed, and I will not attempt to address all of it in my testimony. I will focus instead on aspects that I find to be particularly worthy of comment.

Three themes run through my testimony today:

- NASA needs a clear and compelling long-term goal. That goal should be to send human explorers to Mars.
- NASA is being asked to do too much with too little. Unless program content can be matched to budget, the result will be wasted effort and delay.
- Our nation's civil space program will be best served by having high-level policy set by the Administration and Congress, and implementation details recommended by NASA engineers, scientists, and managers.

Human Space Flight

I recently participated in a hearing before this committee entitled "Next Steps in Human Exploration to Mars and Beyond". An underlying assumption of that hearing was that a crucial future goal for NASA should be to send human explorers to the surface of Mars. In my testimony then I strongly supported that goal, and I reiterate that support today.

Alone among the planets, Mars is enough like Earth that we can imagine life once taking hold there. A vast and growing body of scientific knowledge shows that the martian

surface once possessed many of the essential ingredients required for life. If by exploring Mars we could show that life emerged there – and therefore that it emerged twice in just this one solar system – it would take no great leap of faith, logic, or anything else to conclude that life may be commonplace throughout the cosmos.

One could ask whether it is necessary to send humans to Mars to answer this question. Despite having devoted my career to exploring the solar system with robots, I am a strong advocate of human exploration, particularly at Mars. Humans have an extraordinary ability to function in complex environments, to improvise, and to respond quickly to new discoveries. Robots, in contrast, do best when the environment is simple and well understood, and when the scientific tasks are well defined in advance. Because the capabilities of humans most surpass those of robots in complex environments, the exploration value that humans add is in proportion to the complexity of the environment to be explored. And there is no planetary environment where humans can operate in the foreseeable future that is more complex than the martian surface.

We also must not underestimate the inspirational value of human explorers on Mars. I can tell you from personal experience that NASA's long-lived Spirit and Opportunity Mars rovers were designed and built by people like me who grew up watching the Apollo lunar landings on television, and dreaming of sending spaceships to Mars one day. Sending humans to Mars would surely provide an even more compelling inspirational spark for the next generation of scientists, engineers, and explorers.

Sending human explorers to Mars to learn whether life ever emerged there is a goal worthy of a great national space agency. In my view, it is appropriate to make this goal NASA's top priority.

To make progress toward this goal, the draft Authorization Act wisely calls for NASA to develop "a Mars Human Exploration Roadmap defining the capabilities and technologies necessary to extend human presence to the surface of Mars". But then, with almost no technical justification, the draft legislation also dictates what some of the key elements of that roadmap should or should not be. Specifically, it directs NASA to "establish a program to develop a sustained human presence on the Moon", and forbids NASA to "fund the development of an asteroid retrieval mission to send a robotic spacecraft to a near-Earth asteroid for rendezvous, retrieval, and redirection of that asteroid to lunar orbit for exploration by astronauts."

I believe that it would be unwise for Congress either to prescribe or proscribe any key milestones in NASA's Mars exploration roadmap at this time. To do so would put the cart before the horse. Personally, I agree with the draft Authorization Act's position on the Asteroid Retrieval Mission, and I disagree with its position on a sustained lunar presence. But my personal views are not the point. In the 1960s, the government set the high-level goal of sending humans to the Moon, and then left it to the engineers, scientists, and managers of NASA to find the right program architecture to achieve this goal. I believe that a similar approach should be taken to the achieving the goal of getting humans to Mars.

The key early elements of the architecture that will be used to get to Mars have been agreed upon and are in development. The Space Launch System will provide an initial heavy lift capability, the Orion crew capsule will provide short-duration crew support, and the early flights will be to lunar orbit. Other pieces of the puzzle – new technologies and new vehicles – will be needed later. But these provide a start.

Beyond lunar orbit, milestones that could be considered include an asteroid that has been redirected to lunar orbit, the lunar surface, a near-Earth asteroid, Mars orbit, and the moons of Mars. I urge that milestones not be dictated, either by the Administration or the Congress, without allowing NASA to develop a technically sound Mars roadmap first. The objective of this roadmap should be to achieve the goal of human exploration of Mars as quickly and efficiently as possible. Once a viable roadmap has been generated, the additional technologies, vehicles, and milestones that are needed to make it a reality will become clear.

Moving on to funding levels in the draft Authorization Act, I find cause for serious concern regarding even the most near-term elements of NASA's human exploration program. Nowhere is the mismatch between NASA's aspirations and its budget manifested more clearly.

I have previously testified before this committee regarding the implications of NASA's budget for the flight rate of SLS and Orion. The current cost-constrained development schedule for SLS and Orion calls for:

- In 2014, an orbital test flight of an Orion capsule with no crew, to be launched on a Delta 4 Heavy.
- In 2017, a lunar flyby test flight of an Orion capsule with no crew, to be launched on a 70-metric ton SLS.
- In 2021, eight years from now, the first flight of a crew in an Orion capsule, again launched on a 70-metric ton SLS, on a mission to orbit the Moon.

Subsequent missions would occur on a "pay-as-you-go" basis, with a launch roughly every two years.

I believe that the low flight rate projected for SLS and Orion is a serious problem. No human-rated launch system in NASA's history has flown so infrequently. With such a low launch rate it will not just be difficult to maintain program momentum; it will be difficult to keep flight teams sharp and mission-ready.

So the problem with dictating future milestones now is not just that it puts the cart before the horse. In a situation where funding for even the nearest-term elements of human space exploration is inadequate, dictating a milestone like a sustained presence on the surface of the Moon would also amount to giving NASA an unfunded mandate.

Unfunded mandates are the bane of any government agency. They can be particularly crippling for an agency like NASA that is tasked with attempting things that have never been done before, with the uncertainties regarding schedule and budget that invariably result. If NASA is directed to do something it is not funded to do, I predict that the result will be wasted effort and a delay in achieving the ultimate goal of humans on Mars.

Space Science

Space Science has been one of NASA's major success stories for many years. From the Hubble Space Telescope to the Kepler exoplanet discovery mission to the Mars rover Curiosity, Space Science missions are addressing some of the most significant scientific questions of our day, and are captivating the American public in the process.

Priorities across the full sweep of Space Science have been recommended by the National Research Council's Decadal Surveys. These surveys are generated with broad input from the U.S. and international science communities, and reflect strong consensus views regarding science objectives and mission goals. I am pleased, therefore, that the draft Authorization Act places particular emphasis on assuring that NASA's Space Science program follows decadal priorities.

Unfortunately, tight budgets and mission cost overruns have put NASA's Space Science program under pressure. The Administration and the Congress clearly have different priorities for Space Science, and those differences are brought into sharp focus by this draft Authorization Act.

Recent Administration budget requests have funded most Space Science disciplines adequately, but have included cuts to planetary exploration that were so deep as to seem punitive. The draft Authorization Act, in contrast, restores funding for planetary exploration but introduces alarmingly deep cuts to Earth science.

In difficult budget times, some belt-tightening in Space Science is inevitable. But I feel it is important that cuts be driven by science priorities as outlined in the Decadal Surveys, and that they be distributed sensibly across disciplines. I urge this committee to strive for balance in the Space Science portfolio, rather than singling out Earth science, or any other discipline, for disproportionate cuts.

Aeronautics

In previous Congressional testimony, I have said that NASA's aeronautics program is one of the Agency's shining jewels. I stand by that characterization. If you ask what things NASA does that most directly benefit taxpayers in their daily lives, it's hard to find anything better than the aeronautics program.

I am pleased, therefore, that the draft Authorization Act continues funding for Aeronautics at approximately its current level. Most of the draft language calls for plans and reports to be provided Congress regarding Aeronautics activities; these will serve to keep the Congress well informed in these areas. I see no significant problems regarding the Aeronautics sections of the draft Authorization Act.

Space Technology

Technology development enables NASA's future missions, and decades of experience have shown that adequate upfront investment in technology is a key part of controlling mission costs. Effective management of NASA's Space Technology program is therefore essential.

The draft Authorization Act would reorganize the Space Technology program by moving much of the responsibility for exploration-related technology development to the Human Exploration and Operations Mission Directorate. Some aspects of this proposed reorganization concern me. There is indeed value in having some funding for development of specific technologies reside within NASA's mission directorates, so that the development can be aligned with that directorate's mission goals. The problem is that when budgets are tight it is tempting for mission directorates to use technology funds to solve today's problems rather than enabling tomorrow's missions. So I tend to favor a more distributed approach in which only technology funding for specific near- and medium-term needs of a mission directorate reside within that directorate. I feel that longer-term and more broadly applicable exploration technology funding is better maintained in a separate technology organization, helping protect it from being used to solve immediate mission problems.

I will also note that in order to find and fund the best ideas, it is important for a significant fraction of NASA's Space Technology program to be openly competed.

Education and Outreach

The President's FY 2014 budget request proposed a major restructuring of science, technology, engineering, and math (STEM) education and public outreach at a number of federal agencies. For NASA, this restructuring would eliminate most of the Agency's STEM education efforts, consolidating them under other government organizations that have little or no experience with space flight.

I believe that the restructuring proposed by the Administration is deeply misguided. NASA's space missions are unique within the federal government, both in their technical audacity and in their capacity to educate and inspire. The education and outreach components of NASA's missions have been enormously successful, in large part because they are managed and run by people who have a deep knowledge of the subject matter and a passion for sharing it.

I believe that dismantling NASA's education and outreach efforts would deal a serious blow to our nation's scientific and technical literacy. So I am very pleased that the draft Authorization Act states that NASA "may not implement any proposed STEM education and outreach-related changes proposed in the budget for fiscal year 2014".

Agency Leadership and Management

The draft Authorization Act includes provisions regarding leadership and oversight of NASA. Among these is language calling for establishment of a NASA Advisory Council. I note that both the membership and the responsibilities of this group would be dramatically different from those of the body that is now called the NASA Advisory Council, which I currently chair and which reports only to the NASA Administrator.

I support the formation of a body that is jointly appointed by the Administration and the Congress, and that reports to both regarding NASA. In the absence of such a body, there has been an unfortunate tendency for NASA's implementation of national space policy to overseen in what I view to be excessive detail, particularly by OMB. I have argued above that the government should set high-level policy (like the goal of sending humans to Mars), but that many of the implementation details are better devised and recommended by experienced NASA engineers, scientists, and managers. A high-level advisory body with deep technical and management experience could help provide the Administration and the Congress with assurances that the right recommendations are being made by the Agency, and could suggest corrective actions when necessary.

The devil will be in the details in the establishment of such a group. I note that the draft language calls for eight members to be appointed by Congress but only three by the Administration, an imbalance that could be problematic. I also note that careful coordination will be required to assure that the appropriate range of expertise is represented on the group. But I support the concept strongly.

Overcommitment of NASA: A Possible Long-Range Solution

I believe that the mismatch between NASA's aspirations and its budget is the most serious problem facing the Agency. Unless a solution is found, some very hard choices may have to be made soon. Specifically, a choice is looming regarding whether the focus of human space flight should be ISS utilization or moving beyond low Earth orbit. At projected budget levels, I fear that NASA will not be able to do both of these safely and well.

As I noted the last time I appeared before this committee, part of the solution may be international partnerships. If no major funding increase for NASA is forthcoming, then I believe that the Agency should aggressively seek out international partners for human exploration beyond low Earth orbit. As one example, an international partner might

provide a habitation module that would allow long-duration missions into deep space. If capable partners who are willing to shoulder a substantial fraction of the cost of deep space exploration can be found, then it may be possible for NASA to maintain something like its current portfolio of activities. Otherwise, I fear that a painful reduction in program content lies ahead.

Despite the challenges that it faces, NASA is one of our nation's greatest assets, and is a source of pride for all Americans. An Authorization Act that enunciates a clear and compelling long-term goal for the agency, that matches program content to budget, and that lets NASA formulate the implementation details of national civil space policy will allow it to remain so.

Steven W. Squyres is Goldwin Smith Professor of Astronomy at Cornell University, and is the Principal Investigator for the science payload on the Mars Exploration Rover Project. He received his Ph.D. from Cornell in 1981 and spent five years as a postdoctoral associate and research scientist at NASA's Ames Research Center before returning to Cornell as a faculty member. His main areas of scientific interest have been Mars and the moons of the outer planets. Research for which he is best known includes study of the history and distribution of water on Mars and of the possible existence and habitability of a liquid water ocean on Europa.

Dr. Squyres has participated in many of NASA's planetary exploration missions, including the Voyager mission to Jupiter and Saturn, the Magellan mission to Venus, and the Near Earth Asteroid Rendezvous mission. Along with his current work on MER, he is also a co-investigator on the Mars Express, Mars Reconnaissance Orbiter and Mars Science Laboratory missions, a member of the Gamma-Ray Spectrometer Team for the Mars Odyssey mission, and a member of the imaging team for the Cassini mission to Saturn.

