Overview

The Exploration Systems Mission Directorate (ESMD) develops the systems and capabilities required for human exploration of space beyond low Earth orbit (LEO) and for U.S. crew access to the International Space Station (ISS) after retirement of the Space Shuttle. These systems and capabilities developed by ESMD include launch and crew vehicles for missions beyond LEO, affordable commercial crew access to the ISS, technologies and countermeasures to keep astronauts healthy and functional during deep space missions, and technologies to reduce launch mass and cost of deep space missions. NASA's goals are consistent with the NASA Authorization Act of 2010, which calls for expanding permanent human presence beyond LEO to destinations such as the surface of the Moon, near-earth asteroids, and Mars, while maintaining uninterrupted U.S. human space flight capability in LEO and beyond.

- The Human Exploration Capability (HEC) Theme will develop the launch and space flight vehicles that will provide the initial capability for crewed exploration missions beyond LEO. In particular, HEC's Space Launch System (SLS) Program will develop the heavy lift vehicle (HLV) that will launch the crew vehicle, other modules, and cargo for these missions. The Multi-Purpose Crew Vehicle (MPCV) Program is developing the vehicle that will carry the crew to orbit, providing emergency abort capability, sustaining the crew while in space, and providing safe re-entry from deep space return velocities.

- The Exploration Research and Development (ERD) Theme comprises the Human Research Program (HRP) and the Advanced Exploration Systems (AES) Program, which provides the knowledge and advanced human spaceflight capabilities required to implement the U.S. Space Exploration Policy. HRP will provide technologies, countermeasures, diagnostics, and design tools to keep crews safe and productive on long-duration space missions. The Theme's technology development efforts can contribute toward advances in U.S. high technology products and services.

- Exploration's Commercial Spaceflight Theme creates incentives for commercial providers to develop and operate safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO. This approach will provide assured access to the ISS, strengthen America's space industry, and provide a catalyst for future business ventures to capitalize on affordable access to space. A vibrant commercial space industry will add well-paying, high-tech jobs to the U.S. economy and will reduce America's sole reliance on foreign systems.

One of the greatest challenges for NASA is to reduce the development and operating costs for human space flight missions. NASA will not be able to sustain a long-term U.S. human spaceflight program without such reductions. NASA must plan and implement an exploration enterprise with costs that are credible, sustainable, and affordable for the long term under constrained budget environments. Longer-duration crewed exploration missions to destinations such as near-Earth asteroids, Lagrange points, the Moon, and Mars require additional vehicles and capabilities beyond the crew and launch vehicles. To extend human presence to these destinations, the development and operation costs of the crew and launch vehicles must be affordable enough to allow for the development and operation of the additional vehicles and capabilities.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,625.8**	**3,594.3**	**3,706.0**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**
Human Exploration Capabilities	3,287.5	-	-	2,605.8	2,591.2	2,581.4	2,570.4	2,560.2
Commercial Spaceflight	39.1	-	-	792.8	795.0	792.5	789.7	785.5
Exploration Research and Development	299.2	-	-	211.4	214.3	211.2	207.5	203.7
ESMD Civil Service Labor and Expenses	0.0	-	-	338.7	348.2	363.6	381.1	399.4

Note: For comparability, previous similar program content is shown in the FY2010 column, in the new program structure.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267). The amount shown for the Exploration account, reflects a reduction of $162M from the $250M that was authorized for Exploration Technology Development activities, which were transferred to the Space Technology account.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Exploration

Human Exploration Capabilities

New Initiatives:

The HEC Theme is the successor to the Constellation Systems Theme in the FY 2010 appropriation. The HEC programs were authorized by the NASA Authorization Act of 2010.

Major Changes:

The HEC Theme will focus on two general initial capabilities for human exploration beyond LEO. The former Constellation Theme, which the HEC Theme replaced, focused on ISS crew access, followed later by missions to the surface of the Moon.

Major Highlights for FY 2012

In FY 2012, the SLS and MPCV Programs will build upon the acquisition strategies, program management, and the NASA workforce and institution choices made in FY 2011 in order to maximize value to the American taxpayers and enable groundbreaking human exploration beyond LEO.

