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Summary

The National Aeronautics and Space Administration (NASA) was created in 1958 by the National Aeronautics and Space Act (P.L. 85-568) to conduct civilian space and aeronautics activities. It has four mission directorates. The Science Mission Directorate manages robotic science missions, such as the Hubble Space Telescope, the Mars rover Curiosity, and satellites for Earth science research. The Aeronautics Research Mission Directorate conducts research and development on aircraft and aviation systems. The Space Technology Mission Directorate develops technologies for use in future space missions, such as advanced propulsion and laser communications. The Human Exploration and Operations Mission Directorate is responsible for human spaceflight activities, including the International Space Station and development efforts for future crewed spacecraft. In addition, NASA's Office of Education manages formal and informal education programs for school children, college and university students, and the general public.

While Congress is generally supportive of most NASA programs, government-wide fiscal constraints make funding decisions challenging. The Administration has requested \$19.025 billion for NASA in FY2017. This amount is 1.3% less than the FY2016 appropriation of \$19.285 billion. Unusually, the FY2017 request includes \$763 million in mandatory funds. The House bill (H.R. 5393) would provide \$19.508 billion. The Senate bill (S. 2837) would provide \$19.306 billion. Neither bill includes mandatory funding.

The FY2017 request for the Science Mission Directorate is \$5.601 billion, an increase of 0.2% from FY2016. Within this total, funding for Earth Science, Astrophysics, and Heliophysics would increase, while funding for Planetary Science and the James Webb Space Telescope would decrease. The House bill would provide \$5.597 billion for Science, while the Senate bill would provide \$5.395 billion. Within these totals, the bills differ considerably in their allocation of funding between Earth Science and Planetary Science.

The FY2017 request for the Aeronautics Research Mission Directorate is \$790 million, an increase of 23.5% from FY2016. The request includes New Aviation Horizons (NAH), a new initiative of experimental aircraft and systems demonstrations. The House and Senate bills would provide \$712 million and \$601 million, respectively, for Aeronautics.

The FY2017 request for the Space Technology Mission Directorate is \$827 million, an increase of 20.4% from FY2016. The House and Senate bills would provide \$739 million and \$687 million.

For the Human Exploration and Operations Mission Directorate, the FY2017 request for Exploration is \$3.337 billion, a decrease of 17.2% from FY2016, while the request for Space Operations is \$5.076 billion, an increase of 0.9%. The Exploration request includes \$1.263 billion, a decrease of 35.2%, for Space Launch System launch vehicle development. Funding for the Commercial Crew program (formerly requested in Exploration) is combined with funding for operational cargo and crew transport to the International Space Station in a new Space Transportation item within Space Operations. The House bill would provide \$4.183 billion for Exploration, including \$2.000 billion for SLS development, and \$4.890 billion for Space Operations. The Senate bill would provide \$4.330 billion for Exploration, including \$2.150 billion for the SLS, and \$4.951 billion for Space Operations.

The FY2017 request for the Office of Education is \$100 million, a decrease of 13.0% from FY2016. The House and Senate bills would provide \$115 million and \$108 million, respectively. The request would reduce funding for the National Space Grant College and Fellowship Program, the Experimental Program to Stimulate Competitive Research, and the Minority University Research Education Program. Both bills would fund these programs at their FY2016 levels.

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While Congress is generally supportive of most NASA programs, government-wide fiscal constraints make funding decisions challenging. This report presents an overview and selected highlights of NASA's proposed FY2017 budget and the FY2017 appropriations legislation reported by the House Committee on Appropriations (H.R. 5393, H.Rept. 114-605) and the Senate Committee on Appropriations (S. 2837, S.Rept. 114-239). The report will be updated as Congress takes additional action on FY2017 appropriations legislation.

Overview

The Administration has requested \$19.025 billion for NASA in FY2017. This amount is 1.3% less than the FY2016 appropriation of \$19.285 billion.¹ The House bill would provide \$19.508 billion. The Senate bill would provide \$19.306 billion. See **Table 1**.