Dr. Squyres chaired the most recent planetary decadal survey for the National Research Council. He has also served as Chair of the NASA Space Science Advisory Committee, and is currently Chair of the NASA Advisory Council. His awards include the American Astronomical Society's Harold C. Urey Prize, the Space Science Award of the American Institute of Aeronautics and Astronautics, the American Astronautical Society's Carl Sagan Award, the National Space Society's Wernher von Braun Award, and the Benjamin Franklin Medal of the Franklin Institute. He is a fellow of the American Academy of Arts and Sciences.

Chairman PALAZZO. Thank you, Dr. Squyres.
I now recognize our next witness, Mr. Young.

TESTIMONY OF A. THOMAS YOUNG,
FORMER EXECUTIVE VICE PRESIDENT,
LOCKHEED MARTIN CORPORATION

Mr. YOUNG. Chairman Palazzo, Ms. Edwards and Committee Members, I am pleased to have the opportunity to present my views on issues I believe to be important as you prepare the NASA Authorization Act of 2013.

The United States civil space program has been the source of enormous pride, prestige, knowledge and awe-inspiring technology. This has been the product of the exceptional men and women in NASA, other government agencies, industry and the scientific community working with highly competent leadership. This integrated effort is the foundation of the U.S. civil space program. As we move forward there are storm clouds over this great human endeavor that require attention.

Nothing is more important than maintaining NASA as the premier civil space organization including maintaining the special capabilities of other government agencies, industry and the scientific community. This can only be achieved by having challenging, inspiring and worthy things to do. Studies, technology pursuits and overseeing others are important but will not maintain the civil space program as world class. We must endeavor to populate the Authorization Act with worthwhile opportunities that maintain these critical capabilities.

To maximize the return from the investment in the civil space program requires that program content be in balance with the budget. This is a much discussed but seldom achieved goal. We continually operate with a budget that is inadequate to implement the established program. Our inability to delete worthy but lower-priority endeavors results in this imbalance. Too much program for the available budget results in inefficiencies, excessive risk and program cancellations. The result is that less is accomplished for more. Pay-as-you-go is a much-discussed concept that I believe has merit. Go-as-you-pay is a useful concept when deciding the point at which the budget will support starting a project. Go-as-you-pay is a most wasteful concept for the implementation of a project.

The dominant strategic issue facing the civil space program today is human spaceflight. Today, there is a human spaceflight program but no credible human space exploration strategy. There is much discussion about going to the Moon, an asteroid, Phobos, Deimos and Mars, however, there is no credible plan or budget. There are human exploration elements such as SLS and Orion.

The NASA budget contains about $8 billion for human spaceflight, not including infrastructure costs. This funds the International Space Station, SLS, Orion, some technology, Commercial Cargo and Commercial Crew. If the budget remains approximately the same, my judgment is that there are two basic choices: a space station-focused human spaceflight program or an exploration-focused program. I do not believe the budget is adequate to accomplish both, and a choice needs to be made to have a credible path forward. I believe as a part of making this choice, an independent

assessment of the value of the ISS return for the significant portion of the NASA budget that is dedicated to ISS is necessary. A senior review is a concept that is appropriate for conducting this assessment. If this human spaceflight strategy issue is not resolved, the graveyard of cancelled, abandoned and unachievable endeavors will continue to be populated. The responsibility for leading the resolution of this strategic issue should reside with NASA.

Another strategic issue that is important resides in the science area of the NASA program. There are a small number of profound questions for which the United States is in a leadership position and is on the cusp of greatly increasing our knowledge. These include: Are we alone? What is dark energy and dark matter? What is the future of our climate? Is the United States going to be a leader in these profound areas or are we going to voluntarily move to the sidelines? Decadal Surveys have identified the top-priority programs in pursuing these special opportunities. Sample return from Mars, a wide-field IR telescope and missions identified in the Earth Science Decadal deserve priority consideration in the new Authorization Act.

Technology is important "seed corn" for the civil space program. A debate in any organization involving high-technology pursuits is: Should the technology be managed in a mission organization to maximize the relevance of the technology, or should the technology be managed in an independent organization to maximize the probability that the technology program will be implemented?

The risk of the former is that the demands of implementing challenging projects will consume all the resources, thus sacrificing technology endeavors. The risk of the independent organization is the technology will be less relevant to NASA's missions and become an end in itself with scope beyond what is affordable. I believe the independent organization concept with a strong oversight process to assure maintaining relevance and responsibly containing scope of the endeavor is the best balance of merit and risk.

The final topic I want to discuss in my prepared comments is leadership. I place my toe in these troubled waters with great reservation. However, I believe leadership of the civil space program is a topic that must be openly discussed. I strongly believe the leadership of the U.S. civil space program must be vested in NASA. This includes both formulation and implementation. Politics and ideology are a part of the fabric of a democracy, however, they should be relegated to lower-level issues in the civil space program. I recognize that there are times when national issues are important factors, as was the case for Apollo, however, NASA has been and will be sensitive to such issues.

NASA is about engineering, science, exploration and discovery. NASA really is rocket science in its broadest definition. Leadership of the civil space program must have the capabilities and experience consistent with this demanding charter. Today, leadership of the civil space program is diffuse and authority is invested in organizations, while important, that do not have the expertise to be in a controlling role. This is a prescription for mediocrity whether it be an organization of great national importance, an industrial corporation or a local community organization. I have great worry about what I believe to be a declining trajectory for NASA and the

civil space program. I believe the most significant factor in this negative outlook is the adverse leadership concept I observe.

As an example of what results from diffuse leadership with too much authority in the wrong places is the proposed Asteroid Retrieval Mission. This is a mission that is not worthy of a world-class space program that is focused upon maximizing the return that can be realized from a constrained budget. NASA must be returned to the leadership role of the civil space program. If this occurs, many of the issues confronting the program will be very positively addressed. If not, the outlook is discouraging.

The Authorization Act of 2013 will be important in achieving a positive trajectory correction for NASA and the civil space program. It is hard to overstate the need for a program that is focused upon the highest-priority opportunities, a program that is consistent with available funding, and a program with leadership vested in NASA.

Great nations do great things. The United States is a great Nation, and I continue to believe the civil space program is a great thing.

Thank you very much.

[The prepared statement of Mr. Young follows:]

TESTIMONY

TO THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUBCOMMITTEE ON SPACE

JUNE 19, 2013

A. THOMAS YOUNG

Chairman Palazzo, Ms. Edwards and Committee members, I am pleased to have the opportunity to present my views on issues I believe to be important as you prepare the NASA Authorization Act of 2013.

The United States civil space program has been the source of enormous pride, prestige, knowledge and awe inspiring technology. This has been the product of the exceptional men and women in NASA, other government agencies, industry and the scientific community working with highly competent leadership. This integrated effort is the foundation of the U. S. civil space program. As we move forward there are "storm clouds" over this great human endeavor that require attention.

Nothing is more important than maintaining NASA as the premier civil space organization including maintaining the special capabilities of other government agencies, industry and the scientific community. This can only be achieved by having challenging, inspiring and worthy things to do. Studies, technology pursuits and overseeing others are important but will not maintain the civil space program as world class. We

must endeavor to populate the Authorization Act with worthwhile opportunities that maintain these critical capabilities.

To maximize the return from the investment in the civil space program requires that program content be in balance with the budget. This is a much discussed but seldom achieved goal. We continually operate with a budget that is inadequate to implement the established program. Our inability to delete worthy but lower priority endeavors results in this imbalance. Too much program for the available budget results in inefficiencies, excessive risk and program cancellations. The result is that "less is accomplished for more." "Go as you pay" is a much discussed concept that I believe has merit. "Go as you pay" is a useful concept when deciding the point at which the budget will support starting a project. "Go as you pay" is a most wasteful concept for the implementation of a project.

The dominant strategic issue facing the civil space program is human spaceflight. Today, there is a human spaceflight program but no credible human space exploration strategy. There is much discussion about going to the moon, an asteroid, Phobos, Deimos and Mars; however, there is no credible plan or budget. There are human exploration elements such as SLS and Orion.

The NASA budget contains about 8B$ for human spaceflight, not including infrastructure costs. This funds the International Space Station (ISS), SLS, Orion, some technology, commercial cargo and commercial crew. If the budget remains approximately the same, my judgment is that there are two basic choices, a space station focused human spaceflight program or an exploration focused program. I do not believe the budget is adequate to accomplish both and a choice needs to be made to have a credible path forward. I believe as a part of making this choice, an independent assessment of the value of the ISS return for the significant portion of the NASA budget that is dedicated to ISS is necessary. A Senior Review is an appropriate mechanism for conducting this assessment. If this human spaceflight strategic issue is not resolved, the grave yard of cancelled , abandoned and unachievable endeavors will continue to be populated. The responsibility for leading the resolution of this strategic issue should reside with NASA.

Another significant strategic issue resides in the science area of the NASA program. There are a small number of profound questions for which the U. S. is in a leadership position and is on the cusp of greatly increasing our knowledge. These include:

Are we alone?

What is dark energy and dark matter?

What is the future of our climate?

Is the U. S. going to be a leader in these profound areas or are we going to voluntarily move to the sidelines? Decadal Surveys have identified the top priority programs in pursuing these special opportunities. Sample return from Mars, a wide-field IR telescope (WFIRST) and missions identified in the Earth Science Decadal deserve priority consideration in the new Authorization Act.

Technology is important "seed corn" for the civil space program. A debate in any organization involving high technology pursuits is

Should the technology be managed in a Mission organization to maximize the relevance of the technology?

or

Should the technology be managed in an independent organization to maximize the probability that the technology program will be implemented?

The risk of the former is that the demands of implementing challenging projects will consume all the resources thus sacrificing technology endeavors. The risk of the independent organization is the technology will be less relevant to NASA's missions and become an end-in-itself with scope beyond what is affordable. I believe the independent organization concept

with a strong oversight process to assure maintaining relevance and responsibly containing scope of the endeavor is the best balance of merit and risk.

The final topic I want to discuss in my prepared comments is leadership. I "place my toe" in these troubled waters with great reservation. However I believe leadership of the civil space program is a topic that must be openly discussed. I strongly believe the leadership of the U. S. civil space program must be vested in NASA. This includes both formulation and implementation. Politics and ideology are a part of the fabric of a democracy; however, they should be relegated to lower level issues in the civil space program. I recognize that there are times when national issues are important factors as was the case for Apollo; however, NASA has been and will be sensitive to such issues.

NASA is about engineering, science, exploration and discovery. NASA really is about "rocket science" in its broadest definition. Leadership of the civil space program must have the capabilities and experience consistent with this demanding charter. Today, leadership of the civil space program is diffuse and authority is vested in organizations , while important, that do not have the expertise to be in a controlling role. This is a prescription for mediocrity whether it be an organization of great national importance, an industrial corporation or a local community

organization. I have great worry about what I believe to be a declining trajectory for NASA and the civil space program. I believe the most significant factor in this negative outlook is the adverse leadership concept I observe.

An example of what results from diffuse leadership with too much authority in the wrong places is the proposed asteroid retrevial mission. This is a mission that is not worthy of a world class space program that is focused upon maximizing the return that can be realized from a constrained budget. NASA must be returned as the leader of the civil space program. If this correction occurs many of the issues confronting the program will be very positively addressed. If not, the outlook is discouraging.

The Authorization Act of 2013 will be important in achieving a positive trajectory correction for NASA and the civil space program. It is hard to overstate the need for a program that is focused upon the highest priority opportunities, a program that is consistent with available funding and a program with leadership vested in NASA.

Great nations do great things. The United States is a great nation and I continue to believe the civil space program is a great thing.

Thank you.

A. Thomas Young

A. Thomas Young joined NASA in 1961. He was Mission Director for the Viking Project, Director of the Planetary Program, Deputy Director of the Ames Research Center and Director of the Goddard Space Flight Center.

Mr. Young joined the Martin Marietta Corporation in 1982. He is the former President and COO of Martin Marietta. He retired from Lockheed Martin in 1995.

Following retirement, he has been on Corporate Boards and lead numerous Committees and Review Teams associated with national security and civil space.

Mr. Young is the former Chairman of SAIC.

Mr. Young is a member of the National Academy of Engineering.

Chairman PALAZZO. Thank you, Mr. Young. I thank the witnesses for being available for questioning today, reminding members that Committee rules limit questioning to five minutes. The Chair will at this point open the round of questions. The Chair recognizes himself for five minutes.

One of the first questions I asked Administrator Bolden at our NASA budget hearing earlier this spring was whether the President's budget request would cause a slip in the schedule for the Space Launch System. Administrator Bolden replied that it would not. After looking at the budget request, however, it became apparent that if this was indeed true, the funding levels were barely enough. That is why the discussion draft before us calls for an increase of $70 million above the Administration's request.

Mr. Young, what funding levels are necessary to maintain the current SLS schedule?