Commercial Spaceflight

Major Changes:

The Commercial Spaceflight Theme will transition from completing commercial cargo capability milestones to expanding NASA's efforts to develop commercial crew capability to LEO and the ISS.

Major Highlights for FY 2012

Under the Commercial Spaceflight Theme, NASA's commercial partners will be completing milestones associated with their Commercial Crew Development (CCDev) Round 2 awards. In spring FY 2012, the CCDev Round 2 awards will be completed and NASA plans to further expand commercial crew systems under CCDev Round 3 awards. Round 3 awards will support development, testing, and demonstrations of multiple commercial crew systems for U.S. crew access to LEO and the ISS.

Exploration Research and Development

Major Changes:

In FY 2012, the Exploration Technology Development (ETD) Program, which was an element of the ERD Theme in FY 2011, will be transferred to the Office of the Chief Technologist.

Major Highlights for FY 2012

HRP will conduct biomedical flight experiments on the ISS, including the delivery of a biomedical ultrasound device to the ISS and a training program to use the device for diagnosing bone fractures. HRP will also deliver a design tool to assess radiation shielding on space vehicles and update the acute radiation risk model.

While the ETD Program will be transferred to the Office of Chief Technologist, an Advanced Exploration Systems (AES) Program will be established to contain a few critical efforts that do not fit with the other efforts of that Office. Life support, habitation, and extra-vehicular activity elements of ETD will remain in the AES Program, because these capabilities are critical to crew safety and the success of future vehicle production and human spaceflight missions. It is important that these areas be managed in concert with associated vehicle development and closely overseen by human spaceflight personnel.

AES will develop and demonstrate prototype systems for life support, habitation, and extravehicular activity (EVA), which will enable NASA to conduct future human missions beyond LEO while reducing risk and lifecycle cost. AES demonstrates these systems using ground test beds, Earth-based field and underwater tests, and ISS flight experiments.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities

Theme Overview

The HEC Theme develops the vehicles and supporting elements to extend human presence beyond LEO and enables missions to locations such as near-Earth asteroids, Lagrange points, the surface of the Moon, or Mars. The initial capabilities developed by the HEC Theme are the MPCV and SLS. MPCV Program development efforts include a crew capsule, service module, and launch abort system. SLS Program development focuses on a heavy lift vehicle that can carry the large payloads required for human exploration missions, including MPCV. HEC's programs also provide essential supporting elements, including mission operations, ground operations and processing, ground test facilities, and crew equipment. While HEC's primary purpose is human exploration beyond LEO, the MPCV and SLS could be combined to provide backup crew and cargo services for the ISS.

NASA is developing plans for implementing the MPCV and SLS Programs, including transition of relevant design and developmental activities of the Constellation Program. A major element of the transition involves shifting design and developmental efforts away from a closely coupled system (Ares I and Orion) to a more general launch vehicle (i.e., SLS) and crew vehicle (i.e., MPCV).

Safety and affordability are central to NASA's HEC planning efforts. MPCV and SLS development and operations costs must be sufficiently low to allow development and operation of the vehicles and capabilities required for longer-duration exploration missions beyond LEO. These missions require innovative development of propulsion, crew habitat, and life support, and missions to other planetary surfaces will require additional exploration vehicles.

NASA plans to approach affordability comprehensively in pursuit of exploration beyond LEO to increase the probability that key elements are developed and missions can occur within a realistic budget profile. For all development activities, NASA will emphasize innovative acquisition and program management approaches, including risk management, to reduce recurring and operations costs. In doing so, plans for bringing the MPCV and SLS vehicles online with lower costs will be as credible and realistic as possible, and significant efforts made to ensure cost risks will be well understood. Overall, NASA's designs and acquisition strategies for the MPCV and SLS Programs will not be solidified until all of the pertinent knowledge on cost and safety is obtained to ensure an affordable and executable solution.

