

COMMERCE, JUSTICE, SCIENCE, AND RELATED AGENCIES APPROPRIATIONS FOR FISCAL YEAR 2016

THURSDAY, APRIL 16, 2015

U.S. SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, DC.

The subcommittee met at 2:38 p.m., in room SD-192, Dirksen Senate Office Building, Hon. Richard C. Shelby (chairman) presiding.

Present: Senators Shelby, Cochran, Capito, and Mikulski.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

STATEMENT OF HON. CHARLES F. BOLDEN, JR., ADMINISTRATOR

OPENING STATEMENT OF SENATOR RICHARD C. SHELBY

Senator SHELBY. The meeting will come to order. We have just had a Senate vote. I believe we will be joined by Senator Mikulski and some others in a few minutes. General, your time is valuable, and I thought I would get started.

Again, welcome to the subcommittee. This subcommittee has been very supportive, General Bolden, of NASA and its work to maintain a healthy funding level for NASA while preserving a balanced and I believe a productive space program.

NASA's work is exciting, as you well know, inspiring, and educational. From the photos of galaxies captured by the Hubble Space Telescope to the future of humans traveling to Mars, NASA has captured the imagination of school children and citizens across the globe, and inspired generations of scientists and engineers.

This country has limited resources, however, which requires us to prioritize our spending. NASA spending is not an exception. The NASA budget proposes a total funding level of \$18.5 billion, an increase of \$519 million above the 2015 level. Such a significant increase should represent balanced funding for NASA's priorities. Perhaps not enough.

Instead, there is a sizeable growth in programs like Commercial Crew and Space Technology, while other programs, such as science missions and Exploration Systems Development have significant reductions. The cuts to Exploration are especially concerning to the subcommittee. The successful test of the Orion capsule last December showcased NASA's innovative plans for the future.

This budget could have been an opportunity, I believe, for NASA to boldly support human exploration after years of budget requests, in which I believe it was short changed.

Instead, NASA's budget cuts funding to Orion and the Space Launch System, or SLS, limit our reach in human exploration. A 20 percent cut to SLS during its critical phase of development risks important investments that have been made in communities across the country. It also risks the success of the program.

The budget makes it impossible, a lot of people believe, for NASA to make efficient and cost effective decisions for the long-term development of a launch system that is being built to achieve the Nation's human exploration goals.

While NASA is good at creating charts and talking about moving human exploration beyond our current capabilities, NASA has yet again failed to propose a budget that can accomplish what the agency claims is one of its top priorities.

General Bolden, a lot of us are troubled by the overall priorities included in this budget, requiring key development programs to operate with insufficient funding is irresponsible. While the proposed funding level of \$18.5 billion is a good start, there is much work to do and it must be done to develop a balanced budget that achieves NASA's core missions and its future goals.

I look forward to working with you to address some of these concerns. At this point, I want to recognize Senator Mikulski, the vice chair of the full committee.

STATEMENT OF SENATOR BARBARA A. MIKULSKI

Senator MIKULSKI. Thank you very much, Mr. Chairman. Administrator Bolden, we welcome you. I apologize for being late. We actually had a tremendous victory in the Senate, the Elementary and Secondary Education Act passed 21-0 out of the committee. We were kind of doing a victory lap.

Today, I know we are here to examine the NASA budget request of \$18.5 billion. It is \$0.5 billion more than what was enacted in fiscal year 2015.

As I look at this budget request, I have very deep concerns. I am concerned that we could be having a threat to the balanced space program that we have all worked together on an bipartisan basis on and said yes to human space flight. We need a reliable transportation system both for our astronauts to go where they have not had a chance to go before and can do important servicing missions.

I am concerned, of course, about what is about to happen to the Goddard Space Flight Center, which I do not think gets a fair shake in this particular appropriations. The Goddard request for science missions is \$3.0 billion, it is \$324 million below fiscal year 2015.

The Goddard is currently operating 35 on orbit missions. It also is absolutely key to the Hubble Space Telescope and the James Webb Telescope and others. I want to know why Goddard was cut \$300 million.

Of course, we are deeply concerned about other efforts, one of which is the whole issue of satellite servicing. Satellite servicing is absolutely important to our national interest. It was cut by \$65 million. It was \$130 million in fiscal year 2015.

The whole idea of satellite servicing as we know, is that our country and our private sector have satellites. We do not want them to just die in space and be space junk. They can be re-serviced. There is technology and workforce at Goddard that knows how to do it. Somehow or another, we do not seem to want to invest in it or if we do, we short change it.

Of course, there is the Wallops Flight Facility. We put money into the Federal budget in terms of fixing Wallops after the terrible storm. We know there was \$20 million, Mr. Chairman, you worked with us on, and I know in a recent conversation with Senators Warner and Kaine, they do not feel that Wallops is on track, and if they do not feel Wallops is on track, neither do I.

I have some questions about all this. I really need to hear these answers, because I feel, do we have a balanced space program or not.

Mr. Chairman, I know we want to move on. I am through with my remarks.

Senator SHELBY. Thank you. Senator Cochran, do you want to be recognized?

STATEMENT OF SENATOR THAD COCHRAN

Senator COCHRAN. Mr. Chairman, just to join you and Senator Mikulski in welcoming our witness. We appreciate very much your assistance in helping us identify the priorities of NASA and related activities. We are pleased about the development of the Space Launch System.

As you know, the Stennis Space Center located in my State is very important, not just for the work that it does in the scientific area, in research, but also rocket testing and the infrastructure at Stennis is a very important asset for the entire system and our Nation's goals in space.

Thank you, Mr. Chairman.

Senator SHELBY. Thank you. General Bolden, again, welcome to the subcommittee. Your full statement will be made part of the record, as you know. Proceed.

SUMMARY STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Mr. BOLDEN. Thank you very much, Mr. Chairman. At the outset, Chairman Shelby, with your permission, I would like your indulgence to say a few words of thanks for Ranking Member Mikulski.

Senator Mikulski, it is safe to say that all of us at NASA and across the space community were saddened at your recent announcement that this will be your last Congress. You have been a champion for America's space program.

This week and next week, we celebrate the 25th anniversary of the Hubble's mission, and there is no question that we would not have reached this milestone were it not for your unwavering support.

Of course, there is still 2 years of work ahead of us in the Congress, and we look forward to continuing to work with you, Chairman Shelby, and the other members of this subcommittee.

Mr. Chairman and members of the subcommittee, 5 years ago yesterday, President Obama came to the Kennedy Space Center

and laid out what I believe is a bold transformative agenda for NASA. He challenges us to embark on a journey to Mars.

He spoke of extending the life of the International Space Station (ISS), and increasing earth based observation. He called for investments in new advanced technologies that will not only take Americans farther into space than ever before, but also will provide spin off benefits and create high paying jobs here at home.

Five years later, we have made landmark progress toward those goals. SpaceX's successful launch this week is a shining example.

The budget you consider today furthers the goals that we share of extending our reach into space while strengthening American leadership here at home. It is an \$18.5 billion investment that represents a leap into a future of greater discovery, job creation, and economic growth, as well as a healthier planet.

Thanks to the hard work of our NASA team and partners all across America, we have made a lot of progress on our journey to Mars. In fact, we have now progressed farther on this path to sending humans to Mars than at any point in the history of NASA, and this budget will keep us marching forward.

The support of this subcommittee and the Congress are essential to this journey. The International Space Station is the critical first step in this work. It is our springboard to the rest of the solar system, and we are committed to extending space station operations to at least 2024.

Thanks to the grit, determination, and American ingenuity, we have returned ISS cargo resupply missions to the United States, insourcing these jobs and creating a new private market in low-Earth orbit.

Under a plan outlined by the administration earlier in its term, we have also awarded two American companies, SpaceX and Boeing, fixed price contracts to safely and cost effectively transport our astronauts to the space station from U.S. soil.

This will end our sole reliance on Russia. It is critical that we receive the funding requested in the 2016 budget so that we can meet our 2017 target date and stop writing checks to the Russian Space Agency.

Our newest, most powerful rocket ever developed, the Space Launch System or SLS, has moved from formulation to development, something no other exploration class vehicle has achieved since the agency built the Space Shuttle.

The Orion spacecraft performed flawlessly on its first trip to space this past December. The SLS and Exploration Ground Systems are on track for launch capability readiness by November of 2018, and the teams are hard at work on completing technical and design reviews for Orion.

Our budget also funds a robust science program with dozens of operating missions, studying our solar system and the universe. New Horizons is preparing for its arrival at Pluto in July, and Dawn has entered into orbit around the dwarf planet Ceres.

Before we send humans to Mars, robots are paving the way. We are at work on a Mars rover for 2020, and have begun planning a mission to explore Jupiter's fascinating moon, Europa.

NASA is a leader in earth science and our constantly expanding view of our planet from space is helping us better understand and

prepare for these changes. NASA has 21 research missions studying earth, and in the last year alone, we launched an unprecedented five more.

We also are at work on humanity's first voyage to our home star, a mission that will repeatedly pass through the Sun's outer atmosphere. NASA's Hubble, Chandra, and Kepler Space Telescopes explore the universe beyond our solar system. Hubble's successor, the James Webb Space Telescope, is taking shape right now out in Maryland, and a new mission is in development to extend Kepler's pioneering work in finding planets.