Mr. YOUNG. I really can't answer that question, but I do have some comments on the question. One of the things that is in the authorization bill and I pointed out is that go-as-you-pay is a useful concept when you are deciding when to start a project, but when you are implementing a project, it is a most wasteful concept, and I think if SLS falls into the mode of a go-as-you-pay program, then it is going to be highly inefficiently implemented, and what really happens in a go-as-you-pay concept when you are implementing a program is, good people accomplish all the work in a given Fiscal Year that they can for the money that is available. What they can't accomplish, they move to the right, and this accumulates into schedule delays but it is even more significant that you don't accomplish the program in the most efficient manner and you probably end up with a lot of programs doing one program for the price of two. So I applaud your focus on this issue of assuring that the SLS funding is appropriate to implement a program in the most efficient manner. I am just not in a position to make judgment of exactly what those dollars are.

Chairman PALAZZO. Dr. Squyres, do you have anything to add?

Dr. SQUYRES. Yeah, I think the thing I would add to this, and I have mentioned this to this Committee in the past, is that the real issue to me is not when the first flight of SLS takes place, it is the flight rate thereafter. And if you look at the projected budget and what it implies in terms of the projected flight rate for SLS, you wind up with a flight rate that is almost an order of magnitude lower than what was done for, say, the Saturn V system back in the 1960s and early 1970s. We have no experience with a human-rated flight system that only flies every two or three or four years, and I believe that is cause for serious concern. It is not just simply a matter of maintaining program momentum. It is not even purely a matter of efficiency. It is also largely a matter of just keeping the flight team sharp and safe and mission-ready. So I am deeply concerned about the flight rate of that system.

Chairman PALAZZO. Can NASA afford to develop the 130-metric-ton variant right now or will it have to focus on the 70-ton version? Does anybody want to—no comments on that? We will work that one out later. It keeps popping in my mind. Now, this is something I think you all can elaborate on. Now, the discussion draft includes the requirement that NASA build a Mars human exploration road-

map. Are there any additional requirements for the roadmap that you think should be added? Dr. Squyres?

Dr. SQUYRES. Actually, I think the roadmap requirements in the bill are overconstrained. What I mean by that, I think the idea of establishing a roadmap for human exploration to Mars is great. It is one of my favorite provisions in this bill. But I think it would be best to allow NASA to do that, to work out that roadmap and its technical details and find the best way to achieve that and then come back with a set of recommendations of what the intermediate milestones should be. As written, the bill prescribes certain milestones, for example, sustained presence on the surface of the Moon, which as the Ranking Minority Member of the full Committee noted is an unfunded mandate. It also says that we should not do certain things along the way. I think, and I agree with Tom on this, that allowing NASA to take the first steps towards establishing what the roadmap should be using the technical expertise that resides within the agency would be an appropriate way to go forward.

Mr. YOUNG. I too applaud the roadmap. I mean, I think we are badly in need of a human exploration strategy. I think that the concept of doing the roadmap, NASA leading it, is good, giving NASA as much flexibility as can be and putting together is also good. You will always have an opportunity to critique the products as they come out. The only thing I would add to what Steve has said is that it is also got to be a roadmap that gives appropriate recognition to budget, and what is realistic and what is not realistic, and I don't mean to overconstrain you by that because if I had the job, I would look at options and various levels to understand what we can do, you know, at various levels. But a strategy without the resources to execute the strategy or a roadmap without the resources to execute it is simply a hope as opposed to something that is realistic. So we have got to put it in the context of what is realistic to be implemented. But personally, it is the objective—I was sitting thinking as Steve was doing his testimony, I don't know how long I have been associated with Mars but I almost have three children: Carter, Blair and Mars.

Chairman PALAZZO. Thank you for your comments. I now recognize Ms. Edwards for five minutes.

Ms. EDWARDS. Thank you, Dr. Squyres and Mr. Young. It is always good to have you here, and I just really appreciate the value that you provide for the Committee. As I read your testimony and listened to you today, what I heard is that I think we actually can agree on some of the broad concepts of the bill including identifying a roadmap to Mars as we just discussed, maintaining a balanced and steady agenda for NASA's programs as a multi-mission agency, and taking a look at how we can assure the effectiveness of the agency's leadership in maintaining a long-term vision. But there are some aspects of the draft bill that I think are really problematic, and I wonder if you could discuss with some level of detail—and Dr. Squyres, you did, but Mr. Young, I wonder if we could have a comment from you about this idea of a sustained presence on the Moon and Mars. Because there is where I do think that there is, you know, some significant division in the details, and I wonder if you might comment as well about some of the things that we could

ask for in a roadmap and a timetable that would allow us a Committee to look at what NASA is doing and ask those questions in detail without prescribing the scientific detail for the agency.

Mr. YOUNG. The comment I would make on the Moon question that you have is the following. I do not believe that landing on the Moon or operations on the Moon is a prerequisite to going to Mars. So if Mars—you know, given Mars as the focus, then it is not necessary? And it is probably a significant resource consumer that will take away from the time and the effort to go to Mars.

I also don't want to imply that the Moon is a useless location, and so that is not, from my standpoint, meant to be implied at all. I mean, I think there is enormous, you know, research, understanding and benefit that can be derived from a mission to the lunar surface. I just think that if our focus is on Mars, it is not a necessary prerequisite and it is an enormous consumer of resources including time, and it really takes away from the basic thrust of a Mars roadmap.

Ms. EDWARDS. Dr. Squyres?

Dr. SQUYRES. Well, I certainly agree with Tom that the reason to go to the surface of the Moon is not to help us get to Mars; it is to go to the Moon. With respect to what you could ask for in a roadmap, certainly asking what are the appropriate technologies is the right thing to do, certainly asking what vehicles, what specific pieces of hardware are appropriate to get the job done, and then I think there are a range of different milestones that could be looked at. Clearly, lunar orbit is a sensible first milestone. Whether there is a rock there that has been directed from, you know, an asteroid that has been brought in or not, it is the right place to go. The other milestones you could look at include the lunar surface. They include a near-Earth object of significant size. They include the moons of Mars, Phobos and Deimos. They include operations in Mars orbit, which is clearly going to be necessary.

So I think you could lay out the range of possible milestones and ask the agency, okay, with these possibilities, what are the right ones that will get us most efficiently to the long-term goal, and then what are the specific technologies, what are the specific pieces of hardware that are necessary, and one other thing that I would add is that I think it would be valuable to ask the agency and more broadly ask the question, once we have identified the vehicles, once we have identified the technologies, are there ones in there that could be sensibly provided by an international partner to help spread the costs.

Ms. EDWARDS. Thank you very much, because I think that would help us actually develop an authorization that would be useful to the agency without us, as lawmakers without the requisite experience, pointing out the details of what it is that the agency should do. So I appreciate that.

I want to ask you very quickly, both of you, the draft bill proposes to make drastic cuts in NASA's Earth Science program at a time when natural disasters here at home in the United States and abroad are wreaking havoc on individuals, businesses, municipalities, the entire economic system, and so I wonder if you could share with me what you think the proposed cuts in the legislation mean

to our ability to understand, predict, monitor and respond to natural disasters and to climate change.

Dr. SQUYRES. I am deeply concerned about the magnitude of the proposed cuts to Earth Science, just as I was deeply concerned about the magnitude of the proposed cuts to Planetary Science in the Administration budget. There needs to be a balance found. There needs to be a compromise found in which the cuts if they have to be directed to Space Science are spread more sensibly across the different disciplines.

With respect to Earth Science, the National Research Council's Decadal Survey for Earth Science has very nicely spelled out a sequence of missions, a series of activities that could be conducted by NASA studying the Earth from space and those have broad benefits both in the specific areas that benefit humans that you outlined but also just across the broad sweep of understanding the Earth as a complex system. The climate system, the geology of the Earth, the oceans, the sea ice, all of this are interconnected in a very complex way, and these missions are necessary to understand that system, and there are unexpected discoveries awaiting. There are unexpected consequences of flying these missions, and——

Ms. EDWARDS. Thank you. I appreciate that. I think I am actually out of time, so we will let somebody else continue.

Dr. SQUYRES. I could go on on that one for a long time.

Ms. EDWARDS. I know that you could. I apologize. I have to slip out for a bit but I will be back.

Chairman PALAZZO. And we could listen for a long time. I would like to say this bill does not require NASA to establish a Moon base or lunar outpost. In fact, the 2005 and 2008 NASA Reauthorization Acts required NASA to establish a sustained human presence on the Moon and authorized NASA to establish a lunar base. This bill authorizes NASA to continue those pursuits already in existing law and to plan for eventual missions to Mars. So if there was any confusion, I want to clear that up.

I now recognize Mr. Brooks.

Mr. BROOKS. Thank you, Mr. Chairman.

By way of background, I represent Alabama's 5th congressional district, the home of the Marshall Space Flight Center, and quite frankly, the birthplace of America's human spaceflight program. The Marshall Space Flight community plays a pivotal role in the development of America's Space Launch System, the next-generation rocket system that empowers America to return to exceptionalism in space and stop the current rather humiliating situation wherein America is reduced to having our astronauts thumb rides with the Russians.

The people in my district who either have a keen interest in SLS or who are responsible for building the next-generation SLS rocket system have had scant time to review the draft NASA Authorization Act of 2013. The early response, however, to these reviews have been, to put it mildly, most disconcerting, so disconcerting, in fact, that unless I receive differing expertise that satisfies me that our words and support of human spaceflight match our actions and deeds, I will have no choice but to vote against and otherwise oppose this Authorization Act.

In that vein, I seek today's witnesses' expertise and insight in hopes that it will help satisfy these concerns. Page 5 of the draft discussion bill states, "$1.454 billion shall be for the Space Launch System." Have either of you had communications with any private-sector contractor who is responsible for building the next-generation SLS rocket to determine whether they can meet their 2017 launch deadline if they are authorized only $1.4 billion in FY 2014? And if so, who have you spoken with, what have they said? Mr. Young, have you?

Mr. YOUNG. I have not.

Mr. BROOKS. Dr. Squyres, have you?

Dr. SQUYRES. No, I have not.

Mr. BROOKS. In that vein, let me share with you some of the concerns that I have had shared with me from folks in my district. The first one is a gentleman that I am sure you are very familiar with. I have a letter from former NASA Administrator Mike Griffin dated today, June 19, 2013, at 6:11 a.m. He is doing this while he is at the Paris air show in Europe. Dr. Griffin states in part, and I quote, "I wish to express my concern over the proposal to authorize 2014 funding for the Space Launch System at a level of $1.45 billion. It is not adequate to develop the launch system that was approved by the Congress in the NASA Authorization Act of 2010. Development of the SLS that was mandated by the Congress requires a 2014 authorization and appropriation of $1.8 billion." I repeat that: $1.8 billion. "Specific requirements which cannot be met at this level," cannot be met at this level of $1.45 billion, "include, one, concurrent development of the upper stage required to meet the 130-metric-ton floor for human exploration capability that was mandated by the 2010 Authorization Act; two, schedule protection for completion of core vehicle development by 2017, again, a requirement of the 2010 Act; three, completion of the interim cryogenic propulsion stage by 2017 necessary to reach the initially planned SLS capability of 70-metric-tons; four, continuation of advanced booster development."

I also have a much more candid, and I have excised parts of it for family consumption, communication from a former well-respected NASA employee. This person states, "I have reviewed the draft authorization bill. I really seized up over the amount for SLS. It is too low. I have been talking for months now with the principals on the program on just this point, and the money they need to have a healthy program is $1.8 billion to the project manager for the rocket, not money to JSC, Johnson Space Center, for Orion, not money to Kennedy Space Center for ground facilities. These latter things are good to do, no question, but without the launch vehicle itself, they are irrelevant. As important as building the rocket is building the right rocket, the 130-metric-ton version, not the half-capable 70-metric-ton first step that Lori Garver and the Obamas want to settle for. That version is quintessential white elephant. It is twice as big as what you need to get to low orbit to service the International Space Station, and thus very inefficient for that application, and half what you need for human space exploration and thus inefficient for that application as well."

Mr. Chairman, I urge this Subcommittee conduct as many hearings as are necessary to determine whether $1.4 billion is adequate

to construct the Space Launch System rocket and restore America's exploration in space as scheduled or is merely a painkiller given to a terminal patient to ease the cause of death. That having been said, with respect to these two communications, do you all have any reaction?

Mr. YOUNG. I do. Mike Griffin, that was probably in his afternoon work even though you had it at 6 a.m. Yeah, my comment is the following. We actually know how to estimate the cost of these programs, not with great precision but within, you know, the realm of what is necessary for budgeting, and so this is really an example of some of the things I was talking about and have testified before previously. We have the ability based on experience to do a reasonably credible cost estimate for projects like SLS. We can do it in a statistical manner, and we know that for a standalone project, the most probable result is the 80/20 statistical number, a lot of history on that. I mean, I have looked at NRO data, I looked at NASA data, Air Force data, as others have, and that is the point at which you determine the most probable cost of a program. The next more important item is that the 80/20 not just be a total but it be 80/20 every year, because if I put all of my reserve and contingency into the program, I may feel good about the total but I have done nothing, which is probably what these letters are implying.