NASA is aligning its HEC efforts with the goals and requirements of the NASA Authorization Act of 2010 (P.L. 111-267) in a long-term, affordable, safe, and sustainable manner. Lowering costs will enable ambitious missions and help create a more exciting future for humanity in space.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,287.5**	**-**	**2,605.8**	**2,591.2**	**2,581.4**	**2,570.4**	**2,560.2**
Space Launch System		-	1,689.5				
Multi-Purpose Crew Vehicle		-	916.3				

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Multi-Purpose Crew Vehicle

NASA is developing plans for implementing the MPCV and SLS Programs, including efforts to transition the design and developmental activities of the Constellation Program. These efforts involve concurrent evaluation of MPCV and SLS Reference Vehicle Designs (RVDs) and alternative designs. NASA has developed a process to make progress on them while determining whether the designs are sufficiently affordable, sustainable, and realistic, and at the same time, studying other options to solicit innovative ideas. To achieve human exploration beyond LEO, NASA must determine an affordable and credible development plan for MPCV and SLS.

In addition to improving acquisition and program management approaches, NASA will drive down development and operations costs through innovation, improved practices, right-sized infrastructure, and reducing other fixed costs. These efforts will help NASA achieve the earliest possible date for initial operational capability. During FY 2012, the MPCV and SLS Programs will build upon these choices to maximize the value to the American taxpayers and enable groundbreaking human exploration beyond LEO.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

HEC efforts reflect alignment to the goals and requirements of the NASA Authorization Act of 2010 in a long-term, affordable, safe, and sustainable manner for participation and leadership in the exploration and utilization of space, and expanding a permanent human presence beyond LEO to destinations such as near-Earth asteroids, the Moon, and Mars.

Relevance to the NASA Mission and Strategic Goals:

HEC develops the vehicles that will meet NASA Strategic Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." Capabilities for delivering crew and cargo beyond low Earth orbit enable Goal 1, to "Extend and sustain human activities across the solar system." The HEC Theme will draw upon previously demonstrated capabilities and operational experience from human spaceflight programs in establishing exciting new programs that can take astronauts to many possible destinations within the inner solar system.

Relevance to education and public benefits:

As it has throughout NASA's history, human presence in space will continue to serve as a public symbol of the Nation's leadership. NASA's efforts to exceed the capability, affordability and safety of the Space Shuttle and develop systems leading to human exploration beyond LEO will demonstrate technologies with many possible applications to future prosperity and national security. These activities also provide a training ground for the next generation of scientists and engineers. NASA's exploration initiatives continue to nurture elements of the aerospace industry and workforce and are likely to inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics (STEM) fields.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**	
Objective 1.3.1	**Execute development of an integrated architecture to conduct human space exploration missions beyond low Earth orbit.**	
Performance Goal 1.3.1.1	***Complete design reviews for Space Launch System (SLS).***	
APG 1.3.1.1: HEC-12-1	Successfully complete Space Launch System's (SLS) Systems Requirements Review (SRR).	Space Launch System
Performance Goal 1.3.1.2	***Complete design reviews for Multi-Purpose Crew Vehicle (MPCV).***	
APG 1.3.1.2: HEC-12-2	Complete testing of Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Multi-Purpose Crew Vehicle

Performance Achievement Highlights:

The HEC Theme begins NASA's transition from the Constellation Program in FY 2011 consistent with constraints in NASA's appropriations and authorizations. The Theme shifts focus toward development of capabilities permitting flexible missions to multiple destinations beyond LEO. These efforts involve replanning for vehicle capabilities, realigning schedules, and shifting the management approach from a closely coupled system (Ares I and Orion) to a more general launch vehicle and crew vehicle.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Space Launch System

Program Overview

SLS is a new program to develop a heavy-lift vehicle (HLV) as one of the components to extend human presence in space beyond LEO and to enable ambitious missions with destinations such as near-Earth asteroids, the Moon, and Mars. The SLS Program would provide the capability to lift the MPCV and other vehicles and cargo necessary for exploration missions, as well as large science spacecraft.

To be successful both as an individual program and as a component of an affordable exploration architecture, the SLS program must greatly reduce development and operations costs from NASA's experience in past programs. Affordability, and crew and public safety, are primary objectives for heavy-lift, NASA, with support from industry partners, will investigate alternative vehicle designs and architectures to validate, support, or challenge design plans, ensuring an affordable design that meets NASA's requirements.

To help inform decisions on the final detailed design concept and acquisition details for the SLS, NASA has initiated several industry study contracts regarding heavy-lift and propulsion. These study contracts will provide a "fresh look" at innovative launch vehicle concepts, propulsion technologies, and processes that can be infused into the development of the new human exploration missions. This information that will be used to help inform the overall selection and development of the final SLS vehicle detailed design.