Technology drives science, exploration, and our journey to Mars. With the President's request, NASA will continue to maintain a steady pipeline of technology, to ensure that we continue to lead the world in space exploration and scientific discovery.

NASA is also with you when you fly, and we are committed to transforming aviation by dramatically reducing its environmental impact, maintaining safety in more crowded skies, and paving the way toward revolutionary aircraft shapes and propulsion systems.

Mr. Chairman, America's space program is not just alive, it is thriving. The strong support we receive from this subcommittee is making that happen. I particularly appreciate the generous fiscal year 2015 appropriations that you generated.

The President said at the Kennedy Space Center, and I quote "For pennies on the dollar, the space program has improved our lives, advanced our society, strengthened our economy, and inspired generations of Americans."

NASA looks forward to working with the Congress to continue making this vision a reality.

I would now be pleased to respond to your questions.

[The statement and the President's budget request summary follow:]

PREPARED STATEMENT OF HON. CHARLES F. BOLDEN, JR.

Mr. Chairman and members of the subcommittee, I am pleased to have this opportunity to discuss NASA's fiscal year 2016 budget request. The President is proposing a fiscal year 2016 budget of \$18.5 billion for NASA, building on the significant investments the administration has made in America's space program over the past 6 years, enabled through the strong and consistent support by this subcommittee and the Congress. This request will allow NASA to continue to lead the world in space through a balanced program of exploration, science, technology, and aeronautics research. NASA is an outstanding investment for our Nation not only because we uncover new knowledge, but because we raise the bar of human achievement, inspiring the next generation of scientists, engineers and astronauts.

The fiscal year 2016 request includes \$4,505.9 million for Exploration with \$2,862.9 million for Exploration Systems Development, \$1,243.8 million for Commercial Space Flight, and \$399.2 million for Exploration Research and Development. This funding, with critical investment from each of NASA's mission directorates, supports NASA's plans to, as the President said in his State of the Union speech, continue our journey to Mars and push "out into the solar system not just to visit, but to stay[.]" NASA has made tremendous progress on this journey, and we will continue to progress, with building momentum, through the years to come.

As part of our strategic, stepping stone approach to deep-space explorations, NASA is facilitating the development of a U.S. commercial crew transportation capability with the goal of launching NASA astronauts from American soil in the next couple of years. This initiative to facilitate the success of U.S. industry to provide crew transportation to low Earth orbit will end our sole reliance on Russia and ensure that we have safe, reliable and cost-effective access to the ISS and low-Earth orbit. The Commercial Products Contracts allowed potential providers to better understand and align with NASA human spaceflight requirements and gave NASA

early insight into vehicle designs and approaches. NASA has now entered the development and certification phase with the award of two FAR-based, fixed-price Commercial Crew Transportation Capability (CCtCap) contracts to American companies to transport our Astronauts to and from the ISS. SpaceX and Boeing have laid out milestones with the goal of certified commercial crew capability in 2017. The contractors are committed and at work. Our approach has emphasized competition and redundancy to ensure that NASA's human safety and certification requirements are met, we achieve the best value for the American taxpayer, and we end our sole reliance on Russia for transportation services. Now, we need the funding necessary to execute this plan to completion. With continued support from the Congress, crews will again launch to the ISS from American soil by the end of 2017.

Technology drives science, exploration and economic opportunity. NASA will continue to maintain a steady pipeline of technology to ensure that we continue to lead the world in space capabilities. NASA's fiscal year 2016 request includes \$724.8 million for Space Technology, to conduct rapid development and infusion of transformative space technologies that enable NASA's missions and advance our country's dynamic aerospace industry. Over the next 2 years, NASA will execute several in-space demonstrations including: a deep space atomic clock for advanced navigation, green propellant, and four small spacecraft demonstrating pioneering new technologies. This summer, NASA plans to again test our Low Density Supersonic Decelerator off the coast of Hawaii to continue proving in flight the new technologies critical for landing larger payloads on the surface of the Red Planet. Informed by the results of fiscal year 2014 testing of solar array and thruster designs, NASA continues development of a high-powered solar electric propulsion capability to enable future exploration missions and meet needs of U.S. aerospace industry. This capability will be demonstrated on the Asteroid Redirect Mission. We will continue to progress toward a 2019 demonstration of space-to-ground laser communications, a capability that both American industry and NASA mission teams are eager to explore and harness. But the most exciting piece of our technology investments is the broad portfolio of research grants and other early stage investments, where the new technologies that will change the way we operate in space have a chance to move from ideas to components, to demonstrations of new systems and capabilities. These early stage investments are building stronger links between NASA and academia, and providing unique opportunities for the NASA workforce to innovate.

In December, NASA completed the first orbital test flight of the *Orion* crew vehicle, including a successful high speed reentry through the atmosphere. The Exploration Flight Test 1 (EFT-1) mission of *Orion* was nearly flawless. For the first time in a generation, a deep-space U.S. exploration vehicle has splashed down in the Pacific, and what we are learning from this test gives us increasing confidence in the systems we are designing.

Just as we have recently tested *Orion* by sending it on a shorter version of its future missions, we are continuously testing and experimenting on the International Space Station (ISS) in preparation for long-term missions in deep space. The administration has committed to extending operation of the International Space Station to at least 2024. The fiscal year 2016 request includes \$4,003.7 million for Space Operations, including \$3,105.6 million for ISS. Two commercial providers are now under contract to supply cargo to this critical asset, making the extension possible and giving us increasing confidence in our long-term strategy. On March 27, astronaut Scott Kelly began a 1 year mission aboard the ISS to learn more about how to live and work in space for the long term. We will compare his vital signs to those of his twin brother, Mark, here on Earth in a first-ever experiment using identical twins to learn more about the effects of living in space. This is just one example of the vital knowledge and technology that our outpost in space will provide over the coming decade. The Space Station is the cornerstone of our exploration strategy, a nearby outpost in space where humanity is taking its early steps on its journey into the solar system.

For the next step on the journey, NASA is developing the required deep-space exploration infrastructure while we plan for the earliest missions. NASA has established Agency Baseline Commitments for the Space Launch System (SLS) and Exploration Ground Systems (EGS), each of which supports a launch capability readiness date for Exploration Mission 1 (EM-1) of November 2018. EM-1 is the first mission for SLS and *Orion*. NASA remains on schedule for this EM-1 launch readiness date for SLS and EGS. Baseline cost and schedule for *Orion* are now being developed. NASA's budget request provides the funding needed to keep SLS, *Orion*, and EGS on track. NASA will determine the integrated launch date for the EM-1 mission after all critical design reviews are complete, later this year. SLS and *Orion* are critical to human spaceflight beyond low-Earth orbit as part of an evolvable, sustainable, and affordable exploration program.

The journey to Mars runs through cis-lunar space. NASA's initial deep-space mission, EM-1, will launch to a "Distant Retrograde Orbit" around the Moon. NASA will use this region of space to test and demonstrate flight and mission operations and staging of human-rated vehicles farther from Earth than ever before. Crewed *Orion* missions launched on the SLS in the 2020s will establish our capability to operate safely and productively in deep space. In this 'proving ground' of cis-lunar space, we will prepare for future deep space missions that will lead us to Mars. In late 2020, NASA plans to launch an advanced solar electric propulsion (SEP) based robotic spacecraft to approach an asteroid and remove a multi-ton boulder. After removing the boulder, the SEP spacecraft will redirect the asteroid in a demonstration of slow push deflection, a technique relevant to potential future planetary defense missions, and take the asteroid boulder to a stable Distant Retrograde Orbit around the moon. In 2025, launched by SLS, *Orion* will carry a two person crew on a 24–25 day mission to rendezvous and dock with the robotic SEP spacecraft in cis-lunar space. NASA will maneuver the integrated *Orion* and robotic vehicle stack in lunar orbit for about 5 days. The crew can then conduct Extra Vehicular Activities (EVA) to examine the asteroid boulder and collect samples before returning to Earth. NASA's plan leverages development efforts from existing programs across NASA mission directorates, and provides a critical opportunity to exercise our emerging deep space exploration capabilities.

As NASA strives to achieve the goal of sending humans to Mars, it is important to remember we are already there. For 40 years, increasingly advanced robotic explorers have studied the Red Planet. This has dramatically increased our scientific knowledge and helped pave the way for astronauts to travel there. Our latest Mars spacecraft, MAVEN (Mars Atmosphere and Volatile Evolution), arrived last September to study the upper atmosphere and joined a fleet of orbiters and rovers on the surface. Next year, we will send the InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) lander to study the planet's deep interior. In 2020, a new rover, building on the incredible success of Curiosity, will help us prepare for the arrival of humans at Mars. The Mars 2020 rover will address the highest priority Mars science objectives recommended by the Planetary Decadal Survey and will carry exploration technology investigations focused on capabilities such as in-situ resource utilization that will help in our planning for future human missions.