So my recommendation or comment to you would be, get a credible organization who knows how to do independent cost estimating and get them to do an independent cost estimate for the SLS given the launch date that you want to specify and they can assess the realism of that and they do it at an 80/20 level and then you can really assess where the budget is relative to the reality as to what the program would cost. But I want to emphasize, we know how to do this. This is something that we really have developed a real capability for in the recent times.

Chairman PALAZZO. Thank you, Mr. Young. Dr. Squyres, out of consideration for the other members that are here, I would like to ask the members again to try to keep their questions and comments to five minutes.

I now recognize Mr. Kennedy for five minutes.

Mr. KENNEDY. Thank you, Mr. Chair, and thank you once again to our witnesses for testifying yet again before the Committee. A couple of questions to broaden the base a little bit here.

For both of you, just to start, you mentioned in the Administration's—you each mentioned this, the Administration's STEM education reorganization proposal as an issue moving forward. In my district back home in Massachusetts, we have a number of programs that have been highly successful in reaching students of all ages and getting them interested in STEM fields. I share some of your concerns about potentially reorganizing these programs and losing the expertise of issue area specialists. I visited at some vocational schools that have amazing partnerships with NASA in getting kids really excited about fields of engineering and exploration, and I think we can all agree that increasing the effectiveness and efficiency for Federal STEM efforts is something worth pursuing. Do you have any recommendations or any suggestions on how NASA can improve its education and outreach priorities going forward?

Dr. SQUYRES. I believe that the Administration's proposed reorganization of STEM education at NASA is deeply misguided. NASA is a unique organization within the government. It flies missions into space, and the technical audacity of those missions and their capability to inspire are virtually unmatched in terms of what this government does and its ability to get young people turned on by science, by technology. And to take that responsibility, the responsibility for sharing that capability with the public away from NASA and give it to, I don't care, any organization that doesn't do spaceflight I think is a bad idea. The thing that makes NASA's education outreach programs as effective as they are is that they are conducted by people who have not only a deep knowledge about what they are doing but a passion for sharing it. And you listen to some of NASA's scientists and engineers talk with young people about how excited they are about what we get to do for a living. You know, this is compelling stuff, and to take that away from the agency and hand it off to an organization that has no experience flying stuff in space I think is just a bad mistake.

Mr. KENNEDY. Fair enough. Anything you want to add sir? No? Great.

Then moving on, I would like to hear a little bit more about your thoughts on the Space Technology provisions of the bill. As I understand it, authorization levels included in the draft are obviously much lower, and the program would need to be adjusted to support exploration-related technology development by moving much of the funding to support the Human Exploration and Operations of Mission Directorate. How do you think this would impact the future development of space technology?

Mr. YOUNG. The thing I commented on is not so much the level of the program, because that is important, but it is very difficult for someone in our position to have gone through all the activities. But having been involved both in NASA and in the private sector for a long time, both operational missions and technology, the thing that has always struck me is that there is a constant debate, and that is, there is a motivation to try to align the technology with the management of the missions or the projects because that really makes it most relevant. I mean, no question, they are the users. The problem is when the crunch comes, and it always comes, the resources that are there for the technology gets used to solve problems on the missions that you are trying to execute, and I don't offer that as being wrong. I mean, that is the priorities that people have to take.

The other side of it is, if you put technology in a technology organization, there are some dangers there too because then the technology kind of creeps away from being as relevant as you want it to be. It falls more in the paradigm of building the technology budget as opposed to the overall balance of the activities, and it can kind of become an end in itself, as I commented.

So you have really got those two situations. There is not an optimum solution. Having watched it, lived it, seen the merits and the problems with it over time, I favor putting it in an independent organization, however, with a strong oversight capability——

Mr. KENNEDY. Sir, if I could——

Mr. YOUNG. —to assure relevance and to assure that it doesn't get out of control. The NRC or the Academies is a great oversight kind of an organization.

Mr. KENNEDY. I have got three seconds, but briefly, you both commented on the Asteroid Retrieval Mission. I seem to sense some skepticism from both of you on that mission. Are there other technological advances, are there gains that can be made if our overall goal, NASA's goal, is getting to Mars, that benefit from the Asteroid Retrieval Mission? And if you can, answer it in less than 10 seconds.

Dr. SQUYRES. I personally don't see a strong connection between the proposed Asteroid Retrieval Mission and sending humans to Mars, but I believe NASA should at least be given the opportunity to try to make that case. I haven't heard it yet.

Mr. YOUNG. My belief is that any technology that comes out of it, there are better ways to do it, and I am passionate as you go forward with the Authorization Act to utilize whatever resources are available on the highest-priority endeavors, and my judgment is, this is not a highest-priority endeavor.

Mr. KENNEDY. Thank you both, and thank you, Mr. Chair, for the flexibility.

Chairman PALAZZO. Thank you, Mr. Kennedy. I now recognize Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. We just heard from my colleague from Alabama that the SLS project needs to be funded, and Mr. Young, the people he was quoting are the people who know how to do these numbers, Mr. Griffin and the rest of them. They build the rockets down in his district and they say for this project to be sustainable and to meet the deadlines that we are doing, and that costs a lot more in the long run, as you pointed out, that we are going to need to spend $1.8 billion rather than what is being authorized, which is 1.4. It seems to me that that should be a warning sign for all of us that this project is going to cost a lot more money and that money has got to come from somewhere. The tooth fairy isn't going to leave it under our pillow, and all of this talk, we were talking about these other things that NASA does like whether it is inspire young people or whatever it is that NASA wants to do, that is going to suffer and it is going to go into this rocket, or the SLS Titanic, as I like to describe it, but this huge, massive rocket that our other witness, Mr. Young, has already stated he has studied and it has only got one or two uses that we are going to have out of that rocket.

Doesn't this mean that—frankly, I differ from my colleague from Alabama. I think all of this adds up to, we are on the wrong course and we should just get away, cancel this project. It is not sustainable and will drain money from every other thing that we want to do in space eventually, and worst of all, it may end up being canceled, as you pointed out so many times, Mr. Young. In the past, we have seen so many of these canceled after spending billions and billions of dollars right down the toilet.

I would like to ask Mr. Squyres, you have stated and we all seem to assume that getting to Mars as soon as possible has got to be our ultimate goal. That just seems to me that everybody is accepting that. I don't accept that. There are a lot of other things we need

to do in space before we need to get to Mars. But Mr. Squyres, do you believe that this massive rocket project that you seem to be skeptical about as well, is that a prerequisite to going to Mars?

Dr. SQUYRES. Certainly, some kind of heavy lift capability is a prerequisite to get to Mars. Mars is far away. But SLS—I said in my opening statement that I believe that the biggest challenge, the biggest problem facing the agency is that NASA is being asked to do too much with too little, and this mismatch between the amount of money that is necessary to do SLS right and the amount of money that is actually available is symptomatic of that. Both Tom and I in our opening remarks pointed out that we see some tough choices looming in the area of human spaceflight. We can afford to utilize the Space Station, which we have invested so much in, for as long as its operational lifetime. We can afford to develop SLS and to do it on a safe and reasonable schedule, but I don't see that we can do both, and so there may be some very tough challenges ahead for this agency and some choices to be made.

Mr. ROHRABACHER. There are other alternatives that are out there, and we do have a proven rocket system right now. We have people who have done a good job at producing Deltas and Atlas rockets that are very effective and very safe, and perhaps those systems can be used perhaps combined with a refueling system of some kind rather than spending the tens of billions of dollars that we are going to spend to have this one large system that seems to have one purpose.

Let me just note this. It was noted earlier how important human spaceflight is, and I agree that it is important that we do that, but NASA isn't the only one in this ballgame. There are two other programs that I know that are aimed at putting people into space, and it is not costing us the big bucks from NASA to keep people in space. I mean, we have got Dennis Tito out there and I happen to think that his project will inspire a lot of people. When you are talking about inspiring humankind and especially young people, I think Dennis' concept of sending a man and a woman around Mars, that is going to capture everybody's imagination. Let us hope he is successful, however.

And the other thing is SpaceX, of course, and others are putting money into developing a system much cheaper than what we are talking about here of putting people into space in turn for a number of purposes, one, to go to the Space Station, so we won't have to hitch a ride with the Russians. So when we look at this budget, we are going to be looking at these budgets, Mr. Chairman, and you are going to be looking at this budget—I don't know how much longer I am going to be around—but you are going to be around a long time and you are going to remember when we started this program and in the end, you are going to have to live through all of the cuts of everything else that we are going to have to cut to keep this giant rocket program going. There are other alternatives I think we should be looking at seriously. Thank you very much, Mr. Chairman.

Chairman PALAZZO. Thank you, Mr. Rohrabacher. I now recognize Ms. Wilson—or we will go to Mr. Veasey.

Mr. VEASEY. Mr. Chairman, thank you very much, and I wanted to ask Dr. Squyres and Mr. Young a specific question about the ISS

program. I know there has been a lot of comment on the intrinsic value and strength of the international partnership that the ISS program has engendered over the decades since the partnership was established, and what I wanted to know specifically from you is, how important is it to build on the ISS partnership in future human exploration endeavors?

Dr. SQUYRES. I think it is tremendously important. ISS is a technological marvel but it is also a management marvel. To have had that many nations work together so effectively to build such a magnificent piece of hardware, it is unparalleled I think certainly in the history of space exploration. And the International Space Station truly is international to a deep, penetrating degree. The entire system is deeply international and that is manifested in a whole bunch of different ways. I believe very strongly that in order for NASA to find a way to deal with the level of over-commitment that is expected of the agency, for NASA to be able to do the things out in deep space that we would like to see happen with anything like the budgets that we are talking about here, there has to be a really substantial international component to that. And so I think building on the partnerships that have been really established so effectively in the management of the International Space Station, it has really been a triumph, and I think trying to take that capability and extend it beyond low-Earth orbit is probably going to be absolutely necessary.

Mr. YOUNG. I really don't have anything to add. I think that is exactly right. I mean, you know, the international relationship aspect of it, it is hard to imagine anything more successful than the Space Station has been in that regard, and building on that and doing whatever the next major thing we encounter or we undertake I think is extraordinarily important.

Dr. SQUYRES. If I could just add one more thing to my remarks on that, and that is that if international partnerships are going to be a key element of our roadmap for exploration of deep space, it would make sense to involve our potential international partners in the development of that roadmap so that they have a sense of ownership of it.

Mr. VEASEY. What would be the impact of disrupting the partnership without a follow-on program?

Mr. YOUNG. It is a good question. It is kind of the nature of the business, I mean, you know, to have continuity is certainly a virtue but I would not make it a requirement. In other words, I think that, you know, we should collectively figure out the most important things to do and then how is the most effective way to execute them rather than say we have a workforce and we have an international partnership and now we have got to fill that international partnership. I don't know if that is very helpful, but that would be my general reaction.

Mr. VEASEY. Thank you, Mr. Chairman. I yield back the balance of my time.

Chairman PALAZZO. Thank you, Mr. Veasey. I now recognize Mr. Posey.

Mr. POSEY. Thank you very much, Mr. Chairman, and I thank both the witnesses, and if I heard you correctly, both of you place a high priority on human space exploration as being the number

one thing that we should be doing. If we started today, how long do each of you estimate it would be before we could place a person on Mars?

Dr. SQUYRES. With the current budget?

Mr. POSEY. Yes. Well, we can do it for starters. Give me a date with the current budget and a date with the Apollo-era budget.

Mr. YOUNG. With the current budget, bear with me, I would probably say never.

Dr. SQUYRES. I agree.

Mr. YOUNG. If you said, if we made this a national imperative, you know, to go do it, it took Apollo about eight years, if I recall correctly. I was around doing much of that activity, and, I mean, it was truly a national endeavor. Mars is harder. There are a lot of significant issues to resolve before going to Mars, but I think if we had the same national commitment to it, I would say 2025 we could land on Mars and return home safely to Earth.

Mr. POSEY. During Apollo, you were around and I was around, and that was done in ten years. I am told they could not repeat that performance today. I don't know whether it is true or not. And if you recall, that is when they carried around slide rules. The IBM mainframe was a quarter as big as this room and did about what you can get a little calculator to do for five bucks at Walmart today. It is amazing. It seems like we have regressed somewhat in some of our abilities.

Mr. YOUNG. Can I comment on that?

Mr. POSEY. Certainly.

Mr. YOUNG. I know I am eating into your time. It really builds on some of what I think it is important in this Authorization Act.

I actually think we could repeat that if we managed the enterprise today the way we managed it then, and I knew the leaders who were doing that, and we invested the authority and responsibility in the people executing the program the way we did it then. So I am not distressed so much that we don't have the raw material capability; I am distressed that we have a management process, oversight process, et cetera that complicates the world.

Mr. POSEY. Thank you. And we don't seem to have—I mean, we have seen polling, and I keep copies of it, 76 percent of the people thought the Shuttle was a good program, to some people today, a more recent poll, they rate their dislike of space funding next only to welfare, and that is not a good position for us to be in. I mean, it would be great if we could have—what is it—the Rice University speech the President gave: why go to the Moon. You know, if more of us could hear that kind of thing in this day and time and inspire a little bit more.