In FY 2012, NASA will continue to define a sufficiently affordable, sustainable and realistic SLS development plan. Human Exploration Capabilities will perform technical assessments to determine the best path forward for SLS. Consistent with direction in the NASA Authorization Act of 2010, NASA will leverage existing designs and hardware which includes NASA's selection of an SLS RVD RVD that is derived from Ares and Shuttle hardware. Informed by the NASA analyses, the current RVD is a 27.5-foot diameter core liquid oxygen/liquid hydrogen (LOX/LH2) vehicle with five Space Shuttle Main Engine (SSME)-derived core stage engines, (designated RS-25E), a LOX/LH2 upper stage with a J-2X engine, and two Ares-derived five-segment solid rocket boosters. The RVD would provide a combined lift capability of approximately 100-130 metric tons to LEO.

Program Relevance

SLS directly supports NASA Strategic Goal 1, to "Extend and sustain human activities across the solar system," and Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." SLS develops the affordable, safe, and capable HLV that is essential to launch the crew and cargo elements for exploration missions beyond LEO.

Plans For FY 2012

NASA has established three principles for development of future systems for exploration: these systems must be affordable, sustainable, and realistic. NASA commits to identify a heavy-lift architecture that would meet these goals within the available SLS budget.

NASA recognizes that in order to be sustainable, future launch systems, their infrastructure, and corresponding missions must be affordable and timely. The costs for design, development, test, and evaluation (DDT&E) for new propulsion systems must be within the projected NASA budgets. Similarly, the recurring costs of producing and operating these systems in future space exploration missions must be significantly reduced to enable development of additional needed exploration flight elements, and a sustainable flight rate for future NASA missions.

In FY 2012, NASA will continue to define a sufficiently affordable, sustainable and realistic SLS development plan. FY 2012 efforts will build upon the multiple parallel activities of the SLS FY 2011 formulation phase that are planned to find the most efficient and effective development and recurring annual operating costs for the SLS. NASA will transition relevant work from the Space Shuttle Program and Ares project to the new SLS Program and continue to define the requirements for the SLS. Included in this approach is the performance of technical assessments to determine the best path forward for SLS. Consistent with direction in the NASA Authorization Act of 2010, NASA will leverage existing designs and hardware, which includes NASA's selection of an SLS RVD that is derived from Ares and Shuttle hardware. The RVD will continue to be refined as NASA completes its studies and evaluations. Informed by NASA's analyses to-date, the current RVD is a 27.5-foot diameter core LOX/LH2 vehicle with five SSME-derived core stage engines, a LOX/LH2 upper stage with a J-2X engine, and two Ares-derived five-segment solid rocket boosters. The RVD would provide a combined lift capability of approximately 100 to 130 metric tons to LEO.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Successfully complete Space Launch System's (SLS) Systems Requirements Review (SRR).	Space Launch System (SLS)	New

Program Management

The SLS Program will be managed at the Marshall Space Flight Center (MSFC), with supporting input from the Glenn Research Center (GRC) and the Kennedy Space Flight Center (KSC).

Acquisition Strategy

NASA is developing a full acquisition strategy for the SLS. Given that the current RVD would utilize heritage systems from the Shuttle and Ares, NASA is evaluating existing Ares and Shuttle contracts and potential money saving improvements and modifications to them. This process will determine whether those contracts could be used for development work on the SLS and whether doing so would be the most affordable and efficient option for developing the SLS. As NASA seeks to maintain existing capabilities during this planning effort, HEC continues work on the elements of the Ares I project that are most likely to feed forward into the SLS.

On November 8, 2010, NASA announced the results of the heavy lift and propulsion study contracts that were awarded as part of a Broad Agency Announcement (BAA) issued in May 2010. As part of this competitive solicitation, NASA selected 13 companies to conduct six-month studies examining the trade space of potential heavy-lift launch and space transfer vehicle concepts. The BAA is focused on achieving affordability, operability, reliability and commonality at the system and subsystem levels with multiple users, including other Government, commercial, science and international partners. These trade studies will provide a "fresh look" at innovative launch vehicle concepts, propulsion technologies, and processes that can be infused into the development of the new human exploration missions information that will be used to help inform the overall selection and development of the final SLS vehicle detailed design.