Mars is a key destination, but only one point on humanity's journey of discovery. Ours is a journey of understanding reaching through our Earth system, across our solar system, and beyond, deep into the universe. The fiscal year 2016 budget request includes \$5,288.6 million for Science to continue that mission, with \$1,947.3 million for Earth Science, \$1,361.2 million for Planetary Science, \$709.1 million for Astrophysics, \$620.0 million for the James Webb Space Telescope, and \$651.0 million for Heliophysics.

NASA's Planetary Science program continues to expand our knowledge of the solar system, with spacecraft in place from the innermost planet to the very edge of our Sun's influence. After 9 years and 3 billion miles of travel, the New Horizons spacecraft awakened and began to prepare for its arrival in the Pluto system in July. Right now, Dawn has entered into orbit around the dwarf planet Ceres. Juno is speeding toward Jupiter where it will not only send back unprecedented data from a first ever polar orbit of our giant neighbor, but will also demonstrate how solar power can work at great distances from the Sun. With the fiscal year 2016 request, NASA will continue development of a robotic asteroid rendezvous and sample return mission, dubbed OSIRIS-REx, planned for launch in 2016. OSIRIS-REx will approach the near-Earth Asteroid Bennu, map the asteroid, and collect a sample for return to Earth in 2023. Looking further to the future, NASA is planning a mission to explore Jupiter's fascinating moon Europa, selecting instruments this spring and moving toward the next phase of our work.

The most important planet we study is the one on which we live—Earth. Today, 21 NASA-developed research missions orbit Earth and provide a quantitative understanding of our complex planet, its origins and its future. In the last year, we have launched an unprecedented five Earth science missions, starting with the Global Precipitation Measurement Core Observatory (GPM) that already has observed Hurricane Arthur's brush of the East Coast last July. The Soil Moisture Active Passive (SMAP) mission, launched in January, will give us for the first time ever, a picture of soil moisture on a global scale, allowing scientists to monitor droughts and predict flooding caused by severe rainfall or snowmelt. New research missions in formulation include PACE, the Pre-Aerosol, Clouds and ocean Ecosystem continuity mission, that observes ocean color, aerosols, and clouds; NISAR, the NASA-ISRO Synthetic Aperture Radar mission, being developed in partnership with the Indian Space Research Organization to measure complex processes such as ecosystem disturbances

and ice-sheet collapse; and CLARREO, the Climate Absolute Radiance and Refractivity Observatory Pathfinder that will begin pre-formulation this fiscal year.

The Landsat series of satellites is a cornerstone of our Earth observing capability. The world relies on Landsat data to detect and measure land cover/land use change, the health of ecosystems, and water availability. The President's fiscal year 2016 request recognizes Landsat's critical importance and sets out a multi-decadal plan for an Earth-observing architecture that ensures data continuity and reliability. The Sustainable Land Imaging program partnership with the Department of the Interior's U.S. Geological Survey will include flight of a thermal-infrared free flyer and an upgraded Landsat-9 mission, while infusing new technological developments for future missions and ensuring consistency with the existing 42-year Landsat data record.

Twenty-five years ago this April NASA deployed the Hubble Space Telescope. Hubble is still doing amazing science, and the last textbook that will have to be revised because of its discoveries has not yet been written. In just slightly over 3 years, NASA plans to launch the James Webb Space Telescope (JWST), Hubble's successor, and continue to reveal the unknown with the largest observatory ever put into space. This amazing telescope is taking shape right now in suburban Maryland, where this year the mirrors will be installed on the telescope backplane. The "heart" of the telescope that holds its instruments successfully completed a nearly 4-month test in a cryogenic thermal vacuum chamber. NASA's Astrophysics program operating missions include the Hubble, Chandra, Spitzer, and Kepler telescopes, the Stratospheric Observatory for Infrared Astronomy (SOFIA) airborne observatory, and other missions that together comprise an unrivaled resource for the study of our universe. With the fiscal year 2016 request, NASA will continue development of the Transiting Exoplanet Survey Satellite (TESS). TESS will extend the pioneering work of the Kepler Space Telescope, which showed us that virtually every star in the sky has a planetary system. TESS launches in 2018 and will discover rocky exoplanets orbiting the nearest and brightest stars in the sky in time for Webb to conduct follow-up observations. NASA will also continue pre-formulation of the Wide-Field Infrared Survey Telescope (WFIRST), the top priority for large-scale missions of the most recent National Academy of Science Decadal Survey in Astronomy and Astrophysics.

Just as the most important planet that we study is the Earth, the most important star that we study is our own. NASA's Heliophysics Program is monitoring the Sun, near-Earth space, and the space environment throughout our solar system, with 29 spacecraft making up 18 missions. These missions work toward one goal: to better understand the Sun and its interactions with the Earth and solar system, including space weather. The fiscal year 2016 request supports development of NASA's Solar Probe Plus (SPP) mission, planned for launch in 2018. SPP will be humanity's first voyage to our home star and will repeatedly pass through the Sun's hot outer atmosphere. NASA will also begin science operations of the Magnetospheric Multiscale (MMS) mission to investigate how magnetic fields around Earth connect and disconnect, explosively releasing tremendous amounts of energy in a process called magnetic reconnection.

NASA's Aeronautics research is making air travel cleaner, safer, and more efficient. Every U.S. aircraft and U.S. air traffic control tower has NASA-developed technology on board. NASA's fiscal year 2016 budget request includes \$571.4 million for Aeronautics to fulfill the Agency's strategic research agenda, addressing the most critical challenges facing the aviation sector. NASA is improving safety and reducing development costs of new aviation technologies, developing integrated air traffic management tools to expand airspace capacity with more fuel-efficient flight planning and diminish delays, and researching next generation aircraft configurations, efficient engines, and low carbon propulsion systems such as hybrid electric technology systems. NASA is enabling the future of unmanned and autonomous flight by providing technical data and analysis to directly inform FAA rulemaking related to Unmanned Aircraft Systems (UAS), funding technology development to address emerging needs for UAS integration, and initiating fundamental research in autonomous systems for aviation. Also in fiscal year 2016, NASA is initiating a series of flight demonstrations focused on environmental performance, and expanding our portfolio of rapid-turnover feasibility demonstrations to infuse new ideas into our research program. NASA's aeronautics research continues to play a vital leadership role to air travel and commerce by enabling game-changing technologies and innovation that allow the U.S. aviation industry to continue to grow and maintain its global leadership role. NASA is truly with you when you fly.

NASA's spacecraft are voyaging beyond the solar system, we are developing a mission to pass right through the Sun's atmosphere, and our spacecraft are exploring the planets in between. The venerable Hubble Space Telescope is looking back into

deep time, Kepler is demonstrating the prevalence of planets around other stars, and the James Webb Space Telescope is on the way. An early version of *Orion* splashed down in the Pacific, Astronaut Mark Kelly is preparing for a 1 year mission in space, and the Space Launch System is on track for a November 2018 launch capability. NASA is embracing its mission as never before. NASA looks forward to working with the subcommittee and the Congress to make this vision a reality.

Mr. Chairman, I would be pleased to respond to your questions and those of other members of the subcommittee.

National Aeronautics and Space Administration

FY 2016 PRESIDENT'S BUDGET REQUEST SUMMARY

Budget Authority (\$ in millions)	Fiscal Year						
	Actual	Enacted	Request	Notional	Notional	Notional	Notional
	2014	2015	2016	2017	2018	2019	2020
NASA Total	17,646.5	18,010.2	18,529.1	18,807.0	19,089.2	19,375.5	19,666.1
Science	5,148.2	5,244.7	5,288.6	5,367.9	5,488.4	5,530.2	5,613.1
Earth Science	1,824.9	--	1,947.3	1,966.7	1,988.0	2,009.3	2,027.4
Planetary Science	1,345.7	--	1,361.2	1,420.2	1,458.1	1,502.4	1,527.8
Astrophysics	678.3	--	709.1	726.5	769.5	1,005.5	1,138.3
James Webb Space Telescope	658.2	645.4	620.0	569.4	534.9	305.0	197.5
Heliophysics	641.0	--	651.0	685.2	697.9	708.1	722.1
Aeronautics	566.0	651.0	571.4	580.0	588.7	597.5	606.4
Space Technology	576.0	596.0	724.8	735.7	746.7	757.9	769.3
Exploration	4,113.2	4,356.7	4,505.9	4,482.2	4,298.7	4,264.7	4,205.4
Exploration Systems Development	3,115.2	3,245.3	2,862.9	2,895.7	2,971.7	3,096.2	3,127.1
Commercial Spaceflight	696.0	805.0	1,243.8	1,184.8	731.9	173.1	1.1
Exploration Research and Development	302.0	306.4	399.2	401.7	595.1	995.4	1,077.2
Space Operations	3,774.0	3,827.8	4,003.7	4,191.2	4,504.9	4,670.8	4,864.3
International Space Station	2,964.1	--	3,105.6	3,273.9	3,641.0	3,826.0	4,038.3
Space and Flight Support	809.9	--	898.1	917.3	863.8	844.8	826.1
Education	116.6	119.0	88.9	90.2	91.6	93.0	94.4
Safety, Security, and Mission Services	2,793.0	2,758.9	2,843.1	2,885.7	2,929.1	2,973.0	3,017.5
Center Management and Operations	2,041.5	--	2,075.2	2,105.0	2,136.6	2,168.6	2,201.0
Agency Management and Operations	751.5	--	767.9	780.7	792.5	804.4	816.5
Construction and Environmental Compliance and Restoration	522.0	419.1	465.3	436.1	442.6	449.3	456.0
Construction of Facilities	455.9	--	374.8	344.3	349.3	354.6	359.9
Environmental Compliance and Restoration	66.1	--	90.5	91.8	93.3	94.7	96.1
Inspector General	37.5	37.0	37.4	38.0	38.5	39.1	39.7
NASA Total	17,646.5	18,010.2	18,529.1	18,807.0	19,089.2	19,375.5	19,666.1

FY 2014 reflects funding amounts specified in the June 2014 Operating Plan per P.L. 113-76.