Unusually, the FY2017 request includes \$763 million in mandatory funds. The Administration explains this as follows:

The President believes that arbitrary funding caps are harmful to the economy and the Nation. Although the recent Bipartisan Budget Act provided important relief from sequester cuts, the constrained top line for discretionary funding, especially in FY 2017, has made it difficult to appropriately fund important national priorities, including research and development. In the FY 2017 Budget, the President proposes fully-paid-for one-year mandatory funding to accelerate progress in Science, Aeronautics, Space Technology, and Exploration, as well as additional multi-year mandatory funding for Aeronautics to support research and development for low carbon emission aircraft, including associated transportation systems, as part of a multi-agency effort to enable a 21st century clean transportation system.²

Typically, NASA receives no more than a few million dollars per year of mandatory funding. In FY2015, for example, it received \$2 million for Space Operations from the Spectrum Reallocation Fund and \$1 million from the Science, Space, and Technology Education Trust Fund.³ The discretionary portion of the FY2017 request, \$18.262 billion, would be 5.3% less than the FY2016 appropriation. The House and Senate bills include no mandatory funding.

¹ FY2016 amounts in this report are based on the Consolidated Appropriations Act, 2016 (P.L. 114-113) and the accompanying explanatory statement, *Congressional Record*, December 17, 2015, at pp. H9741-H9743. Some amounts (but not the total) may change under NASA operating plans that reflect transfers and reprogramming.

² FY2017 NASA congressional budget justification, p. SUM-10. The justification does not identify a source for most of the proposed mandatory funding.

³ FY2017 Budget of the United States Government, Appendix, pp. 1190 and 1193.

Table I. NASA Appropriations, FY2016-FY2017
(budget authority in \$ millions)

	FY2016	FY2017 Request		FY2017 Legislation		
	Enacted	Total	Mand.	Discr.	H. Cte.	S. Cte. Enacted
Science	\$5,589	\$5,601	\$298	\$5,303	\$5,597	5,395
Earth Science	1,921	2,032	60	1,972	1,690	1,984
Planetary Science	1,631	1,519	128	1,391	1,846	1,356
Astrophysics	731	782	85	697	793	807
James Webb Space Telescope	620	569	—	569	569	569
Heliophysics	650	699	25	674	699	679
Education	37	— ^a	—	— ^a	— ^b	— ^c
Aeronautics	640	790	156	635	712	601
Space Technology	687	827	136	691	739	687
Exploration	4,030	3,337	173	3,164	4,183	4,330
Exploration Systems Development	3,680	2,860	173	2,687	3,779	3,934
- Orion MPCV	1,270	1,120	66	1,053	1,350	1,300
- Space Launch System	2,000	1,310	80	1,230	2,000	2,150
- Exploration Ground Systems	410	429	26	403	429	484
Exploration R&D	350	477	—	477	404	396
Space Operations	5,029	5,076	—	5,076	4,890	4,951
Space Shuttle	n/s	—	—	—	n/s	8
International Space Station	n/s	1,431	—	1,431	n/s	n/s
Space Transportation	n/s ^d	2,758 ^e	—	2,758 ^e	n/s	n/s ^e
Space and Flight Support	n/s	887	—	887	n/s	n/s
Education	115	100	—	100	115	108
Space Grant	40	24	—	24	40	40
EPSCoR	18	9	—	9	18	18
MUREP	32	30	—	30	32	32
Other	25	37	—	37	25	18
Safety, Security, & Mission Services	2,769	2,837	—	2,837	2,835	2,797
Construction & EC&R	389	420	—	420	398	400
Inspector General	37	38	—	38	38	38
Total	19,285	19,025	763	18,262	19,508	19,306

Sources: FY2016 enacted from P.L. 114-113 and pp. H9741-H9743 of the explanatory statement, *Congressional Record*, December 17, 2015. FY2017 request from NASA FY2017 congressional budget justification. FY2017 House Committee from H.R. 5393 as reported and H.Rept. 114-605. FY2017 Senate Committee from S. 2837 as reported and S.Rept. 114-239.

Notes: Some totals may not add because of rounding. For readability, a dash indicates zero. n/s = not specified. MPCV = Multipurpose Crew Vehicle. R&D = Research and Development. EPSCoR = Experimental Program to Stimulate Competitive Research. MUREP = Minority University Research Education Program. EC&R = Environmental Compliance and Remediation.