Reducing recurring costs and the cost of operations will be one of the greatest challenges for the SLS team. For all SLS acquisitions and development activities, NASA will employ improved acquisition approaches such as design-to-cost and lifecycle cost analyses that use industry best practices, consider incentives for contractor reductions in fixed costs, and address cultural changes within the Agency to focus more on affordability rather than just performance factors.

NASA hopes to finalize its acquisition decisions as early as the spring of 2011. Details will be included in a follow-on report to Congress.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Multi-Purpose Crew Vehicle

Program Overview

MPCV is a new program to develop a spacecraft that will carry humans beyond LEO. MPCV will be capable of conducting in-space operations with other payloads and vehicles in low Earth orbit and beyond. NASA's initial assessments show high applicability of the Orion spacecraft development to the MPCV requirements. To the extent possible NASA will utilize the progress made by the Orion project. NASA will continue the advanced development of the human safety features, designs, and systems already identified.

The current RVD for MPCV consists of a crew module capsule, service module, and launch abort system. The combined crew and service modules provide power, life support, crew systems and habitability, communications, and propulsion for operations beyond LEO. The RVD lands safely on water, with land as a contingency option. The MPCV Program includes the supporting functions of mission operations and suits for launch/entry/landing and EVA.

The MPCV development and operations cost must be affordable enough to allow development and operation of the vehicle and capabilities required for longer duration exploration inherent in missions beyond LEO. Controlling and reducing costs requires implementing affordability measures such as streamlining NASA's insight/oversight of contractor activities, implementing a streamlined test and verification strategy consistent with other aerospace practices, phasing work to meet spending rate targets, adopting incremental development methods to achieve capabilities consistent with the Agency strategy, realizing efficiencies in the implementation of internal NASA governance and program management processes and practices, and optimizing Agency facilities and infrastructure costs. Flexibility to develop optimal technical solutions and a schedule that best benefits the Agency's long-term exploration needs are essential to the development of a robust and affordable MPCV.

Program Relevance

MPCV is a direct element of NASA Strategic Goal 1, to "Extend and sustain human activities across the solar system," and Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." The plan for MPCV is to develop an affordable and safe, crew vehicle that will facilitate exploration missions beyond LEO.

Plans For FY 2012

In FY 2012, the MPCV Program will focus on maturing designs from the Orion Crew Exploration Vehicle's Preliminary Design Review toward an MPCV Critical Design Review level of maturity. Integrated and component ground testing will continue, including evaluation of the Ground Test Article and the parachute system. Facilities construction and outfitting will continue where needed to enable testing, assembly, and processing of test flights.

An MPCV master program schedule, including all major milestones from inception to achieving operational capability, will be developed as part of program initiation. NASA will achieve an early operational readiness date within the available budget and in a manner that leads to affordable operations over the long term.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Multi-Purpose Crew Vehicle

Program Commitments

Commitment/Output **FY 2012**	**Program/Project**	**Changes from FY 2011 PB Request**
Complete testing of Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Multi-Purpose Crew Vehicle (MPCV)	New

Program Management

The MPCV Program will be managed at the Johnson Space Center (JSC), with support from the four research Centers--Ames, Dryden, Glenn, and Langley--and MSFC and KSC.

Acquisition Strategy

NASA is adhering to guidance set forth in the 2010 Authorization Act, which states that the Administrator shall "to the extent practicable extend or modify existing vehicle development and associated contracts necessary" to develop to MPCV. Existing Constellation Program contracts pertaining to the Orion project and supporting functions continue to be executed while the final MPCV implementation plan is being developed. This approach provides the least impact on jobs in the near term, while providing maximum leverage to the Agency as it plans development of the earliest affordable MPCV.

Final plans for leveraging existing contracts, civil service, and contract workforce will be updated when the final FY 2011 appropriation is provided. Initial planning is focusing on using the existing Orion project contracts, organization, and workforce to the maximum extent possible.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight

Theme Overview

NASA's vision of commercial space flight to LEO is a robust, vibrant, profitable enterprise with many providers and a wide range of private and public customers. NASA is embracing this vision with the newly established Commercial Spaceflight Theme.