FY 2015 reflects only funding amounts specified in P.L. 113-235, the Consolidated and Further Continuing Appropriations Act, 2015. For projects in development, NASA's tentatively planned FY 2015 funding level is shown. FY 2015 funding levels are subject to change pending finalization of the FY 2015 operating plan.

The totals for the Exploration and Space Operations accounts in this document supersede the figures in the draft appropriations language.

SPACE LAUNCH SYSTEM TEST LAUNCH

Senator SHELBY. Thank you, General Bolden. The Government Accountability Office (GAO) found that NASA's cost estimates for the SLS and Orion projects do not extend beyond the first flight for the combined system, and the 2016 budget before us bears this out.

GAO states that NASA's budget estimates do not include production costs for the second test flight scheduled for 2021, the development costs for upper stage development for SLS, or production operations and sustainment costs for Orion beyond the first test flight. GAO further states that NASA has continued to request funding that does not meet requirements.

In the case of SLS, I cannot agree more with GAO's assessment of NASA's inadequate funding proposal. My question, General, is this: considering NASA will have to conduct multiple test flights for SLS, which require additional development and production, why does the 2016 budget only account for the first test launch of SLS?

Mr. BOLDEN. Mr. Chairman, the 2016 request supports what we project in the budget horizon as required over the next 5 years to get us to a sustained program, of deep space exploration using SLS and Orion.

You mentioned or I think you mentioned charts and graphs, and we are not about charts and graphs. We are talking about hardware. The barrel for the engine section of SLS was welded together at Michoud Assembly Facility, and other hydrogen and oxygen tanks are being done. We launched Orion in December. We hot fire tested the RS-25 engines down in Mississippi at Stennis, as Senator Cochran has said. We fired the next milestone test on the five segment solid rocket booster.

I would say our budget as we have run it out has us on the path that we think is necessary to get humans back to deep space and then onto Mars.

UPPER STAGE ENGINE

Senator SHELBY. In the detailed portion of the 2016 budget for SLS, NASA only proposes development funds, as I understand it, through 2018 for an upper stage engine with no funding beyond that date. There is a known need to develop a human-rated upper stage engine for the second test flight. The upper stage, it is my understanding, is on the critical path to the second test flight of SLS in 2021, yet it is my understanding there is no mention beyond preliminary planning for an upper stage required for a mission that is expected to launch say 6 years hence.

The question is this: why are no funds identified for the anticipated development for an upper stage when that development must be worked on in earnest during 2016?

Mr. BOLDEN. Mr. Chairman, in prioritizing the work that we need to do over this next budget horizon, we recognize that an exploration upper stage is something that will be necessary.

You are absolutely correct in that if we had unlimited funds, we would begin development of the exploration upper stage today. We are given a budget that is no longer flat, I will say, people used to say flat was the new "up," but the new up is starting to look like you are going to let us work inflation in, so it is no longer flat. I think the budget that we submitted presents a balanced portfolio of missions for the agency that show us on a time line to get to Mars in the 2030s.

NASA'S RELATIONSHIP WITH RUSSIA

Senator SHELBY. I am on my last area that I will get into momentarily, the International Space Station. When we discussed the budget here last year, I asked about our relationship with the Russians in regard to the space station and what would happen if they were to end the partnership.

At that time, you said, and I quote "Should we or the Russians choose to pull out, the International Space Station as we know it no longer exists." Those were your words, General.

The Russians have indicated that their intent is to separate their portion of the station in 2024. We know that is down the road. That essentially gives the facility an expiration date.

My question is this: has Russia formally notified you that this is their intent, to separate their portion of the space station in 2024?

Mr. BOLDEN. Quite the contrary, Mr. Chairman. In my meetings with my counterpart, Mr. Komarov, in Baikonur on the periphery of Scott Kelly's launch about 3 weeks ago, he made what I would not call a startling announcement, but he made a very encouraging announcement that contrary to what we heard, the rhetoric from the Russians, that they were committed to the International Space Station through 2024, and they did not intend to pull pieces off and start their own space station.

Senator SHELBY. Did he indicate that would be a hard commitment or a soft one?

Mr. BOLDEN. Mr. Chairman, it is no harder a commitment than ours. I think if everyone will remember, when the President allowed me to propose that we go to 2024, we said at least 2024.

The only hard date we know about the space station today is 2028 because that is as far as the engineering analyses of all the partners say that 2028 is about as long as we can keep the space station flying, but we do not want to keep the current space station flying forever.

We want to get NASA and other agencies out of low-Earth orbit and onto exploration. The vision that we see——

Senator SHELBY. The space station was never constructed to be there in perpetuity, was it?

Mr. BOLDEN. Mr. Chairman, that is absolutely correct. We have never built anything intended to be there in perpetuity. I am smiling at Senator Mikulski. We did not build the Hubble Space Telescope to be there as long as it has been, but thanks to her shepherding the program. we are getting ready to celebrate 25 incredible years.

JAMES WEBB SPACE TELESCOPE (JWST)

Senator SHELBY. We are also moving to another stage, past the Hubble, because of what we found in the use of having the Hubble.

Mr. BOLDEN. Again, I think you are helping me to emphasize the critical importance of your ranking member.

Senator SHELBY. She did a great job.

Mr. BOLDEN. She chewed me out and I appreciated it when I became the NASA Administrator. It was not really chewing me out.

Senator SHELBY. Appreciated years later.

Mr. BOLDEN. She told me she wanted me to straighten out the James Webb Space Telescope, and we relooked at the program. I came in, and I went to the President. I came to Senator Mikulski and said we are not going to make it, and we need to redo this program, and we are now on schedule on cost to launch the James Webb Space Telescope in 2018, and that is primarily because of the work and the encouragement of Senator Mikulski.

INTERNATIONAL PARTNERS

Senator SHELBY. Thank you. What is the level of commitment from some of our other international partners to operate the space station beyond 2020?

Mr. BOLDEN. Now that we have the Russians on record saying they are with us through at least 2024, other partners are beginning to feel better. That is what they were waiting for, to see the two primary partners get on board with each other. I expect that over the coming year or two, just as it was to get everybody to go to 2020, I think in the next couple of years, you will see that all the partners will agree that 2024 is the horizon for the International Space Station now.

Senator SHELBY. Is it even possible to operate as you know it the space station without the Russian segments should we choose to operate the station on our own?

Mr. BOLDEN. Yes, sir.

Senator SHELBY. Okay. Senator Mikulski.

GODDARD SPACE FLIGHT CENTER BUDGET

Senator MIKULSKI. Thank you, Mr. Chairman. Administrator Bolden, first of all, thank you for your kind words about me and what I have done and the Hubble Telescope.

I think also it is a tribute to really bipartisanship, and I know really very early in my Senate career, I became the chairman of the Subcommittee on VA/HUD, of which NASA was part of. My colleague at the time and vice chairman was Senator Jake Garn. I cannot say enough about the appreciation I had for Senators Garn and John Glenn. Bill Nelson was not here. It showed how the astronaut senators and I with Goddard Space Flight Center really worked on the whole idea of a balanced space program.

What we did initially to fix Hubble was because we worked on a bipartisan basis, and the efforts of Senator Garn and with Senator Garn, we had the credibility, although I had the gavel, they had the credibility, and then NASA had the know-how.

That is really kind of the spirit of the way it is, and I wanted to just acknowledge the role that others have played. We have kept that going with Senator Shelby.

Now, as we also look, and you commented on the New Horizons, yes, the press is reporting as is JPL, that we are really now pretty close to that Pluto thing, and by all accounts and reports, technological reports, we are absolutely on target for its arrival at Pluto on target.

I want to be sure that our best days are not behind us, and we are committed to a balanced space program. The human space flight, a reliable transportation system for our astronauts to go

where they have not, and also to do the kind of servicing that will be necessary, along with space science.

Of course, you know I am going to ask you about Goddard. When I saw the President's budget, in which Goddard was funded at \$324 million below fiscal year 2015, when they have 32 on orbit missions, when they make sure that Hubble is targeted and maximizing its use in its current age and stage, and then managing the satellite construction for two of the major National Oceanic and Atmospheric Administration (NOAA) projects, along with the James Webb, they have a full plate, and yet you cut them \$300 million.

Can you tell me, number one, why, and what are the consequences of that? I am very apprehensive that they are doing all this great work and they have been cut roughly 10 percent.

Mr. BOLDEN. Senator, our projection for this year, for this fiscal year, at the end of the year, because we do not formalize some projects until we are well into the fiscal year, but as a result of that, our estimate is that the Goddard Space Flight Center will end up with about \$2.6 billion, their portion of the NASA budget.