- a. Astrophysics includes \$25 million for education.
- b. Other Science themes include \$37 million for education and public outreach.
- c. Astrophysics includes \$42 million for education.
- d. Includes up to \$1,244 million for Commercial Crew.
- e. Includes \$1,185 million for Commercial Crew.

There is no authorized level for NASA appropriations in FY2017. The most recent authorization act (the NASA Authorization Act of 2010, P.L. 111-267) authorized appropriations through FY2013. The NASA Authorization Act for 2016 and 2017 (H.R. 2039, ordered reported by the House Committee on Science, Space, and Technology in April 2015, but not yet reported) includes proposed authorization amounts for FY2017.⁴

Science

The FY2017 request for the Science Mission Directorate is \$5.601 billion, an increase of 0.2% from FY2016. Within this total, funding for Earth Science, Astrophysics, and Heliophysics would increase, while funding for Planetary Science and the James Webb Space Telescope would decrease. As shown in **Table 1**, the House bill would provide \$4 million less than the request, while the Senate bill would provide \$206 million less. Relative to the request, the House bill would shift more than \$300 million from Earth Science to Planetary Science. In contrast, most of the Senate bill's decrease would be in Planetary Science.

Within Earth Science, the request includes \$131 million (up from \$100 million in FY2016) for the Landsat-9 land imaging satellite. Launch is anticipated "as early as" 2021. NASA previously proposed the Thermal Infrared Free Flyer, a lower-cost satellite intended to reduce the risk of a gap in data availability prior to the launch of Landsat-9. Congress rejected funding for the Thermal Infrared Free Flyer in the FY2016 appropriations cycle, and the mission is not included in the FY2017 request. The House report directs NASA to prioritize funds for Landsat-9 and to evaluate commercially available data in the event of a data gap in the Landsat program. The Senate report recommends the requested amount for Landsat-9 and directs NASA to provide a plan detailing the technical and schedule progress needed for a 2020 launch date.

Within Planetary Science, the request includes \$50 million (down from \$175 million in FY2016) for a mission to Jupiter's moon Europa. Although a mission to Europa was a high priority of the 2011 National Research Council (NRC) decadal survey of planetary science,⁵ the NRC expressed reservations about its anticipated cost. For several years, Congress has appropriated more for formulation of a Europa mission than NASA has requested. As directed by the Consolidated Appropriations Act, 2016, NASA's FY2017 congressional budget justification includes a five-year estimate of the funding required assuming a 2022 launch (see **Table 2**). The justification states that "the notional outyear profile in the Budget may support a launch as early as the late 2020s, assuming the mission concept and scope remain stable.... Acceleration of the launch to 2022 is not recommended, given potential impacts to the rest of the Science portfolio." The House report recommends at least \$260 million for Europa orbiter and lander missions, with the orbiter launch no later than 2022 and the lander launch no later than 2024. The Senate report calls for "an expeditious launch and reduced travel time" in order to maximize the scientific return of a Europa mission, but it does not specify a funding level or a launch date. It directs NASA to provide a report on options for the mission "to assist the Committee in evaluating potential mission configurations."

⁴ For details, see CRS Report R43419, *NASA Appropriations and Authorizations: A Fact Sheet*, by (name redacted)

⁵ National Research Council, *Vision and Voyages for Planetary Science in the Decade 2013-2022* (National Academies Press, 2011). Available online at http://www.nap.edu/catalog.php?record_id=13117.

Table 2. Estimated Five-Year Cost of a Europa Mission Assuming Launch in 2022
(\$ in millions)

FY2017	FY2018	FY2019	FY2020	FY2021
\$194	\$272	\$456	\$678	\$482

Source: NASA FY2017 congressional budget justification, p. PS-58.

Aeronautics

The FY2017 request for the Aeronautics Research Mission Directorate is \$790 million, an increase of 23.5% from FY2016. The request includes New Aviation Horizons (NAH), a new initiative of experimental aircraft and systems demonstrations. NAH projects on subsonic aircraft would receive \$100 million in mandatory funding from the President's proposed 21st Century Clean Transportation Plan.⁶ An additional \$56 million in mandatory funding would fund a low-boom supersonic flight demonstrator.