Activities within this Theme aim to incentivize and encourage commercial providers to build and operate safe, reliable, and cost-effective commercial crew and cargo transportation systems for flight to and from LEO and the ISS. During the development phase, NASA plans to partner with U.S. industry, providing technical and financial assistance as they develop commercial launch and transportation capabilities. During the operations phase, NASA plans to be a customer for these transportation services. NASA anticipates that these activities will stimulate the development of new commercial services available to many customers, not just the U.S. Government.

NASA expanded its commercial spaceflight efforts in 2006 with the formation of Space Act Agreements for the development of ISS cargo resupply systems under the Commercial Orbital Transportation Services (COTS) Program. Space Act Agreements are written to maximize the flexibility and innovation of private development efforts by ensuring Government specifications are kept to a minimum. As part of these Agreements, companies partnering with NASA were required to contribute their own funding to the activity thereby leveraging NASA dollars and ensuring a larger net investment in commercial cargo capability development. The COTS Program made significant progress in FY 2010, culminating in the successful first demonstration flight of the Falcon 9 launch vehicle and Dragon spacecraft. This flight attested to the viability of Government and private sector partnerships in the development of commercial cargo space flight services.

In FY 2010, NASA further expanded its commercial spaceflight efforts to encompass crew transportation systems in addition to the cargo transportation systems. NASA made Commercial Crew Development (CCDev) awards in order to stimulate efforts within the private sector, encouraging them to develop and demonstrate human spaceflight capabilities. Crew transportation efforts will be further expanded via CCDev Round 2 awards in early 2011.

In FY 2012, NASA proposes to take the accomplishments and lessons learned from the successes of CCDev and CCDev2, and incorporate them into a new initiative called CCDev Round 3. This initiative will facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS. CCDev Round 3 will result in vehicles that could become the Nation's primary means for ISS crew transportation reducing American reliance on foreign systems and allowing NASA to focus on deep space exploration missions.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**39.1**	**-**	**792.8**	**795.0**	**792.5**	**789.7**	**785.5**
Commercial Crew	0.0	-	792.8	795.0	792.5	789.7	785.5
Commercial Cargo	39.1	-	0.0	0.0	0.0	0.0	0.0

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Commercial Crew

The two primary activities planned for FY 2012 are: the continued execution and completion of CCDev Round 2 Space Act Agreements, which will be awarded in the spring of 2011, and the formation of long-term agreements with industry for CCDev Round 3, planned for late spring 2012.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's Commercial Spaceflight Theme is stimulating the development of a commercial space industry in the United States by encouraging the growth of a new competitive market that will help decrease launch costs, reduce NASA's reliance on foreign systems, enable exploration beyond LEO, and transform spaceflight for future generations. By pushing the boundaries of private enterprise and commerce into LEO, NASA has initiated the first truly sustainable activity for expansion into space.

Relevance to the NASA Mission and Strategic Goals:

The Commercial Spaceflight Theme supports two of NASA's strategic goals. Goal 1, to "Extend and sustain human activities across the solar system," directly applies by developing competitive opportunities for the commercial community to provide best value products and services to LEO (Sub-goal 1.2). Goal 3, to "Create the innovative new space technologies for our exploration, science, and economic future" is being applied by facilitating the transfer of NASA technology and engage in partnerships with other Government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits (Sub-goal 3.4).

Relevance to education and public benefits:

As it has throughout NASA's history, human presence in space will continue to serve as a public symbol of the Nation's leadership in space exploration. The Agency's renewed efforts to leave LEO and to explore the Moon and other destinations will accelerate the development of technologies critical to the economy and national security. These efforts will also provide a training ground for the next generation of scientists and engineers. By enabling emerging enterprises to achieve commercial viability, U.S. technology sectors will expand, providing opportunities that are likely to inspire the Nation's youth to pursue careers in STEM disciplines.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.2	**Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.**	
Objective 1.2.1	**Enable the commercial sector to provide cargo and crew services to the International Space Station (ISS).**	
Performance Goal 1.2.1.1	***Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.***	
APG 1.2.1.1: CS-12-1	Conclude the commercial crew transportation systems (CCDev2) agreements and make initial selections for the design, development, and demonstration of commercial crew transportation systems.	Commercial Crew
Performance Goal 1.2.1.2	***Develop and document evaluation and certification processes for an integrated commercial crew transportation system.***	
APG 1.2.1.2: CS-12-2	Begin evaluation and certification of integrated commercial crew transportation system.	Commercial Crew

Performance Achievement Highlights:

COTS and CCDev have made significant progress over the past year. Within the COTS effort, Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (Orbital Sciences) steadily achieved impressive results in their respective cargo transportation development efforts, with NASA's financial and technical assistance.