The projection for fiscal year 2016 is given the work they are about to do, that they are embarking on, an example would be if you told me today in this hearing to go ahead and authorize the beginning on the tiers for continuous land imaging, Goddard would start tomorrow morning. That is not in their portfolio right now.

We anticipate that Goddard will again in fiscal year 2016, when all is said and done, end up managing \$2.6 billion of projects. It is actually a preliminary look at what we have based on the programs we have directed—

Senator MIKULSKI. Are you saying you are going to give them more work during the year and then as the year goes on, you are giving them more money?

Mr. BOLDEN. They get more work as the year goes by. Subsequently, they get more money. They get responsibility for more money.

Senator MIKULSKI. In other words, if they get more responsibility, does the resource follow the responsibility?

Mr. BOLDEN. Yes, ma'am; it does. Yes, ma'am. I was going to get cute, but I will not.

Senator MIKULSKI. No, do not.

Mr. BOLDEN. I am not.

Senator MIKULSKI. In terms of time, we have a lot of ground to cover, but space to cover.

Mr. BOLDEN. Yes, ma'am.

SATELLITE SERVICING

Senator MIKULSKI. Which then takes us to an area called "satellite servicing." To my colleagues who are also interested in national security, I know we are worried about our satellites, number one, not for the purposes of this hearing, it would be inappropriate, but we worry about the Chinese and what they are doing in terms of any satellite technology, so that is one dimension not for this hearing, and of course, across committees.

Also, we have satellites that our Government has, particularly science satellites, and our private and even non-profit sector have. Goddard has been developing a technology and workforce to sat-

ellite servicing, so they do not end up space junk. That was funded at \$130 million in fiscal year 2015, and they have been cut by 50 percent to \$65 million.

Could you tell me the rationale for that, or do you not want to do satellite servicing?

Mr. BOLDEN. Senator, we sincerely—I think we are all on the same sheet of music. No one is more dedicated, for example, to SLS and exploration than I. I share your enthusiasm there.

I share the enthusiasm for making sure that this Nation is second to none when it comes to being able to maintain and secure our satellites. With that in mind, I would request that you allow me to come and have a conversation with you, and I can bring staff members or some of your staff, so we can talk about satellite servicing and the challenges that we face there.

It is my belief that with industry, companies like MacDonald, Dettwiler and Associates Ltd. (MDA), like Alliant Techsystems Inc. (ATK), who already have hardware in hand that does some of the functions we know we are going to need, and working with the Defense Advanced Research Projects Agency (DARPA) collaboratively—

Senator MIKULSKI. You come and talk to me.

Mr. BOLDEN. Yes, ma'am. I would really appreciate that. To be quite honest, I want to be in sync with the subcommittee, and I will admit, I am the one person in this room who is probably not in sync with you all, because for 4 years I have pleaded with people to tell me who the customer is going to be, and the potential customers keep telling me they would much rather have me be their customer.

I want to make sure that we are not at odds with American industry. I need to talk to you, if that would be good. I think we can get in sync.

Senator MIKULSKI. My time is up. I have another question about Wallops. I say to my chairman of this subcommittee and the chairman of the full committee, satellites are on my mind, and they are really a big budget, not only in the NASA committee.

Whether it is NOAA or the Department of Defense (DOD), I am worried that we do not know how to build them and maintain them and service them. We often run into satellite boondoggles.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. That is one thing. The second thing is then when they are up there, what do we do with them when they are no longer functional and can they be rescued. And third, the national security protection of key satellites from those nation states or others that would have a predatory intent.

I have satellites on my mind. I would like it in the budget.

Mr. BOLDEN. Yes, ma'am.

Senator MIKULSKI. Mr. Chairman, I have used up a lot of time.

Senator SHELBY. It is okay. Senator Cochran.

SPACE EXPLORATION PROGRAM

Senator COCHRAN. Mr. Chairman, thank you. Welcome again to our hearing. We appreciate the cooperation that we have received over time in helping to share our views with the Administration officials who have come before our subcommittee requesting funding

for the programs and activities. It is a pleasure to work with you on all these challenges.

As NASA continues to work on development of the space launch system, are you satisfied that the Administration and the Congress are constructively working together to help reach our goals of our space exploration program?

Mr. BOLDEN. Senator Cochran, because I am a part of the Administration, I will say I am not satisfied that I have sufficiently worked with this subcommittee, and I pledge I will do better.

It is like I mentioned to Senator Mikulski, I have pledged that I will be here much more than I have been, communicating with members of the subcommittee. I am pleading for the Senate to confirm Dr. Dava Newman as my deputy because I need the help. I think that will free me up to be able to spend more time with members of the subcommittee.

As I said in my opening statement, together, the Administration and this Congress have done an incredible job over the last 5 years. I want the members of the subcommittee to take credit for what you have done, to be quite honest. It is like trying to get the Administration to take credit. It seems like we are in the middle, and we are really happy about what has been done. We are not fooling ourselves that we have done everything. We think we are the best in the world at what we do, but that is not good enough.

I know that is a jumbled answer to your question, but I do not want you to think I am satisfied. I am not. I will do better.

ENGINE TESTING INFRASTRUCTURE

Senator COCHRAN. Specifically—thank you for that. The budget request provides information for us that is very helpful. We want to be sure we are doing the right thing, too. I want to know what your reaction is to whether we are providing adequate resources for the engine testing infrastructure to support the development of the Space Launch System, that would be a credit to our country.

Mr. BOLDEN. Senator, this subcommittee and the Congress have provided everything that we have asked for. I do not have any complaints about that. I would point out when you talked specifically about Stennis, the fact that we have had testing done by SpaceX, Aerojet Rocketdyne, DOD is now talking to us about doing testing at Stennis, Blue Origin is now doing testing at Stennis.

That in itself says we are being successful at capitalizing on the ability of American industry to augment what NASA does, so that we can utilize the funds that this subcommittee gives us to get on with the business of going into deep space.

Getting to Mars is our main objective right now. In order to do that, we need other things. We need the International Space Station to be viable and sustainable. We are comfortable we are okay there. We keep taking little bits of money away from the station to do other things in space operations that make me nervous sometimes.

We have to have the money we requested for commercial crew because that will finish off NASA getting out of low-Earth orbit access, and we will have successfully turned that over to American industry, and that puts us one step farther to being Earth independent. Not there, but one step farther.

We then need to move out into what we call the “proving ground,” going back to space, to orbit around the Moon for about a 10-year period of time to develop the technologies that we need to move onto Mars.

We have a lot of work to do, but this subcommittee, I cannot complain. I thank you for the funding you have given us.

Senator COCHRAN. We appreciate that. We want to continue to do what is necessary to ensure a robust engine testing infrastructure as Stennis, and if we think they have earned the right to continue to contribute up to date military intelligence capabilities that would be a credit to our country, and we are looking to develop and test even new rocket engines in the future.

What is your reaction to that? Is there a future?

Mr. BOLDEN. Senator Mikulski said she wanted to make sure that our best days were not behind us. Our best days are in front of us, I can promise you that. I am not smiling and sounding optimistic because I am trying to look good or something. I am excited about the future.

When I travel around to college campuses or high schools around the country or around the world, young people are really excited about what we are doing. They see this is their future. It is not ours. We are passing through. There is no doubt in my mind, Senator, all of you, that our best days are ahead of us.

Senator COCHRAN. It looks like we have a new city there, Stennis.

Mr. BOLDEN. It is the Federal city.

Senator COCHRAN. As well as the testing facility.

Mr. BOLDEN. Yes, sir.

Senator COCHRAN. We appreciate the fact that it has grown to become a Federal city due to the multiple Federal tenants that are there and seemed to be happy with what is going on, access to people, a beautiful view along the Mississippi Gulf Coast to boot.

Mr. BOLDEN. Yes, sir.

Senator COCHRAN. Thank you very much.

Mr. BOLDEN. Yes, sir.

Senator SHELBY. Senator Capito.

INDEPENDENT VERIFICATION AND VALIDATION (IV&V) FACILITY

Senator CAPITO. Thank you, Mr. Chairman. Thank you to the Administrator. General Bolden, we are really proud of the work that NASA does in West Virginia with the IV&V Program in Fairmont. The employees there are making a great contribution to our State, and I think to your agency, and to our country. It seems to me the service they provide is critical to complete your agency's objectives, both for the manned and unmanned missions. Can you share some thoughts about IV&V and what you think the future is for that part of NASA?

Mr. BOLDEN. The facility in West Virginia, but IV&V in general, in the broadest sense, because a lot of its work is not just done there, but done other places around the country. The work that is done for NASA is incredible. Again, the measure of your success or the measure of respect people show for you is to have outside organizations come to you and ask for assistance. We finished off the work we were doing for Homeland Security, for folks in New York

City, so there have been other outside organizations that have asked for help that IV&V has been able to provide for them. They provide a very necessary capability to this agency.

Senator CAPITO. Thank you. They also in their program, as you probably know, are inspiring students and educators in West Virginia, have over 100 educator workshops that they participated in, and have had a good impact.