As shown in **Table 1**, the House bill would provide \$78 million less than the request for Aeronautics, while the Senate bill would provide \$189 million less. The House committee's recommendation includes \$61 million (of discretionary funds) for a low-boom flight demonstrator. The House and Senate committee reports both direct NASA to work with the Federal Aviation Administration on research related to the integration of unmanned aerial systems in the National Airspace System.⁷

Space Technology

The FY2017 request for the Space Technology Mission Directorate is \$827 million, an increase of 20.4% from FY2016. Space Technology was first established as a separate account in FY2011. Each year since then, the Administration has proposed to increase Space Technology funding. Congress has provided increases each year except FY2014, but always less than the Administration's request. Proposed mandatory funding of \$136 million would account for almost all of the requested increase in FY2017. The bulk of the mandatory funding would support technology demonstration missions, including the Restore-L satellite servicing mission for which Congress appropriated \$133 million in FY2016.

As shown in **Table 1**, the House bill would provide \$88 million less than the request for Space Technology, but more than the FY2016 appropriation, while the Senate bill would provide the FY2016 amount. The Senate committee report recommends \$130 million for Restore-L. The House and Senate committee reports both identify nuclear propulsion research and a small launch technology demonstration platform as funding priorities.

⁶ See "Fact Sheet: President Obama's 21st Century Clean Transportation System," White House press release, February 4, 2016, <https://www.whitehouse.gov/the-press-office/2016/02/04/fact-sheet-president-obamas-21st-century-clean-transportation-system>.

⁷ For more information on this issue, see CRS Report R44352, *Unmanned Aircraft Operations in Domestic Airspace: U.S. Policy Perspectives and the Regulatory Landscape*, by (name redacted)

Human Exploration and Operations

The Human Exploration and Operations Mission Directorate (HEOMD) is funded by two appropriations accounts: Exploration and Space Operations. The FY2017 request for Exploration is \$3.337 billion, a decrease of 17.2% from FY2016. The request for Space Operations is \$5.076 billion, an increase of 0.9%. As shown in **Table 1**, the House and Senate bills would both provide significantly more than the request for Exploration and somewhat less than the request for Space Operations.

Exploration

The Exploration account primarily funds development of the Orion Multipurpose Crew Vehicle and the Space Launch System (SLS) heavy-lift rocket, the capsule and launch vehicle mandated by the NASA Authorization Act of 2010 for future human exploration beyond Earth orbit. The account previously also funded development of a commercial crew transportation capability for U.S. astronaut access to the International Space Station (ISS), but Congress transferred this activity to Space Operations in FY2016. Within Exploration, the FY2017 request for Orion, the SLS, and related ground systems (known collectively as Exploration Systems Development) is \$2.860 billion, a decrease of 22.3% from FY2016. The bulk of the reduction would be for SLS launch vehicle development, which would receive \$1.263 billion, down 35.2% from \$1.950 billion in FY2016. According to NASA, the SLS program remains on track for a first test flight carrying Orion but no crew (known as EM-1) in November 2018. The launch readiness date for the first flight of Orion and the SLS with a crew on board (known as EM-2) continues to be FY2023.

The increases for Exploration in the House and Senate bills, relative to the request, would fund the SLS at the FY2016 level (in the House bill) or higher (in the Senate bill). The House and Senate reports both recommend funding for development of the SLS Exploration Upper Stage (EUS)—\$250 million and \$300 million, respectively—which is not included in the Administration request. The House report specifies that none of the funds in the House bill are for the Asteroid Redirect Mission, which was first proposed in the FY2014 budget and which has faced ongoing opposition in Congress.

Space Operations

The Space Operations account primarily funds operational human spaceflight: the ISS, transportation of crew and cargo to and from the ISS, and formerly the space shuttle program.⁸ It also funds the Space and Flight Support program, which consists of launch site operations, space-to-ground communications, and other support activities. Because Congress gave limited direction about how the FY2016 appropriation for Space Operations should be allocated, it is difficult to determine how the allocation of the FY2017 request compares to FY2016. The FY2017 budget is the first to highlight Space Transportation (to and from the ISS) as a top-level item within Space Operations. In previous budgets, the cost of U.S. commercial cargo flights to the ISS and payments to Russia for Soyuz flights carrying ISS crews were subcategories within the ISS budget. Meanwhile, the program to develop a U.S. capability for commercial transportation of

⁸ Although the last flight of a space shuttle was in 2011, program closeout activities, such as subcontractor audits, are still ongoing.