SpaceX completed many challenging, funded milestones during FY 2010, culminating in the first successful COTS demonstration mission in December 2010. SpaceX launched the Falcon 9 vehicle, which demonstrated separation of the Dragon spacecraft and completion of two full orbits, orbital maneuvering and control, Dragon reentry, parachute decent, and Dragon spacecraft recovery after splashdown in the Pacific Ocean.

Orbital Sciences also completed several funded milestones over the past year. These included:

- A Critical Design Review, which determined that the system design maturity was appropriate to support proceeding with full scale fabrication, assembly, integration, and test;
- Completion of the spacecraft service module structural core;
- A service module test readiness review; and
- A successful cargo integration demonstration using a sample manifest of cargo simulators for physical stowage and demonstration of cargo handling procedures. NASA astronauts participated in this demonstration.

Under the CCDev program, $50 million in America Recovery and Reinvestment Act (ARRA) funds were competitively awarded to five companies to encourage significant progress on developing long-lead capabilities, technologies, and commercial crew risk mitigation tasks that will ultimately accelerate their commercial crew transportation concepts. The accomplishments of these five companies included the following:

- Sierra Nevada Corporation successfully completed several development milestones, including space vehicle propulsion hybrid motor testing and the Dream Chaser spacecraft composite test article and structural testing.

- Blue Origin successfully met milestones for multiple pusher launch abort motor tests to verify operation of new jet tab thrust vector control and the manufacture, assembly, and structural testing of their crew composite pressure vessel.

- Paragon Space Development Corporation manufactured and tested an air revitalization system engineering development unit and successfully moved their concept through a Preliminary Design Review.

- Boeing matured their commercial crew system architecture and design through a Systems Definition Review. They also demonstrated key technologies and capabilities including crew module mockup, base heat shield fabrication, avionics systems testing, landing attenuation system demonstration, demonstration of air bags in water and on land, life support system demonstration, and crew module pressure shell fabrication.

- United Launch Alliance developed and demonstrated a prototype emergency detection system that can be used with launch vehicles, providing real time launch vehicle health monitoring and providing the earliest warning of impending catastrophic launch vehicle failures. System warnings are essential for commanding crew launch escape and improving crew launch safety.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight
Program:	Commercial Crew

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**792.8**	**795.0**	**792.5**	**789.7**	**785.5**
Commercial Crew	0.0	-	792.8	795.0	792.5	789.7	785.5

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight
Program:	Commercial Crew

Program Overview

In 2009, NASA began commercial crew activity with the initial round of five CCDev awards to stimulate efforts within the private sector to develop and demonstrate human space flight capabilities that could ultimately lead to the availability of commercial human space flight services. In October 2010, NASA solicited proposals from U.S. space industry participants for a second round of CCDev initiatives (CCDev 2) to further advance commercial crew transportation system concepts and mature the design and development of elements of the system such as launch vehicles and spacecraft. The agreements are expected to result in significant maturation of commercial crew transportation system capabilities, with consideration given to NASA's draft human certification requirements and standards or industry equivalent to those requirements and standards.

The results of these efforts will feed into CCDev Round 3. The primary objective of CCDev Round 3 will be to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS. Once the capability is matured and available to customers, NASA plans to purchase transportation services to meet its ISS crew rotation and emergency return obligations.

CCDev Round 3 will follow an alternative business method that allows U.S. private companies more design ownership of their space systems and requires those companies to invest private capital to complement government funds. This approach is similar to that in use with the development, demonstration, and eventual purchase of cargo transportation services pioneered under the COTS and ISS Commercial Resupply Services (CRS) Programs.