One of the areas that I am interested in and because I am the co-chair of the recently formed Diversifying Technology Caucus, you know, we all have a caucus in a different name, I am a science major myself, and there is a great concern, and I share this concern, and you spoke about young people, a lot of the STEM education is not as diversified, both by females and minorities, what does NASA look like? You have a lot of science majors over there. I know you do not have this at the tip of your fingers. I am just curious.

Mr. BOLDEN. Unfortunately, I have it at the tip of my finger because I am not happy.

Senator CAPITO. Okay; good.

Mr. BOLDEN. We at NASA feel we should be the model for every other agency in the Federal Government, and as I said before, we have been the best place to work in Government for the past 3 years based on the Employee Viewpoint Survey, but we are worried. I am worried about the inability to maintain, to retain women and minorities in senior levels of leadership in the STEM fields.

The Deputy Associate Administrator, my chief scientist, Center Director Ellen Ochoa, Astronaut Cady Coleman, I have people all over trying to figure out what we are not doing right. We are probably better than most other Federal agencies, but that is not satisfactory.

Senator CAPITO. If you have the figures, since you mentioned it—

Mr. BOLDEN. Let me get it to you, so I do not guess.

[The information follows:]

Diversity of NASA Scientists and Engineers

As of April 2015

Explanation of terms and acronyms:

AAPI = Asian American and Pacific Islander. The percentage of Native Hawaiian and Other Pacific Islanders in the science and engineering civilian labor force is so small that meaningful comparisons with NASA's workforce could not be made if they were reported in a separate category (i.e., everything rounds to zero); they are therefore combined with Asian Americans for the purpose of comparing NASA with the RCLF.

AIAN = American Indian/Alaska Native

AST = Aerospace Technologist. AST is a special designation approved by OPM for the types of scientists and engineers hired by NASA. It is NASA's main mission critical occupational category.

RCLF = Relevant Civilian Labor Force (the portion of the 2010 civilian labor force that most closely matches the science and engineering workforces at NASA. There is one RCLF calculated for NASA Engineers and one calculated for Physical Scientists because the demographic diversity for these occupational categories is quite different. The RCLF is the benchmark used to compare NASA's diversity with that of the available technical labor pool. Note: for senior level positions, a different benchmark is used, namely the total NASA AST workforce. The logic is that, for

example, if 8 percent of NASA's AST workforce is African American, then approximately 8 percent of NASA's senior AST positions should be African Americans. This is an internal benchmark, as opposed to the RCLF, which is an external benchmark.

RNO = Race/National Origin

SES = Senior Executive Service

SL = Senior Level

ST = Senior Technologist

Diversity Statistics

(as of April 2015)

NASA Engineers by Race/National Origin (RNO) Compared to Relevant Civilian Labor Force (RCLF)*

	Asian American and Pacific Islander	Black	Hispanic	Multiracial	Amer. Indian	White	Total
#	827	640	671	12	92	7512	9754
%	8.5%	6.6%	6.9%	0.1%	0.9%	77.0%	100%
RCLF%*	11.4%	4.7%	5.2%	1.3%	0.3%	77.2%	100%

NASA Physical Scientists by Race/National Origin Compared to Relevant Civilian Labor Force (RCLF)**

	AAPI	Black	Hispanic	Multiracial	Amer. Indian	White	Total
#	82	22	36	0	1	761	902
%	9.1%	2.4%	4.0%	0.0%	0.1%	84.4%	100%
RCLF%**	13.0%	3.3%	4.3%	1.8%	0.3%	77.3%	100%

NASA Engineers by Gender Compared to Relevant Civilian Labor Force (RCLF)*

	Male	Female	Total
#	7562	2192	9754
%	77.5%	22.5%	100%
RCLF%*	88.8%	11.2%	100%

NASA Physical Scientists by Gender Compared to Relevant Civilian Labor Force (RCLF)**

	Male	Female	Total
#	685	217	902
%	75.9%	24.1%	100%
RCLF%**	64.1%	35.9%	100%

*RCLF for Engineers includes General, Electrical, Computer, Electronic, and Aerospace Engineers.

**RCLF for Physical Scientists includes Physical Scientists, Physicists, and Space Scientists.

Diversity Statistics

(as of April 2015)

NASA Senior Aerospace Technologists (AST) Positions by Race/National Origin

#	AAPI	Black	Hispanic	Multiracial	Amer. Indian	White	Total
SES	13	13	9	0	0	212	247
SL	2	1	4	0	1	50	58
ST	9	1	3	0	1	68	82
Total AST	931	672	715	12	95	8,231	8,425

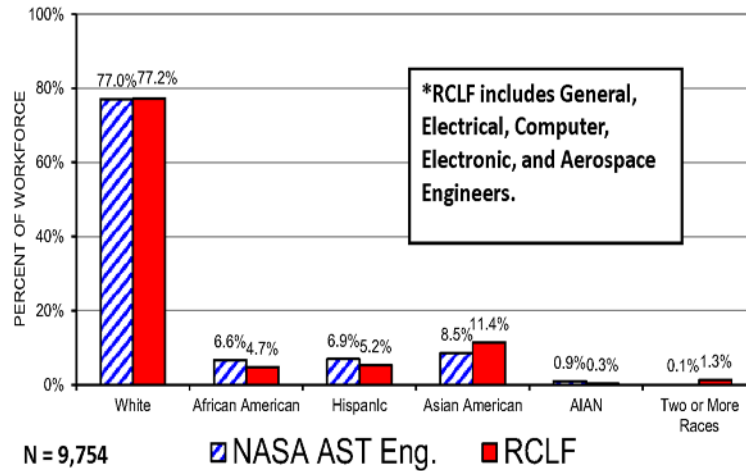
%	AAPI	Black	Hispanic	Multiracial	Amer. Indian	White	Total
SES	5.3%	5.3%	3.6%	0.0%	0.0%	85.8%	100%
SL	3.4%	1.7%	6.9%	0.0%	1.7%	86.2%	100%
ST	11.0%	1.2%	3.7%	0.0%	1.2%	82.9%	100%
Total AST	11.1%	8.0%	8.5%	0.1%	1.1%	97.7%	100%

NASA Senior Aerospace Technologists (AST) Positions by Gender

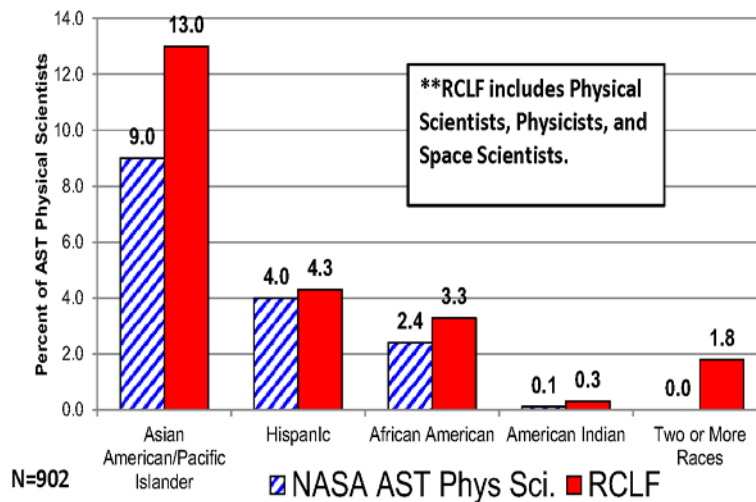
#	Males	Females	Total
SES	200	47	247
SL	46	12	58
ST	73	9	82
Total AST	8,390	2,460	10,850

%	Males	Females	Total
SES	81.0%	19.0%	100%
SL	79.3%	20.7%	100%
ST	89.0%	11.0%	100%
Total AST	77.3%	22.7%	100%

FY 15 Aerospace Technologist (AST) Engineers by RNO vs. the Relevant Civilian Labor Force (RCLF)*



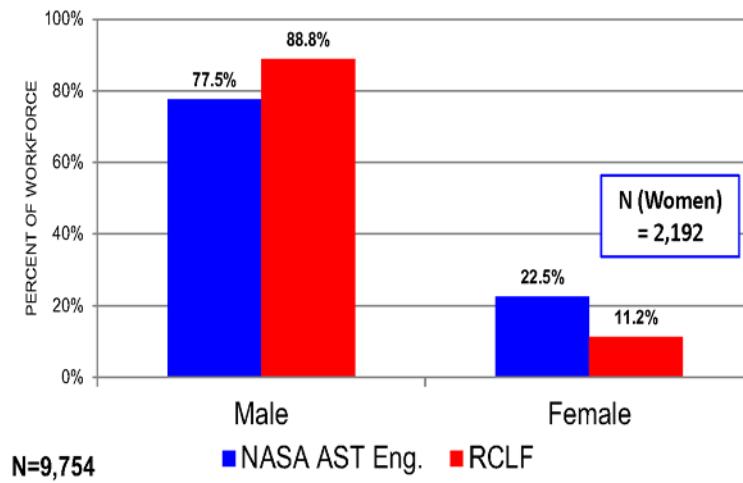
NASA AST Physical Scientists by RNO vs. the RCLF**



Aerospace Technologist is a special occupational category approved for NASA by OPM that includes scientists and engineers.