The President projects 2030, a quarter of a century from now, is when we could get to Mars, and the question is, do you think we could maintain the public's interest, if we even have it now, to take a generation to complete a mission, do you think without shorter, more precise, more exciting stepping stones?

Dr. SQUYRES. Well, I think that a necessary part, probably not sufficient, but a necessary part of maintaining public interest is in fact a focus on Mars. When the Curiosity rover landed on Mars recently, thousands of people showed up in the middle of the night in Times Square to watch it on television. People are actually cap-

tivated by Mars exploration. So I believe the focus on Mars is necessary. I am not sure that it is sufficient, and so as you say, the time scales are substantial and so I think having some compelling milestones along the way is an important part of the program as well.

I believe, and Tom and I, I think, are very of like mind on this, that it should be first and foremost left to engineers and scientists and managers at NASA to come up with the technically appropriate set of milestones, the ones that get us to the goal safely and efficiently, and then to have those reviewed carefully, both by organizations like the National Academy but also of course by the Congress and the Administration to make sure that they make sense in terms of maintaining the program.

Mr. POSEY. And I concur. You know, you just—we say on the one hand we need to have priorities. Then people say well, you need to balance your spending, you need to balance your spending, and I am just afraid we are going to end up making NASA a jack-of-all-trades and a master of none, and you are shaking your heads "yes." You have the same fears. Thank you.

Mr. YOUNG. Yeah, I am going to cheat, if I might. I think the other aspect of the milestones is, don't forget about the robotic program and the excitement that will go along with return of samples from Mars robotically, which I think a necessary prerequisite for the human program, and the idea of having a rover going out and collecting that sample and storing it somewhere where a vehicle is going to come along a few years later and pick it up and return it, I think you can build a lot of excitement around it.

And as long as I have cheated a little bit, you will remember Aaron Cohen, and Aaron told me one time—who was significant in the Apollo program. When we were talking about the Constellation program, he said we are about to find out how hard it really was to go to the Moon.

Mr. POSEY. Thank you, gentlemen. Thank you very much. Thank you, Mr. Chairman.

Chairman PALAZZO. Thank you, Mr. Posey. I now recognize Ms. Bonamici.

Ms. BONAMICI. Thank you very much, Mr. Chairman. Thank you both for being here today and bringing your expertise.

I just want to start by following up on Mr. Kennedy's remarks about the importance of STEM education. I just came from the Education Committee, where we are marking up a bill, and a lot of discussion about STEM education, and I just share the concern of making sure that we are engaging the next generation. I do want to note that NASA recently selected its trainees to become astronauts, and half of them are women. I think that is the first time that that has happened. We want to make sure that we have the next generation of astronauts and scientists and people who are interested in these fields. So I am very concerned about whether we are going to be through restructuring affecting those existing partnerships between NASA and other education groups and entities. So I want to share that concern, and I know you have commented on it.

I also want to bring up another thing. You know, many of us on the Committee do not have NASA facilities in our districts. We

might have involvement with programs like human spaceflight and missions to Mars just through subcontractors or others in the supply chain. But NASA has historically been a multi-mission agency with a balanced portfolio in human exploration, human spaceflight, science and aeronautics, and I know we are having conversations about whether those priorities should change, but because of that multi-mission history, I often discuss the importance of NASA's other missions including the Earth Science mission, and I know Representative Edwards brought this up. I am the Ranking Member on the Environment Subcommittee. I know the chairman was here. And the Environment Subcommittee has jurisdiction over NASA Earth Science programs, so cuts to those programs cause me some serious concern.

There is some significant national activity such as weather monitoring. Oregon State University, for example, receives funding through this program and the work that they do helps in that area. And according to the National Academies, NASA's aging Earth Observation System threatens a disruption in information that can help detect long-term climate trends that contribute to severe weather patterns. That affects not only space exploration but a lot of other issues as well.

So can you discuss the Authorization Act's reduction in funding for the Earth Science programs, for NASA's Earth Science programs? What impact might that have on long-term weather and climate forecasting, both within NASA and other agencies, and how important is that work to space exploration?

Dr. SQUYRES. Well, as I remarked in my opening comments, I view with considerable concern the deep cuts to Earth Science that are contained in the proposed Authorization Act. It is clear that the Administration and the Congress have, at least as Congress' views are expressed in this draft Act, very different views of how to allocate money within the Space Science enterprise at NASA. And on the Administration's side, I have seen what I view to be alarmingly deep cuts in Planetary Exploration which has been, I think, one of NASA's real shining successes in recent years. In this bill, the pendulum swings too far in the other direction, in my view, and has alarmingly deep cuts to Earth Science. If it is going to—if we are going to see a NASA budget, if we are going to see an authorization level that is consistent with sequestration sorts of budgets, clearly some tough choices have to be made. But rather than singling out any one scientific discipline for disproportionate cuts, which is what I am seeing on both sides right now, having those cuts sort of sensibly distributed across the Space Science enterprise I think makes more sense. It is going to fall on committees like this to come up with some compromises, and I urge you to try to do that.

To get specifically to your question, if you look at the suite of missions that were recommended by the Earth Sciences Decadal Survey from the National Academies, they would focus on understanding the Earth as a system, not just focusing on trying to forecast tomorrow's weather but trying to really understand the Earth's climate system, the Earth geosciences, to really try to develop a systems approach to understanding the Earth. And that is inevitably going to pay off in providing decision makers who are

wrestling with things like climate change with the kinds of information that would be necessary to make smart decisions.

Ms. BONAMICI. Mr. Young, you are nodding your head.

Mr. YOUNG. Yes.

Ms. BONAMICI. Thank you very much. I see my time is expired. I yield back. Thank you, Mr. Chairman.

Chairman PALAZZO. Thank you, Ms. Bonamici. I now recognize Mr. Stockman.

Mr. STOCKMAN. I have a quick statement to make about—I am feeling as NASA is more symbolism over substance, and we have gotten away from as you talked about in the 1960s where we actually did things. I think the reason the popularity has dropped is because a lot of people have no idea really what we are doing now, and it is kind of muddled, and we keep going off in these different directions, and I was wondering, what was the ratio of bureaucrats to engineers in the 1960s versus now?

Mr. YOUNG. I obviously——

Mr. STOCKMAN. I could do Jay Leno, I guess.

Mr. YOUNG. Yeah, I don't have that number. It is a great question. I will tell you maybe a little bit relevant to that because I grew up in NASA, and even up through some, you know, modestly senior positions on Viking program where they landed a couple spacecraft on Mars and be a director of Goddard, and I finished that, I went off to my next life in, like, 1982 or 1983. The amount of time that I spent doing other than what I would call important NASA science and engineering discovery research would have been single digit. I mean, you know, it was just not a factor. Now, don't get me wrong. I mean, OMB existed, you know, other organizations existed, but I—you know, my time and my dedication was 95-plus percent of doing science, engineering, research, discovery, whatever you want to call it. So I personally think that is a significant difference to what I observe today, and a source of enormous worry.

Dr. SQUYRES. Well, I don't have anything like Tom's depth of experience but in the 30 or so years that I have been in this business, I cannot recall a time when I have seen organizations like OMB exercising the level of oversight of minute details of NASA's program. I haven't seen that to this extent in the years that I have been in this business. And I think one of the things that characterized the early days that we are talking about here, the 1960s, was that we had government organizations like OMB and like the Congress providing high-level priorities for the organization and then allowing people like Tom when he worked for NASA to figure out how to actually implement those policies and carry them out in detail. There was a level of oversight, you know, give and take back and forth that goes with that but I think that the level of detailed oversight that I am seeing at the agency these days is certainly unprecedented in my experience. And I think in some respects—and Tom touched on this in his opening statement—this has been detrimental to the agency doing its job as effectively as possible.

Mr. STOCKMAN. I think it is kind of ironic hearing a government agency complain about government. I kind of like that idea.

I am just amazed. I am a little bit familiar with that, and I am amazed at the side roads we take, and I think it adds 50 percent or more in the cost of a program, or more. I mean, it is bizarre

some of the things that NASA is requested to do and that the employees are requested to do, the diversion of time. It is just amazing to me that we don't have the ability to trim that back, but if we could do it all across government, I think we would be much more efficient.

Mr. YOUNG. I think you are right again. You are talking about, you know, going by—the first large space project I worked on was Lunar Orbiter, a robot which was fundamentally aimed towards picking landing sites for Apollo and Surveyor. We signed a contract for it, and 27 months after that we were in orbit above the Moon, and people were a little upset because it was supposed to have been 24 months.

Mr. STOCKMAN. Well, and the last thing I got is a more parochial question. They are moving the Arc Jet facility, and I was wondering how that is going to impact future development or authority of other projects. Oh, you are not familiar with it? Then I will submit the question and you can research it.

I am extremely frustrated seeing firsthand the amount of tangential and what I call nonproductive compliance. It is over the top at NASA, and I just wish that somehow we could reduce that. Thank you. I yield back the balance of my time.

Chairman PALAZZO. Thank you, Mr. Stockman.

You know, there has been a lot of talk about priorities and missions without the proper funding, and I would just like to—I think this garners consideration, that as mandatory spending continues to erode important discretionary investments like NASA, we are forced to make very difficult decisions. This is unfortunately the reality we must face until the Federal Government can get its finances in order. That is why this discussion draft complies with current law, the Budget Control Act, which passed the Senate, the House and was signed by the President, and I do hope that we can get mandatory spending under control soon so that we can continue funding essential and discretionary programs like NASA, like national defense, like homeland security, without having these debates over making sure that we fund our priorities appropriately.

So I want to thank the witnesses for their valuable testimony and the Members for their questions. The Members of the Committee may have additional questions for you, and we will ask you to respond to those in writing. The record will remain open for two weeks for additional comments and written questions from members.

The witnesses are excused and this hearing is adjourned.

[Whereupon, at 11:32 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Squyres

House Subcommittee on Space
Hearing Entitled
"NASA Authorization Act of 2013"

Responses by Steven W. Squyres to
Questions for the Record
August 15, 2013

Questions submitted by Chairman Palazzo:

1. As mandatory spending continues to erode important discretionary investments like NASA, we are forced to make very difficult decisions. This is unfortunately the reality we must face until the federal government can get its finances in order. That is why the proposed NASA Authorization Act of 2013 complies with the law of the land – the Budget Control Act, which passed the Senate, the House, and was signed by the President. The proposed legislation does, however, allow for increases in the event that an agreement is reached in the future. Understanding that nobody is happy with sequestration, what impact would a failure to reach a compromise on mandatory spending reform have on discretionary spending - particularly NASA?

The impact would be severe. As I have stressed to this committee several times, I feel that NASA is being asked to do too much with too little, even at the budget levels requested by the Administration. Still lower funding levels would exacerbate the problem, and I fear that very painful choices could lie ahead. Can we continue to conduct robotic missions across all Space Science disciplines that are consistent with the NRC's decadal survey recommendations? Can we continue to conduct a healthy Aeronautics program? Can we continue to utilize ISS and develop SLS/Orion simultaneously in a safe and effective manner? A failure to address the problems imposed by mandatory spending cuts will mean that before long the answers to some of these questions may be "no".

2. Over the last five years, how much has the exploration budget for NASA gone down? How much has the Earth Science budget gone up since 2008?

I do not know either of these numbers precisely.

How many other agencies fund human space exploration?

None.

How many fund earth science?

Several, if "earth science" is broadly defined. However, most of these focus on terrestrial geoscience or on routine environmental monitoring (e.g., weather

observations). Only NASA funds the critically important space missions that explore more complex aspects of Earth System Science.

3. The first test launch of the SLS is in 2017 and the first crewed launch is in 2021. How could the draft bill be improved to ensure on-time development of the SLS system for these deadlines?

The best way would be to increase the top-line budget authorized for NASA, so that more funding can be directed to the SLS and Orion developments.

4. The current acquisition plan for the SLS calls for a flexible vehicle that starts with a 70 ton lift capability and evolves to a 130 ton lift capability. The final vehicle would require a new upper stage and advanced boosters to reach maximum lift capability. What further direction could Congress give NASA to ensure compliance with these requirements?

I believe that Congress has already placed more than enough constraints on the SLS program, and that to provide additional direction to NASA would be unwise.

5. You have noted your concern in the past that the launch rate for the SLS is very low. Is the risk associated with the low launch rate mitigated by building an anchor plan such as the Human Exploration Roadmap that gives specific planning guidance for future missions?

Not significantly in my opinion. The low flight rate is driven by inadequate funding levels, and I believe that it poses a significant risk regardless of the specific missions that will be flown.

6. The discussion draft includes a report for a study on the use of the SLS as a cargo vehicle for national security and science payloads. What other uses or customers for the SLS in the future should be included in this study?

I believe that national security and space science are the most likely additional uses for SLS in addition to human spaceflight.

7. NASA plans to do a test launch of the Orion in 2014 and then another in 2017 with the SLS. Should NASA be required to have the Orion dock with the station in 2017 to ensure appropriate pressure on the commercial crew providers to lower the prices?