ISS crews was funded in the Exploration account. These functions are now combined in the request for Space Transportation.

The House and Senate bills would provide \$186 million less and \$125 million less, respectively, than the request for Space Operations. For the most part, the committee reports do not specify how the recommended funding should be allocated. However, the Senate report does note that its total includes \$1.185 billion for Commercial Crew, the same as the request.

Orion and SLS vs. Commercial Crew

The balance of funding between Exploration Systems Development and the Commercial Crew program has been contentious. Before the FY2017 request, recent Administration budgets proposed to decrease funding for Exploration Systems Development while increasing funding for Commercial Crew. NASA argued that the amounts it requested for the Commercial Crew program were necessary to maintain the scheduled availability of commercial crew transportation to the ISS starting in 2017. It noted that without a U.S. commercial capability, it would need to pay Russia for additional Soyuz flights (although it has also stated that it will likely purchase some additional Soyuz flights in any case). Meanwhile, NASA officials stated that the schedule for the EM-1 test flight would be difficult to accelerate, even with additional funding, because it depends on technical requirements such as engineering design and manufacturing schedules and the need for adequate testing.⁹ Congressional supporters countered that the Orion and SLS programs were not receiving the funds they needed, and many saw this pattern as demonstrating a difference in human spaceflight priorities between Congress and the Administration. Congress has generally appropriated less than the Administration's request for Commercial Crew and more for Exploration Systems Development. In the FY2017 request, the Administration is again requesting a reduction for Exploration Systems Development, especially the SLS, but it appears to be requesting approximately the FY2016 amount for Commercial Crew (although the FY2016 allocation of Space Operations funds is not yet clear). The House and Senate bills would again provide more than the request for Exploration Systems Development, but the Senate bill would provide the requested amount for Commercial Crew. The House report does not specify a recommended allocation for Commercial Crew.

Education

The FY2017 request for the Office of Education is \$100 million, a decrease of 13.0% from FY2016. Programs of particular congressional interest include the National Space Grant College and Fellowship Program (\$24 million), the Experimental Program to Stimulate Competitive Research (EPSCoR, \$9 million), and the Minority University Research Education Program (MUREP, \$30 million). Note that not all NASA education activities are managed or funded by the Office of Education. For example, the request for Astrophysics in the Science Mission Directorate includes \$25 million for science, technology, engineering, and mathematics (STEM) education. However, recent Administration initiatives to consolidate and reorganize STEM education activities across the government (see CRS In Focus IF10229, *The Changing Federal STEM Education Effort*, by (name redacted)) appear to have reduced NASA's efforts outside the Office of Education. Most notably, the previous Science Mission Directorate policy, under which

⁹ See, for example, Charles F. Bolden, Jr., Administrator, National Aeronautics and Space Administration, testimony before the House Committee on Science, Space, and Technology, March 7, 2012.

1% of all Science mission funding was allocated to education and public outreach, is no longer in effect.

As shown in **Table 1**, the House and Senate bills would both provide more than the request for the Office of Education: \$115 million and \$108 million, respectively. Within these totals, both would provide the FY2016 amounts for Space Grant (\$40 million), EPSCoR (\$18 million), and MUREP (\$32 million). For education activities in the Science Mission Directorate, the House report recommends \$37 million, while the Senate report recommends \$42 million.

Other Accounts

The three remaining NASA appropriations accounts fund cross-cutting, supporting, and oversight activities. The FY2017 request for Safety, Security, and Mission Services, which funds management and operations at the NASA centers and NASA headquarters, is \$2.837 billion, an increase of 2.5% from FY2016. In part, this increase reflects the transfer of funding from other accounts to support the consolidation of NASA information technology services. The request for Construction and Environmental Compliance and Remediation is \$420 million, an increase of 7.9%. The request for the Office of Inspector General is \$38 million, an increase of 1.9%. The House and Senate recommendations for these accounts are shown in **Table 1**.

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