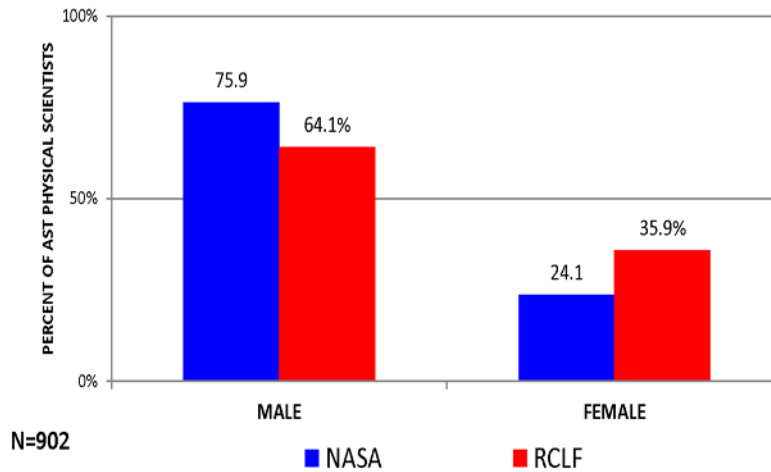
NASA data as of April 2015.

NASA FY 15 AST Engineers by Gender vs. the RCLF*



*RCLF includes General, Electrical, Computer, Electronic, and Aerospace Engineers

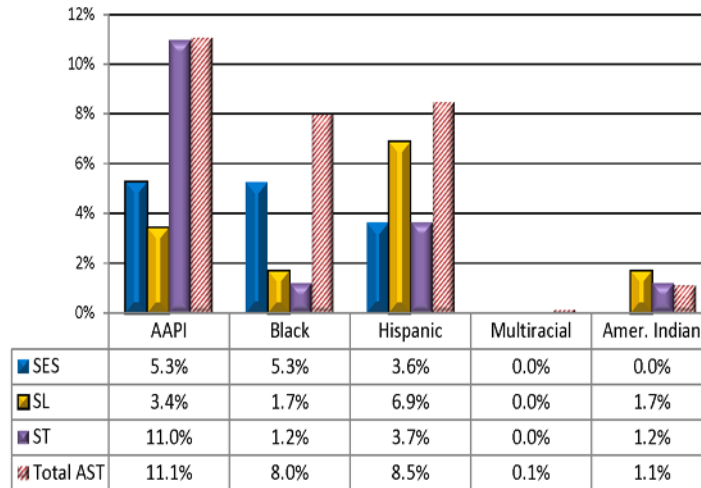
NASA FY 15 AST Physical Scientists by Gender vs. the RCLF**



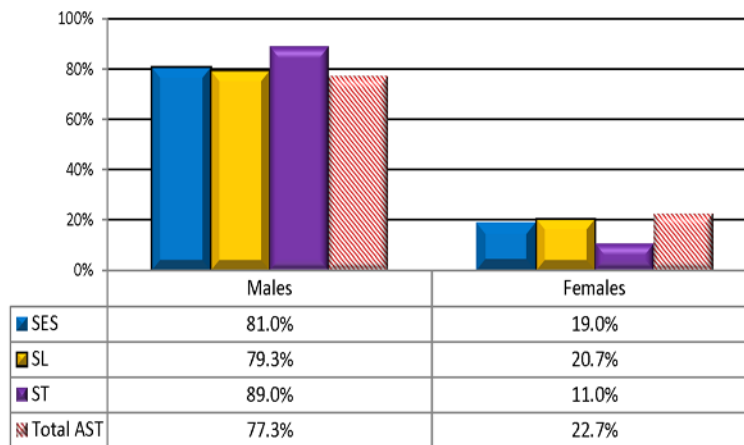
**RCLF includes Physical Scientists, Physicists, and Space Scientists.

NASA data as of April 2015.

NASA Senior Aerospace Technologists (AST)* Positions by RNO



NASA Senior AST* Positions by Gender



*Aerospace Technologist is a special occupational category approved for NASA by OPM that includes scientists and engineers.

NASA data as of April 2015.

DIVERSIFYING TECHNOLOGY

Mr. BOLDEN. I can tell you the mix of women in the STEM field marries what it is in society, and that is why I say that is unacceptable.

Senator CAPITO. It is unacceptable.

Mr. BOLDEN. We have 51 percent women in the population and we are in the low teens of percentage of women in STEM. That does not say 51 percent of the STEM workforce ought to be women, but it ought to be better than 13 or whatever it is.

Senator CAPITO. I would suggest, and I think the IV&V Program has done this by doing educator outreach—for some reason, it is probably the same thing Senator Mikulski and I have, we get the question all the time, why are there not more women in the Senate, why are there not more women in public service.

It is one of these things that the numbers have to feed on one another and one another, and it is a slow progress. I think by starting early, K through elementary, K through three, you really do have to start there, because when you see what is coming at our young people in terms of how they can get a lot of knowledge from their phones and everything else, their minds are forming, I think, earlier on what direction they want to go.

I would love to partner with NASA in this endeavor on diversifying technology. I think it is a natural spot. Since we have a good presence in Fairmont, that might be a good jumping off place for some kind of pilot programs to be able to inspire our young women and more minorities to join this exciting field that can be very, very lucrative at the same time and very stable.

Mr. BOLDEN. Yes, ma'am.

Senator CAPITO. I thank you for your service. Thank you.

Senator SHELBY. Senator Mikulski.

JAMES WEBB SPACE TELESCOPE

Senator MIKULSKI. Mr. Chairman, just one question and one comment. The James Webb Space Telescope, you are exactly right, Administrator, that we were deeply troubled about the Webb, that there were cost overruns, could we meet both the technological targets as well as the fiscal targets.

Could you tell the subcommittee the status of the James Webb and have you also addressed the GAO questions about schedule reserves and the cryocooler to make sure it—as you know, there is the GAO report, some press reports, and flashing yellow lights.

Could you tell us are you on target, and have you addressed these concerns raised by these outside oversights?

Mr. BOLDEN. Senator, I would venture to say we are on target, and we are on target for one primary reason, and that is after I promised you, the responsibility for the James Webb Space Telescope came into the Office of the Administrator. First, we had Chris Scolese as the Associate Administrator, and now Robert Lightfoot, and in their respective roles, they were representing me in James Webb almost every day.

Chris Scolese is now at the Goddard Space Flight Center that has primary responsibility for it. Chris is in it every single day. I now have a monthly tag up with Wes Bush, the CEO of Northrop

Grumman, because we both agree on the critical importance of the James Webb Space Telescope, not just to this Nation but to the world, but also it is critical for both him and me to demonstrate we know what the heck we are doing.

If we cannot deliver it on time and on budget or under budget, then it says there is something wrong. We are concerned about the technological challenge of the cryocooler, but we think that is getting back on track.

We still have about a 10 month cushion in the schedule, but I caution people——

Senator MIKULSKI. What does a cryocooler do?

Mr. BOLDEN. It is actually what enables the telescope to go down to almost absolute zero. It takes it to really cold. It is going to operate a million miles away from Earth, and it is an infrared imaging telescope. The reason why it is so phenomenal and that it is going to dwarf the capability of Hubble is because although it only operates in the infrared range, keeping it as cold as we do, it is going to be able to look into the atmosphere of distant planets around the billions of distant stars, some that are not even in our own Galaxy. That is what is going to make it really, really good.

It would still be phenomenal without it, but that is not what we——

Senator MIKULSKI. Presuming this actually happens, do you believe the completion and successful launch and operation of the James Webb will secure America's preeminence in astronomy for the next 30 or 40 years?

Mr. BOLDEN. Senator, there is no question. Now that we are on the Hubble anniversary, I tell people about our crew before we launched on the deploy mission, we knew, we absolutely knew that Hubble was going to do something great. We had no clue. If anybody had asked us if it was going to have taken its place in the pantheon of great scientific instruments, we did not know that. We are very confident that James Webb will further revolutionize the fields of planetary science, astrophysics. We will know more about this universe as a result of James Webb after 2018 than anybody ever imagined.

Senator MIKULSKI. I am glad I went into orbit.

Mr. BOLDEN. You and me both.

Senator MIKULSKI. Thank you very much.

Senator SHELBY. Thank you, Senator Mikulski. I think Senator Mikulski knew it. She knew what the potential was or she would not have pushed so long and so hard and successfully, and we should all be grateful. She must be akin to her cousin, Copernicus, in looking ahead in some way.

COMMERCIAL CREW MILESTONE SCHEDULE DELAYS

General, I have a couple more questions. NASA entered into, in my understanding, two milestone based contracts worth up to \$6.8 billion in September of this last year to finish the development and testing of crewed vehicles.

Aside from five milestones that NASA required, the contractors were able to add milestones and time lines of their own, with payment only given when a milestone is achieved. NASA has already publicly stated that a significant number of the milestones are

being altered. In other words, they have not met them, some with delays of 6 months or more.

A lot of us are concerned by the potentially large number of changes and delays so soon in the program. My question is this: the subcommittee has seen the first quarter report on the Commercial Crew Program. Who asked for the changes to the milestones, and how will altering the milestone schedules delay the expected date for taking our astronauts to the space station?