No. In my opinion the 2017 Orion mission should be focused on tasks that will most advance its future contributions to deep space exploration.

Does the ability to launch Orion on an EELV put enough pressure on one commercial provider to possibly lower the cost of crew and cargo transfer services?

Transfer of crew and cargo to ISS is not the intended use of Orion. I believe that Orion development should focus on its intended goal of enabling deep space exploration. To also use Orion as a tool to further the aims of the commercial crew program would in my opinion place too many burdens on the Orion program.

8. You have stated your concerns about requiring NASA to do more than it has money to do. The stepping stone approach to exploration described in the bill is a framework for missions that could be funded individually and gradually. How can NASA use this roadmap as an anchor for proposing future missions and incremental steps to Mars?

As I stressed in my written and oral testimony, the key is to produce a roadmap that gets humans to Mars in the quickest, safest, and most efficient manner possible. The Agency's (and the Nation's) resources will be used most effectively if the roadmap concentrates on getting humans to the ultimate goal of Mars without unnecessary and costly distractions along the way. I urge the committee not to prescribe or proscribe any stepping stones in the roadmap a priori. Instead, I feel that NASA should be directed to achieve the high-level goal of getting humans to Mars, and that the Agency itself should be left to propose the most efficient roadmap toward achieving that goal.

If you were the administrator, who would you include in the team to design this roadmap?

I would include capable engineers, scientists, and managers from within the Agency, perhaps augmented by a few retired senior NASA personnel who could bring in an experienced and independent perspective.

Do you think NASA needs to be directed to include certain people or experts on the team?

No.

9. The discussion draft authorizes $700 million for the commercial crew program and requires quarterly reports to the committee from NASA on its progress as well as specific metrics for success. What additional information would you require from NASA in these reports, if anything?

I believe that the report called for in the draft authorization bill is adequate and appropriate as described.

10. The discussion draft does not include a requirement to down-select immediately but allows NASA to make the determination as to when and how to down-select for a provider. Does this flexibility create too much risk to the flight readiness deadline or should NASA be required to follow a specific down-select

schedule?

I believe that it is best to allow NASA to determine the appropriate schedule for the down-select. While I would like to see the down-select happen as soon as possible, external imposition of a timeline, even though well intentioned, could have the undesirable consequence of creating schedule pressure that could adversely affect safety.

11. There are currently no requirements in the discussion draft for NASA to evaluate the commercial providers in the final stages of selection under any specific criteria. Should Congress direct NASA to evaluate the systems available for contract based on a specific set of criteria?

No. NASA has the necessary expertise in this area, and in my opinion they should be responsible for establishing the appropriate evaluation criteria.

12. The draft bill directs NASA to "ensure that the development of the Wide-Field Infrared Survey Telescope (WFIRST) continues while the James Webb Space Telescope is completed." Is it appropriate for NASA to conduct preliminary pre-formulation review for WFIRST if doing so would not impact JWST, or be cost prohibitive?

Yes, although I believe that the severe budget constraints that exist within the Science Mission Directorate will mean that a study of WFIRST that is not cost prohibitive will be very modest in scope. And note that I take "cost prohibitive" to mean having an unacceptably adverse affect on any science in the SMD portfolio, not just on astrophysics.

Is it common for NASA to begin studying follow on missions while concurrently developing other systems?

Yes.

13. The International Space Station is a time-limited asset. Rather than providing a specific date for the end of station, the discussion draft directs NASA to develop a set of criteria on how to define it as a success. Are there any considerations unaddressed by the report required?

I note that the requirements for the report make no mention of the contributions that international partners make to this highly international enterprise. I think it would be good for the report to explicitly address the roles that NASA anticipates international partners will play in both defining and achieving research success on ISS.

14. There is currently no thorough plan for utilization of the International Space Station by all government agencies that could have an interest in doing so. What

would you add to the report required in the discussion draft for development of this plan?

Nothing – I think it is adequate as currently conceived. I was particularly pleased to see the emphasis on consistency with the priorities identified in the decadal survey on Biological and Physical Sciences in Space.

15. Part of the budget request this year includes an additional $20 million for the Near Earth Object Observations program. This money is supposed to be used for additional telescope time, for detection of candidate asteroids for a retrieval mission. The discussion draft permits NASA to continue its work to track and categorize those objects that are most hazardous. Are the restrictions in the draft bill enough to ensure NASA is focused on finding those objects which present the greatest threat or should there be additional direction?

I do not feel that there should be additional direction.

16. The Administration's budget request proposes transferring the Radioisotope Power System development infrastructure from the Department of Energy to NASA. A 2009 report from the National Academy of Science titled "Radioisotope Power Systems: An Imperative for Maintaining U.S. Leadership in Space Exploration" found that "roles and responsibilities as currently allocated between NASA and the Department of Energy are appropriate, and it is possible to address outstanding issues related to the short supply of Plutonium 238 and advanced flight-qualified RPS technology under existing organizational structures and allocation of roles and responsibilities."

a. How is NASA qualified to manage, fund, and maintain the facilities and production of Plutonium 238?

NASA's experience in this area is limited, and under the new arrangement I feel that lack of experience is a potential cause for concern.

b. What are some of the possible repercussions from NASA taking over production responsibility of Plutonium 238 from DOE?

That is difficult to predict. If things were to go poorly, a possible repercussion would be that the necessary ^{238}Pu would not be available on the required schedule. I do believe that the new arrangement is potentially workable, but it strikes me as non-optimal and warranting close attention.

17. How important is it to follow the National Academies' decadal survey recommendations for a steady cadence of large, medium, and small astrophysics missions?

The decadal survey recommendations represent the carefully considered

consensus views of the astronomy community. So I believe that following decadal recommendations is of critical importance to astrophysics, and indeed to all of space science.

What are the potential consequences for disregarding their recommendations?

Loss of important science.

If budgets do not allow for the existing mission portfolio, what is more important to keep on track - large, medium or small class mission?

All mission classes contribute, each in their own way. Small missions provide a steady flow of data, and allow rapid follow-up to recent discoveries. Larger missions can make particularly important discoveries that smaller missions cannot. So it would be a mistake in my opinion to target a specific class of missions for disproportionate cuts. Instead, it is important to maintain a balance across mission sizes.

18. What is the single most important technological advancement that is needed to further exoplanet research? What advancement should be our highest priority?

My personal choices would be advanced coronagraph technology for starlight suppression, and space-based interferometry technology, particularly in the mid-infrared. However, a better way to get a good answer to this question would be to canvass the exoplanet science community, rather than asking a single space scientist.

19. What role should NASA's suborbital and Explorer programs play in exoplanet exploration?

One potential use for suborbital programs (sounding rockets and balloons) would be as low-cost testbeds for exoplanet instrumentation ultimately intended for orbit. There may be other innovative uses as well. And clearly important exoplanet research can be done by Explorer-class missions, as shown by the recent selection of the Transiting Exoplanet Survey Satellite for flight.

Are there any NASA missions not currently used for exoplanet research that could have exoplanet applications?

There are none that I am aware of.

20. The Space Telescope Science Institute indicated that a telescope larger than the James Webb Space Telescope is needed to detect biosignatures from terrestrial-like exoplanets. They also indicated that a heavy launch vehicle such as the Space Launch System is needed to launch a spacecraft of this size. How does the development of the SLS enable future exoplanet discoveries?

A monolithic very large telescope could indeed be enabled by a heavy-lift capability of the sort offered by SLS. However, such a telescope is not the only potential approach to investigation of earth-like exoplanets. Other potential options that could make use of smaller launchers could involve a free-flying constellation of station-keeping spacecraft, or a fixed interferometer assembled on orbit.

21. What it the most significant challenge facing completion of the James Webb Space Telescope by its launch date of 2018?

The re-baselining of the JWST program has brought the development back on track. While it remains one of NASA's most challenging programs, at this point I see no one challenge that stands notably above all others.

22. What is the significance of ensuring that early-stage development of the Wide-Field Infrared Survey Telescope is funded as the James Webb Space Telescope enters its operational phase?

To do so would make progress toward implementing the highest priority large astrophysics mission identified in the most recent astronomy decadal survey. As I noted above, however, the costs of doing so will have to be balanced carefully against the rest of the NASA Space Science portfolio.

23. The recent Science Definition Team (SDT) for the Wide-Field Infrared Survey Telescope Project reported that "if used for a mission, the 2.4-meter telescope [donated by NRO] would be significantly more capable than the smaller versions of WFIRST studied in previous SDTs." In the June 10,2013, edition of Space News, Dr. John Grunsfeld, Associate Administrator for the Science Mission Directorate, said that WFIRST built with the 2.4-meter NRO telescope would cost "between $1.5 billion and $1.7 billion." Given cost estimate challenges with other large NASA projects, including the James Webb Space Telescope, how confident are you that this cost estimate is close to being accurate?

I cannot answer this question, because I do not know what cost estimation methodology was used to arrive at the numbers quoted by Dr. Grunsfeld.

24. How can NASA expand its collaborative public-private partnerships with private sector organizations in order to study life's origin, evolution, distribution, and future in the Universe?

The best scientific work in this area is being done under fundamental research grants funded by NASA's Space Mission Directorate. These grant programs are heavily oversubscribed, with low proposal selection rates. If the goal is to further Astrobiology research, I believe that the best approach is to increase Astrobiology funding within SMD.

25. Over the past 50 years, robotic planetary missions have opened up the solar system. Few programs are as visible, inspirational, or scientifically important as NASA's planetary program. Yet, the FY14 budget continues the disproportionate and deep cuts begun in FY12 and FY13. The FY13 request alone represented a 20% cut ($300M) to the program, and FY14 fundamentally continues that path, despite Congress' current objection to this path in the FY13 Appropriations bill. NASA's behavior seems to indicate a "going out of business" philosophy with few new missions slated for full-scale development, and eventual withdrawal.

a. Why has the planetary program been singled out for such significant budget cuts?

I do not know. Given the highly successful nature of the planetary program, singling it out for deep cuts does not make sense to me.

b. Do you believe that the U.S. should cede its leadership in solar system exploration?

No.

If not, what should be done to ensure that NASA implements a program consistent with the priorities in the decadal survey?

Necessary funding cuts should be distributed sensibly across the Space Science program and the agency, and should not fall disproportionally on any single Space Science discipline.

c. How will the proposed cuts to Planetary Science impact specific missions?

The answer to that question would depend very much on how the cuts were implemented. One obvious program-level impact is that the selection rate of future Discovery and New Frontiers missions would be dramatically reduced.

d. How would restoration of funding levels impact Planetary Science specific missions?

Again, the answer to that question depends on the implementation of the cuts. One important outcome of such a restoration would be that Discovery and New Frontiers selection rates could be kept more nearly in line with decadal recommendations.

26. Do we have the tools and technology necessary to detect all near-Earth objects that threaten the planet?

We have the technology, but that technology has not yet been fully implemented

to create the necessary set of tools.

27. Why is NASA choosing to move forward with an Asteroid Retrieval Mission – a mission of debatable merit – at a cost several billion dollars, while longstanding priorities of undeniable scientific value and comparable cost, such as a robotic Mars Sample Return or a mission to Jupiter's moon Europa, are passed over?

The Agency has made it clear – correctly so, in my opinion – that it does not regard ARM as a scientific mission. So I believe that the Agency is moving forward with ARM because of the contributions they feel it will make to advance human spaceflight, not science.

28. Both Dr. Holdren and Administrator Bolden testified to our committee in March that we have a long way to go to accomplish the goals established by Congress in the NASA Authorization Act of 2005 of detecting 90 percent of the near-Earth objects with a diameter of 140 meters or greater by 2020. What are the most important steps that should be taken in the next five years to accomplish these goals?

There should be increased emphasis on and funding for ongoing programs such as Pan-STARRS, LINEAR, LONEOS, NEAT, Spacewatch, the Catalina Sky Survey, etc. There should also be strong continued support for the ongoing development of the Large Synoptic Survey Telescope (LSST).

What size object should we be monitoring and tracking? Is 140 meters still an appropriate minimum size, or 'should we lower that threshold?

Clearly objects significantly smaller than 140 meters can have serious consequences, as was shown recently in Chelyabinsk. However, I feel the primary emphasis for now should be placed on more fully utilizing facilities now online, and effectively completing facilities now in development, rather than changing the threshold.

What costs would be associated with lowering that threshold?

This is difficult to guess, but again, I would not recommend changing the threshold.

29. Once we identify an object, what are our means of tracking it?

Objects can be tracked via periodic monitoring with optical telescopes, and (when close enough to Earth) with radar.

30. In keeping with the latest Planetary Science decadal survey, Congress provided direction in the FY13 Appropriations bill to begin work on a mission to Jupiter's moon Europa one of the most interesting destinations in the solar

system with vast ice-covered oceans that could potentially support some forms of life. (Language from HR 933 is below.) The bill provided $75 million in FY13 for such a mission.

What are NASA's plans to comply with this direction?

A pre-project team has been formed at the Jet Propulsion Laboratory, and is working to develop the Europa Clipper mission.