Mr. BOLDEN. Mr. Chairman, I will get you specific answers for the record.

[The information follows:]

Commercial Crew Program Milestone Schedule Delays

As reported to the Committee, both Commercial Crew Transportation Capability (CCtCap) companies updated their schedules to reflect additional design maturation and to allow sufficient time to complete system development and certification. NASA anticipated a number of these types of changes during this timeframe because the original contract milestones were established when the companies submitted their CCtCap proposals, over a year ago. Such changes are not indicative of poor company performance, but are viewed by NASA to be the normal evolution of refining sub-contract schedules and finalizing development plans after contract award. Accordingly, the companies requested the milestone date changes, and NASA has reviewed and approved them. We will continue to work with the companies to adhere to the new overall schedule. We will identify any possible changes quickly making minor milestones adjustments only as required. This will protect overall schedule while maintaining a safe configuration for our crews.

As reported in the first Quarterly Report, the Certification Review milestone date (i.e., the expected date for NASA certification of the companies systems to transport NASA personnel to the ISS) for Boeing was changed from August 2017 to October 2017; the SpaceX Certification Review milestone date was changed from April 2017 to October 2017. The Commercial Crew Program is a large, complex development effort whereby the partners are expected to conform to a set of requirements in a fixed price contract.

Mr. BOLDEN. I will tell you how it works. Frequently, we ask for the slip in the milestone because we do not have the money to pay it. That is why it is critically important. We now have two contracts, so we are contractually obligated to Boeing and SpaceX to pay them up to \$6.8 billion. We have guaranteed them two missions each minimum, and up to six.

Senator SHELBY. You want to meet those obligations.

Mr. BOLDEN. I want to meet those obligations, and the only way for me to meet them—

Senator SHELBY. Will they meet their obligations?

Mr. BOLDEN. They will meet their obligations. Mr. Chairman, I do not have any doubt. I have the utmost confidence in both Boeing and SpaceX that they will meet their obligations if we meet ours to pay the bill.

Our obligation is to provide oversight and insight, and make sure that we know what they have to do to provide us a safe vehicle. I have to have the money to pay them.

Senator SHELBY. Will you get this information for the subcommittee to evaluate?

Mr. BOLDEN. I will.

RUSSIAN SEAT SOLICITATION

Senator SHELBY. My last question has to do with the Russian seat solicitation. The Commercial Crew Program is intending to re-

place our reliance on the Russians for transport to and from the space station as early as 2017.

NASA has put a solicitation out, is my understanding, to purchase six more seats on Russian vehicles at a time when seats on the commercial crew vehicles should be available. I said "should."

Mr. BOLDEN. Yes, sir.

Senator SHELBY. It appears NASA is already purchasing its own insurance policy in case the crew providers are not ready. I do not know that. The current cost of a seat from the Russians, I understand, is about \$76 million, and it will likely be even more for those additional seats.

The question I have for you, General, and for the record, too, what has NASA seen so far in the continued development of our own crewed vehicles to justify paying Russia hundreds of millions of dollars for seats that should already be covered by the U.S. providers if the U.S. companies meet their milestones?

I do not know the situation. Could you explain?

Mr. BOLDEN. Yes. The primary we have seen is the lack of commitment on the part of the Congress to fund the program at the amount requested by the President, and the President's request was to meet the contractual price that we negotiated with Boeing and SpaceX. That is not an estimate.

Senator SHELBY. The bottom line is you need more money; is that right?

Mr. BOLDEN. We always need what we ask for in the budget. I would be more than happy to take more. We really need \$1.2 billion in 2016 because this is a critical time for us to make the 2017 launch date. We need \$1.2 billion so they can complete the milestones that we have both agreed to.

Senator SHELBY. If they can complete them, we would not need to spend that money with Russia; right?

Mr. BOLDEN. When we have an American capability, then we do not spend any more money with the Russians. We do not pay them for seats any more. We definitely will not pay them for seats any more once we have an American capability.

COMMERCIAL CREW TRANSPORTATION CAPABILITY (CCTCAP) CONTRACTS

Senator SHELBY. Let me share this with you. It is my understanding that in the Commercial Crew Program, NASA initially decided to spread, General, the limited funding resources across five companies. It took NASA 5 years and \$1.9 billion to finally pick two companies.

Mr. BOLDEN. Yes, sir.

Senator SHELBY. That will share \$6.8 billion to develop a commercial crew capability. However, NASA continues to blame Congress for lack of resources, when it was NASA that chose to spend nearly \$2 billion on a competition.

While I agree as we all do that competition is important, prudent decisions in constrained fiscal environments such as this, are very important.

My question here is this: in your view, has the decision to fund multiple companies during the initial competition delayed the de-

livery of a viable commercial crew capability? You spent a good deal of money doing that.

Mr. BOLDEN. Senator, it is my belief that spending that money did not delay it at all. In fact, it gave us assurance that the two systems that we finally selected would in fact be the absolute best. We are still investing money in some of the companies that were in competition initially because they are still getting milestone payments under the original Space Act Agreements that we had, because they are bringing us benefits that we do not have to develop ourselves or the two contractors do not.

If you look at Blue Origin, for example, as a result of the work that they have been doing with engines, we may have a new launch system by an American company with American engines. That remains to be seen.

Some of the development that they did in the area of engines was as a result of collaborating with NASA, some of the test of components, as Senator Cochran mentioned, was done at Stennis. They do not test the full engine but they are where they are today, perhaps 2 years away from being able to develop a heavy lift engine of American origin, and that is because of the work that we supplemented.

Senator SHELBY. We appreciate that. We will continue to look at that. It is incumbent upon this subcommittee, as Senator Mikulski has said many times, that we are accountable to the American people and to our colleagues, and you are accountable to us. We are going to have to ask the right and tough questions.

Mr. BOLDEN. Yes, sir.

ADDITIONAL COMMITTEE QUESTIONS

Senator SHELBY. Thank you very much, General. This will conclude our hearing. We may have some follow-up questions for the record.

Mr. BOLDEN. Yes, sir. Mr. Chairman, I will get you the information.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

QUESTIONS SUBMITTED TO HON. CHARLES F. BOLDEN, JR.

QUESTIONS SUBMITTED BY SENATOR CHRISTOPHER A. COONS

SPACEPORT LAUNCH PAD 0

Question. What is the status of funding to complete repairs to launch Pad 0-A (Spaceport) in order to return to flight the Antares Rocket from the Wallops Flight Facility?

Answer. NASA is strongly committed to maintaining a small/medium class launch vehicle capability at the NASA Wallops Flight Facility (WFF) in support of cargo resupply for the International Space Station (ISS), and is pleased at the progress of repair activities at pad 0A. NASA intends to ensure the needs of the ISS are met through the Commercial Resupply Services (CRS) contract between NASA and Orbital Sciences Corporation (now Orbital ATK). In fiscal year 2015, consistent with NASA's communications with the House and Senate Committees on Appropriations, NASA has provided a total of \$5.0 million for commercial launch site services at WFF. Orbital ATK has made clear they intend to recover the capability to launch resupply missions again from Wallops, and has allocated funding in this regard. The Mid-Atlantic Regional Spaceport (MARS) has allocated funding from their annual maintenance budget for site cleanup and environmental remediation activities, site

and engineering damage assessments, disassembly of damaged pad infrastructure, and repair of pad systems. NASA is continuing to work with all the parties—MARS, Orbital ATK, and the Commonwealth of Virginia—to ensure a small/medium class launch capability is restored to Wallops under the terms of the existing contracts and agreements. In sum, MARS continues to make good progress towards Pad 0A repair and return to service. All required demolition work has been completed, and all concrete structures have been repaired or replaced. In addition, all damaged fueling and pressure system piping have been identified, and fabrication and installation of new items is proceeding well. MARS, Orbital ATK, and NASA WFF are currently (end of July) in the replacement, cleaning and testing stage of the pad recovery. Environment monitoring is continuing to ensure there is no lasting impact to the launch pad area. Funding allocated to date supports the schedule for Pad 0A turnover to Orbital-ATK as planned.

NATIONAL SPACE ACCESS NEEDS

Question. What is NASA's plan to upgrade the range capabilities at Wallops Flight Facility, NASA's only launch range and one of the few active commercial spaceports to meet emerging national space access needs?

Answer. NASA missions use a number of launch sites, including the Agency's facilities at Kennedy Space Center in Florida and Wallops Flight Facility in Virginia.

- The Wallops Range Control Center expansion and upgrades are continuing, and the remote range support systems in Bermuda are being upgraded and hardened. Bermuda support is required for Orbital-ATK Antares Commercial Resupply Services (CRS) launches. The work being done in Bermuda includes:
 - Instrumentation formerly in mobile command and telemetry trailers will be housed in a concrete building originally built by NASA;
 - Radomes will be installed to protect sensitive antennas, previously subject to extreme corrosion; and
 - Upgrades and hardening will significantly reduce annual funding requirements for personnel and maintenance associated with Bermuda activities.

SUBCOMMITTEE RECESS

Senator SHELBY. Thank you very much. The subcommittee is adjourned.

[Whereupon, at 3:30 p.m., Thursday, April 16, the subcommittee was recessed, to reconvene subject to the call of the Chair.]