When might a mission to Europa be accomplished?

The earliest possible launch date is probably about 2022.

31. How could advances in astrobiology be affected if decadal cadences for astrophysics and planetary science are not followed?

They would inevitably be slowed.

32. NOAA recently determined that certain sensors on the Joint Polar Satellite System were not as important to keep on the satellite given difficult budget times. The Administration then directed NASA to pay for their development. Why should NASA pay for instruments that an operational agency decided were not important enough to keep?

A system like JPSS serves multiple uses. One is operational weather monitoring of the sort for which NOAA is largely responsible, and another is Earth System Science that is largely the purview of NASA. A sensor that does not serve important needs for one agency can serve important needs for the other – and all can serve important needs for the Nation.

33. The most recent decadal survey for Earth Science stated "[h]istorically, new Earth remote sensing capabilities have been developed in a process in which NASA develops first-of-a-kind instruments that, once proved, are considered for continuation by NOAA." The same report goes on to state that "Historically, NASA has viewed extended-phase operations for Earth-science missions as "operational" and therefore the purview of NOAA." Given the current budget situation, should this process be continued?

I would answer by quoting the same paragraph of the Earth Science decadal survey as quoted above: "[T]he compelling need for measurements in support of human health and safety and for documenting, forecasting, and mitigating changes on Earth creates a continuum between science and applications—illustrating again the need for multiple agencies to be intimately involved in the development of Earth science and applications from space." In other words, there are important roles for NASA to play in both sensor development and operations.

34. NASA has a long history of building Earth Science satellites such as LANDSAT and TIROS. Given the substantial increases in other agencies' budgets for earth science, what role should NASA play in developing these systems?

Where it makes technical and programmatic sense to do so, NASA could continue to do such work, particularly on a reimbursable basis.

35. Can NASA conduct a viable Aeronautics research program under the current funding levels? Will a program funded that the current level significantly contribute the U.S. aeronautics industrial base?

An Aeronautics program funded at current levels can be viable and can make significant contributions to aeronautics in the United States. However, in order to do so, the program must be thoughtfully crafted to fill specific high priority niches that are not addressed adequately elsewhere.

36. Are there any areas of Aeronautics research that NASA cannot afford, but would given more money?

There certainly are areas that would benefit from increased investment.

How would you prioritize those efforts, and what impact would they have on U.S. competitiveness in the aerospace field?

I would place highest priority on expanding Aeronautics investments in areas that leverage particular NASA strengths, both currently and historically. Examples include aeronautics autonomy research, research on unmanned aircraft systems and their integration into the national airspace, "green aviation", rotorcraft research, and hypersonic research. As just one example why such items are important for U.S. competitiveness, the top two rotorcraft providers to the U.S. civil market are European companies; the highest-ranking U.S. company is third.

37. How can NASA better coordinate with other government agencies regarding research areas that overlap such as rotorcraft, hypersonics, and supersonic research?

My sense is that the coordination with other government agencies in these areas is already good.

38. Despite receiving $1.1 billion over the last three years, the Space Technology program doesn't really have any success stories yet. The draft bill includes guidance on mission priorities for Space Technology. What else could the committee include to ensure the program is on track and producing results?

Technology development by its nature involves very long lead times, and three

years is not enough time to judge the success of a technology program. I believe that the authorization bill could best promote technology development by permitting long-term and broadly applicable exploration technology funding to be maintained in a separate organization, rather than moving it to the Human Exploration and Operations Mission Directorate.

39. In our most recent hearing about the future of human space flight, you mentioned that the most critical technologies to develop for human exploration to Mars included better entry, decent, and landing capabilities as well as advanced life support system. How could the draft bill be improved to ensure these two categories are priorities for technology development?

I do not believe that changes should be made to the bill to establish specific priorities for exploration technology development. Instead, I feel that these priorities should be set within the Agency, consistent with the content of the exploration roadmap called for in the bill.

40. The Administration's proposal would consolidate, or effectively terminate, numerous small STEM education activities that are embedded in larger NASA research programs. Their funding would be redirected to other agencies to pay for a smaller number of larger STEM education activities that will likely not be embedded in research programs. What does the termination of these small STEM programs mean to the larger research programs, and the research communities that support them?

The termination would have little detrimental effect on the research done by the large programs themselves, but in my opinion they would have an enormously detrimental effect on the efficacy of STEM education in the U.S.

What are the advantages and disadvantages of embedding STEM education programs within research programs?

The enormous advantage is that the education programs are run by people with deep knowledge about and passion for the subject matter.

Do you agree with the proposed consolidation or termination of these STEM programs?

No.

41. In your opinion, what are the strongest STEM programs that NASA offers?

The ones directly associated with and carried out by its active space flight projects.

42. What has been the reaction to the Administration's proposed STEM

education reorganization plan within the scientific community? Have scientists expressed concern that the programs that inspired their commitment to science and exploration may be threatened?

In conversations with my scientific colleagues, I have encountered widespread and deep concern that the proposed reorganization would adversely affect STEM education in this country.

43. NASA programs account for nearly half of the programs whose funding would be "redirected" to other agencies under the Administration's proposed STEM reorganization. Why do you think such a large number of NASA STEM programs have been targeted for consolidation? .

I suspect that the number is large simply because NASA has many such programs – more than most other affected agencies.

44. Is a six year term appropriate for the NASA Administrator? Should it be longer or shorter? Is a term even necessary?

While I think history shows that six years is a reasonable length of time for a NASA Administrator to serve, I do not feel that a fixed-length term for the Administrator is necessary.

45. How would the requirement to report to both the President and the Congress impact the advice provided by the NASA Advisory Council?

I think it would help force it to be balanced and actionable, since it would have to be responsive to the concerns of both branches of the government. (I note here, as I did in my written testimony, that the "NASA Advisory Council" called for in the draft authorization bill is distinct from the group of the same name that I currently chair.)

46. How would termination liability relief impact current NASA programs?

It could increase the amount of funding that could be applied to program development, although at some difficult-to-quantify risk of incurring termination costs that would require additional funds to be appropriated by Congress.

47. Should Congress consider permanently extending indemnification?

I assume that this question refers to commercial launch indemnification. Such indemnification has significant benefits, in that government risk sharing with commercial launch providers can help spur growth of the commercial launch industry. Given the rapid pace of change in this arena, however, I feel it is probably best for Congress to re-approve commercial launch indemnification on a periodic basis, rather than extending it permanently at this time.

48. What impact would placing a cap on NASA's use of funded Space Act Agreements have on the agency? What is an appropriate level for a cap?

If such a cap were too low it could have a stifling effect on partnering arrangements. I have not gotten the sense that there is a need for such a cap, so I would not advocate setting one.

49. Should NASA conduct large scale development programs using Space Act Agreements?

In my opinion, very large scale development programs, like major new launch systems, are best implemented using more traditional contracting arrangements.

50. Would it be burdensome for NASA to post Space Act Agreements online? Would it be burdensome for NASA to post Space Act Agreements for Public Notice and Comment?

I do not know how much of a burden it would be to post such material.

51. Your testimony indicates that in order for NASA to accomplish all of the missions on its plate, it should look to a greater degree to international cooperation - specifically in the field of human exploration. Do you believe there are similar opportunities in other fields, such as earth science?

A growing number of nations have viable, exciting space programs. I believe there are opportunities for international cooperation in almost everything that NASA does, earth science included.

Questions submitted by Ranking Member Edwards:

• What are your views on the draft bill's proposed direction that NASA develop the WFIRST mission while continuing to carry out the James Webb Space Telescope mission for a 2018 launch date? Is WFIRST ready for development? Given the bill's proposed funding levels, can NASA make effective progress on two major missions?

The devil is in the details. WFIRST was the highest priority large mission in the recent astronomy decadal survey, and it could be brought closer to readiness for development by investments made in parallel with JWST development. However, costs must be balanced appropriately across all Space Science disciplines, keeping in mind the recommendations of all of the decadal surveys. Considering the high cost of JWST and the need for balance, the amount of significant work that could be done on WFIRST in a balanced program may be small.

• While the draft bill would authorize increased funding levels for Planetary Science over the President's request in order to restore cuts made in FY2013, is the funding in this 2-year draft bill sufficient for NASA to meet the cadence directed in the bill for small, medium, and large flagship missions in Astrophysics, Heliophysics, Earth Science, and Planetary Science?

I do not believe that it is.

• In your opinion, is the successful completion of a Mars Sample Return Mission necessary before sending humans to Mars?

No. In my opinion Mars Sample Return has very high priority because of its scientific importance, but I do not see it as a necessary precursor to sending humans to Mars.

Appendix II

Additional Material for the Record

SUBMITTED STATEMENT BY REPRESENTATIVE DANA ROHRABACHER

Opening Remarks from Mr. Rohrabacher
NASA Authorization Legislative Hearing
June 19, 2013

Thank you Mr. Chairman.

First, I would like to note that, while rebalancing our science portfolio is a good step, I believe it is time for us to have a serious discussion about whether or not Earth Science needs to be done by NASA at all, or if the other 12 federal agencies performing Earth Science can get the job done. I believe NASA should not be doing Earth Science, but should focus on its core and unique mission of exploring space.

Second, I received a letter from Dr. Bobby Braun, NASA's former Chief Technologist, and Professor of Space Technology at the Georgia Institute of Technology. The entire letter is included below, but here is a short passage –

> *Because the Space Technology account accommodates the SBIR/STTR programs and approximately 1000 civil servants across the Agency, a significant reduction in this account can only came from one place ... the higher TRL demonstratians ... eliminating the passibility for NASA ta make critical investments in the landing and surface technalogies required for its future human exploratian missions ... solar electric propulsion, cryogenic propellant storage and transfer, optical communications, solar sails, deep space navigation, rabotic refueling ... would all terminate prematurely. Such cuts will alsa sever the connections Space Technology has built over the last few years with industry and academia.*

Which leads me to the chosen architecture to meet our Exploration goals - I would like to note, once again, that I believe the SLS heavy lift launch vehicle to be both unsustainable and unnecessary to human exploration of the solar system. This heavy lift path we are on is the same strategy and same plan that doomed the Constellation program, but with less coherence. We are foolish if we do not expect the same results that we saw with Constellation.

The heavy lift strategy seeks to minimize the number of launches required for a given mission because of the assumption that rockets are likely to fail. That may have been true in the hottest days of the Cold

War, but NASA, DOD, and our commercial industry have worked diligently over these past decades to make certain that is no longer the case. Change may be difficult, but it is the strongest constant in the universe.

Let me briefly mention the NASA employees and contractors – the brilliant, hard-working, and dedicated men and women all across America – the failure of Constellation was not their fault. And the coming failure of the Heavy Lift Architecture will not be their fault. It is our fault – here in Congress, and at the White House, and NASA Leadership, for giving them goals that cannot be met with the resources we make available.

Orion can be launched on a Delta IV Heavy – we're scheduled to do it next year. That strategy, along with a little bit of new technology, can take us on a different path. We can build fuel depots in orbit – gas stations for spaceflight – which can enable all of our missions in LEO, to the Moon, to Mars, and beyond. We can develop and demonstrate the necessary technologies for less than one year's funding of the SLS.

Let's use our NASA teams across the nation to build and improve fuel depots, and to build the other components necessary for Exploration – deep space habitats, landers, propulsion systems. This approach will not only yield faster, less expensive human exploration of the Moon and Mars, but will enable a robust market for American launch vehicles – leading to safer, better, less expensive and more capable rockets. That is beneficial to our civilian space programs, and our military space programs. And it just might open up space to private individuals in ways never before available.

The strengths of America – liberty, individual initiative, the free-market capitalist system – can permanently expand humanity into the solar system under the rule of law. Sustainable space settlement must be our long-term goal, and that must inform our decisions now.

SUBMITTED LETTER BY REPRESENTATIVE DANA ROHRABACHER

Georgia Institute of Technology

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June 19, 2013

Congressman Dana Rohrabacher
2300 Rayburn House Office Building
Washington, DC 20515

Dear Congressman,

The attached narrative provides my view regarding the importance of Space Technology to our nation's future.

Unfortunately, the draft House of Representatives Authorization bill for NASA cuts NASA's Space Technology Mission Directorate by $243 million vs. the President's FY14 request, or 33%. This is also well below the FY12 and FY13 appropriated levels ($575M and $640M, respectively). This reduction will not place NASA on a path aligned with 21st century innovation and job creation and will instead do real harm to NASA's future exploration and science missions.

Since Space Technology houses the SBIR/STTR program and covers nearly 1000 civil servants, these cuts would have to come entirely from the Space Technology procurement budget, severing connections Space Technology has built over the last few years with industry and academia. In such a scenario, NASA's present work towards flight demonstration of solar electric propulsion, cryogenic propellant storage and transfer, optical communications, non-toxic propellants, solar sails, deep space navigation, robotic refueling, in-situ resource utilization, and supersonic aerodynamic decelerators would likely need to be terminated prematurely.

In my view, NASA is at a crossroads. We can attempt to rebuild the costly infrastructure of a historic, yet bygone era, or invest in new technologies that promise the capability to efficiently reach new vistas and increase the societal benefits that result from full utilization of space. A NASA that is reaching for grand challenges and operating at the cutting-edge is critical not only for our country's future in space, but also for America's technological leadership position in the world, and a robustly funded Space Technology account, authorized above $750M in FY14 and FY15, is central to that theme.

Sincerely,

Dr. Robert D. Braun
David and Andrew Lewis Professor of Space Technology
Georgia Institute of Technology
Daniel Guggenheim School of Aerospace Engineering
Atlanta, GA 30332-0150

SUBMITTED LETTER BY REPRESENTATIVE STEVE STOCKMAN

Statement Steve Stockman
Release of House NASA Authorization
June 19, 2013

This NASA authorization is essential guidance for an agency in crisis. The perception is of a rudderless agency stumbling around for a purpose—yet refusing to consider the only possible roadmap with will result in a successful Mars mission: build a modest lunar base which will teach us how to live on another world.

Without this authorization, a human landing on Mars will fail by not having first learned to live on another world.

Without this authorization, scarce resources and years of time will be spent on an asteroid mission which offers little of value in exploring deep space and living on the moon and Mars.

Without this authorization, our moon/Mars rocket; SLS and Orion, as well as our commercial launch services may be delayed or endangered.

Without this authorization, the International Space Station may not get the timely extension review necessary to offer launch providers and science users the certainty they need that the station will be there throughout the next decade.

Without this authorization, youth may continued to be uninspired to major in STEM for a career in the space program.

Most importantly, without this authorization, NASA and its employees may continue to twist in the wind without a clear vision and roadmap to the future.

I encourage my colleagues in the House and Senate to support this authorization.

SUBMITTED REPORT BY ROBERT D. BRAUN

Investment in Space Technology is Critical for NASA and our Nation's Future

Robert D. Braun
David and Andrew Lewis Professor of Space Technology
Georgia Institute of Technology

June 19, 2013

American technological leadership is paramount today, vital to our national security, our economic prosperity and our global standing. With applications as diverse as weather prediction, navigation, communications, agriculture, military operations and disaster relief, our society's demands from its space assets continue to increase. Aerospace remains a strong component of our national fabric and is the largest positive contributor to our nation's trade balance. However, this technological leadership position is not a given. Recently, Congressman Lamar Smith, Chairman of the House Science, Space and Technology Committee, observed, "The future is bright for discovery, but failure to invest in innovation and space exploration could leave America in the dark." To remain the leader in space exploration, space science and space commerce, we must invest in new technologies and capabilities. Doing so, not only positions our nation for continued global leadership, but grows a critical component of our nation's economic competitiveness. NASA's Space Technology account was created precisely for this purpose.

As recognized by Congress and outlined in the NASA Authorization Act of 2010 and America COMPETES Act, our Nation's economic competitiveness and high standard of living are based on decades of investment in innovation. A focus on innovation and technology is required both to enable new approaches to NASA's current missions and allow the Agency to pursue entirely new missions in aeronautics, science and exploration. Consider the following five examples of NASA technology investment:

- Following decades of investment in solar cell technology by both government and industry, NASA conceived, designed and is operating a solar-powered robotic mission at Jupiter (Juno). This distant location from the Sun is a regime where only nuclear-powered missions were once possible. This breakthrough is enabling collection of planetary science through a New Frontiers mission at a cost not possible through alternative means. This same high-efficiency solar cell technology is now making its way into other space science and human exploration missions as well as the space infrastructure that supports our society here on Earth.
- Following a decade of investment in lightweight carbon ablators, NASA matured the high-performance thermal protection system PICA that has enabled analysis of dust samples obtained from a comet following safe completion of the highest speed Earth reentry of all time (Stardust). Demonstrating the broad applicability of this technology, PICA was utilized to enable entry of the Mars Science Laboratory after a potentially catastrophic problem was uncovered late in the development cycle of this mission. The SpaceX Dragon capsule is presently using a form of PICA and this same material has been considered for use by the Orion project.

- In 1996, the NASA TransHab program began development of large-scale inflatable structures suitable for space habitation. This technology was later transferred to the commercial sector through patents and intergovernmental personnel acts, enabling companies that included Bigelow Aerospace to engage in space commerce. Investing its own resources, Bigelow Aerospace is now taking on the challenge of producing human-rated inflatable space modules sized to provide the habitation needs for a multi-person crew. Coming full circle and as a stepping-stone on that technology development path, NASA is now planning to attach a Bigelow Aerospace produced inflatable module to the International Space Station. In addition to its in-space uses, this technology could serve to provide a surface habitat to future human explorers on the Moon or Mars.
- In 2000, NASA and the University of Arizona developed the Mars Oxygen Generator, a two-pound experiment designed to generate oxygen for life support and fuel production on Mars. The device used solid oxide electrolysis cells to convert carbon dioxide and water into oxygen and fuel. When operated in reverse as a fuel cell, this device has been shown to produce clean, reliable electricity here on Earth. Development and commercialization of this technology as a NASA spin-off by Bloom Energy, which is now largely supported by the private sector, has moved beyond demonstration, with the goal of generating electricity at prices lower than traditional methods while producing half the amount of greenhouse gases. Today, Bloom Energy energy servers are in use by more by more than two dozen U.S. companies including Walmart, AT&T, Google, Coca-Cola, FedEx, Staples and Bank of America. Clearly, NASA technology investments are of benefit to more than the Agency's missions and the aerospace industry.
- In the late 1960's before the detailed design concepts that were to become the Viking mission to Mars were even on the drawing board, this nation embarked on a wide-ranging technology development efforts that yielded aeroshells, heatshield materials, supersonic parachutes, radar systems, landing engines and other technologies that were to make out first robotic planetary landing a success in 1976. These same building block technologies were then evolved twenty years later as part of the Mars Pathfinder mission and have formed the basis of every Mars mission since. Many of these systems have also found there way into uses at other planets or during Earth return. As exciting as the 2012 Mars Science Laboratory was, it would not have been possible without the broadly applicable technology development effort that preceded Viking.

One characteristic is common across these examples (and there are many more). Each was matured from broadly applicable space technology roots, not mission-focused objectives. As such, when the time came for flight project development, Stardust, Dragon and Mars Science Lab did not need to be planned inclusive of the cost and risk associated with the maturation of PICA and Juno did not need to be planned inclusive of the cost and risk associated with the maturation of high-efficiency solar cells. Removing this technology development risk has been cited numerous times by the GAO as a means to better manage NASA's future spaceflight missions. This is the principle upon which NASA's Space Technology account was built.

Looking at NASA's past and present missions it is clear that past space technology investments led to success in design and flight of the Apollo missions, the Space Shuttle, the International Space Station, and a myriad of robotic explorers that allowed us to reach destinations across our solar system and peer across the universe. Where will we be without such investments to build

NASA's future space capabilities? Unfortunately, the pioneering spirit embodied by this storied agency is presently endangered as a result of chronic underinvestment in space technology. A number of recent external reviews have addressed the issues of innovation and technology development at NASA, with a strikingly common set of themes. In 2009, the "*Report of the Review of U.S. Human Space Flight Plans Committee*" (Augustine Committee) strongly endorsed an increased focus on innovative technologies and approaches to achieving broadly defined NASA and national goals. This recommendation is similar to one made earlier by the "*President's Commission on Implementation of United States Space Exploration Policy: A Journey to Inspire, Innovate and Discover*" (Aldridge commission) in its 2004 report. Also in 2009, the National Research Council (NRC) report, "*America's Future in Space*," specifically calls for NASA to create a capability to develop game-changing approaches to national challenges while the 2009 NRC report "*Fostering Visions for the Future: A Review of the NASA Institute for Advanced Concepts*", recommended re-creating an early stage innovation engine like the NASA Institute for Advanced Concepts (NIAC). Finally, in a 2012 report on this topic, "*NASA Space Technology Roadmaps and Priorities: Restoring NASA's Technological Edge and Paving the Way for a New Era in Space*," the NRC offered the following stark assessment:

> *Success in executing future NASA space missions will depend on advanced technology developments that should already be underway. However, it has been years since NASA has had a vigorous, broad-based program in advanced space technology. NASA's technology base is largely depleted. Currently, available technology is insufficient to accomplish many intended space missions. Future U.S. leadership in space requires a foundation of sustained technology advances.*

Each of these NRC reports emphasized the need for a broadly applicable technology organization independent from the mission-focused parts of the Agency in order to provide stability to the technology investment portfolio and a more risk-tolerant environment to foster innovation. These Committees recommend a broad reach, across disciplines and organizations, to ensure the best ideas are brought forth and supported. All of these reports suggest that failure to invest in technology and innovation puts the Agency's future viability at great risk. Fortunately, NASA has such an activity today. Space Technology is focused on investing in the capabilities required by the Agency's future human exploration and science missions while lowering the cost of other government agency and commercial space activities.

America is setting out on an exciting new chapter in human space exploration. This chapter centers on full use of the International Space Station, maturation of multiple, American vehicles for delivering astronauts and cargo to low-Earth orbit, and development of a crew vehicle and an evolvable heavy-lift rocket (two critical building blocks for our nation's deep space exploration future). Equally important is advancement of a suite of cutting-edge space technologies that will allow us to safely and efficiently send explorers to new destinations for the first time.

With a sizeable budget increase, NASA can certainly recreate the systems and repeat the accomplishments of the Apollo program. However, to efficiently explore the surface of the Moon, the moons of Mars and the Mars surface, investment is required in a host of new capabilities that include the in-space propulsion, robotics, radiation protection, in-situ resource utilization, and entry, descent and landing technologies, presently being advanced through

NASA's Space Technology account. Developing these technological solutions creates high-tech jobs. Because high-tech companies account for 40 percent of America's increase in productivity and half of all U.S. exports, investing in new innovations and technological advancements is a good strategy for our nation as well as our space program. In fact, there is no aspect of the NASA budget better suited to building the economy of the 21st century than the Space Technology account.

Modest, sustained federal investment in Space Technology, at a funding level of approximately 5 percent of NASA's budget (well below the R&D budget of many corporations and well below the budgets of NASA's Human Exploration and Science enterprises), is the key ingredient to accomplishing NASA's future science and human exploration missions. Space Technology was funded at a level of $575M in FY12 and $640M in FY13. With these funds, many accomplishments were achieved and numerous technologies are now in the pipeline. Among the Space Technology accomplishments to date are flight testing of a new compactly-launched and lightweight acrodynamic decelerator with applications to the challenges of ISS downmass and Mars entry, testing of the largest out-of-autoclave composite cryotanks ever constructed, a key to low-cost propellant storage in-space or at a variety of surface destinations, a new low-cost thermal protection material that has application to Venus and Saturn entries as well as a possible use when integrated with the Orion capsule. In addition, there are now approximately 200 graduate students across our nation's universities who feel part of our nation's space program having aligned their research with NASA technology objectives. If authorized at a FY14 and FY15 budget level above $750M, NASA's Space Technology account will be able to continue the steady progress it has achieved, maturing the technologies and delivering the capabilities needed for our nation to achieve a vibrant future in space.

NASA and our nation face a very different future in space if the Space Technology account is significantly cut. Because the Space Technology account accommodates the SBIR/STTR programs and approximately 1000 civil servants across the Agency, a significant reduction in this account can only come from one place: cuts to the procurement budget that allow for NASA technology partnerships with industry and academia. Such cuts will dramatically curtail existing Space Technology projects including all of the higher TRL demonstrations presently planned for FY14 and FY15 while eliminating the possibility for NASA to make critical investments in the landing and surface technologies required for its future human exploration missions. In such a scenario, NASA's present work towards flight demonstration of solar electric propulsion, cryogenic propellant storage and transfer, optical communications, non-toxic propellants, solar sails, deep space navigation, robotic refueling, in-situ resource utilization, and supersonic aerodynamic decelerators would all terminate prematurely. Such cuts will also sever the connections Space Technology has built over the last few years with industry and academia.

Fifty years ago, a young President gave NASA a grand challenge, one chosen not for its simplicity, but for its audacity. One chosen not for its ultimate goal or destination, but to "organize and measure the best of our energies and skills." We didn't go to the Moon because it was a destination within our reach, but instead to remind us of who we are and give notice to the world of what free men can do when they set their minds to a singular objective. In accomplishing that goal, NASA made a lasting imprint on the economic, national security and geopolitical landscape of the time.

More important than destination, is how we choose to explore space today. We can do so by rebuilding the costly infrastructure of a historic, yet bygone era, or by investing in new technologies that promise the capability to efficiently reach new vistas and increase the societal benefits that result from full utilization of space. A NASA that is reaching for grand challenges and operating at the cutting-edge is critical not only for our country's future in space, but also for America's technological leadership position in the world. A robustly funded Space Technology account is central to that theme.

Robert D. Braun is the David and Andrew Lewis Professor of Space Technology at the Georgia Institute of Technology and served as the NASA Chief Technologist in 2010 and 2011.

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