For CCDev Round 3, NASA plans to award competitive, pre-negotiated, milestone-based agreements that support the development, testing, and demonstration of multiple commercial crew systems. CCDev Round 3 will feature an acquisition strategy based on pay-for-performance milestones, a fixed Government investment, the use of negotiated service goals instead of detailed design requirements, and a requirement for private capital. CCDev Round 3 will also use a Government insight/oversight model featuring a core team of sustaining engineering and discipline experts who closely follow the development of the vehicles. Additionally, CCDev Round 3 will use tailored human rating requirements, standards, and processes, with NASA providing the final crew transportation system certification.

Plans For FY 2012

Throughout most of FY 2012, the CCDev Round 2 commercial partners will be executing milestones associated with their Space Act Agreements. In spring 2012, NASA plans to make awards for CCDev Round 3. Partnering with industry in this innovative way potentially accelerates the availability of U.S. human access to LEO and reduces the risk of relying solely on foreign crew transports to the ISS for years to come. It will strengthen the U.S. commercial space launch industry, encourage competition, act as a catalyst for the development of additional space markets, provide new high-technology jobs, and reduce the cost of human access to space.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conclude the commercial crew transportation systems (CCDev2) agreements and make initial selections for the design, development, and demonstration of commercial crew transportation systems.	Commercial Crew	None
Begin evaluation and certification of integrated commercial crew transportation system.	Commercial Crew	None

Program Management

The Commercial Crew Program Manager, located at Kennedy Space Center, reports to NASA Headquarters. The Deputy Program Manager resides at Johnson Space Center.

Acquisition Strategy

NASA is still developing the specific acquisition strategy for CCDev Round 3. Based on industry input and the lessons learned from COTS, CCDev, and CCDev Round 2, NASA is planning an acquisition approach that provides the following features:

- Pre-negotiated, pay-for-performance milestones to shift risk during the development phase to the private sector, encouraging innovation and efficiency in vehicle design;

- A fixed government investment that will permit NASA to seed the development of a risk-balanced portfolio of multiple concepts and systems;

- A tailored approach to government oversight of programmatic activities during development, including eliminating the need to validate contractor costs, reducing reporting requirements, and cutting down on significant paperwork, thereby decreasing costs and schedules;

- Identification of less prescriptive goals and objectives during the development phase that enables the companies the flexibility to provide innovative design solutions that effectively meet the needs of the commercial market and NASA while ensuring crew safety;

- Minimal Government retention of intellectual property to provide companies with confidence that they will retain the benefit of their investment; and

- A requirement for industry investment to leverage NASA dollars and ensure a larger net investment in commercial crew capability development.

NASA's objective is to remain primarily goal-based in the development phase, establishing a set of top-level performance requirements to encourage innovation and cost effectiveness.

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Failure of a Commercial Partner	Commercial partners may not be able to complete the demonstration phase and thus NASA's investment would not result in available commercial services.	Commercial partners are incentivized to work through difficulties in order to avoid losing future funding and NASA technical assistance. Also, in order to insulate the agency in the unlikely event of a single commercial partner not completing their agreed-to milestones, NASA plans to execute agreements with multiple commercial providers.
Uncertainty Regarding Emerging Commercial Market Demand	With a minimum of only two flights per year from NASA and an uncertain non-NASA market, potential providers may be wary of the commercial business potential.	Given the decision to extend the life of the ISS, NASA will be an ongoing, long-term customer for commercial crew services, providing a strong base market for commercial providers. In addition, NASA plans to have extensive interaction with industry via requests for information, industry days, and draft announcements that will allow NASA to optimize the strategy of the program prior to awards.
Requirements Unique to NASA	NASA-unique requirements will increase the cost to provide services such that the commercial providers may not be able to capture non-NASA markets.	NASA has explicitly acknowledged that there are two objectives for the Commercial Crew program. One is the safe transportation of astronauts to and from the ISS, and the other is to enable the development of non-NASA commercial markets for human transportation services to and from LEO. NASA will seek a balance to achieve both objectives, not achieving one objective at the expense of the other.

Theme Overview

The ERD Theme expands fundamental knowledge that is key to human space exploration, and develops advanced exploration systems that will enable humans to explore space in a more sustainable and affordable way.

The ERD Theme is comprised of HRP and the AES Program, and provides knowledge and the advanced human space flight capabilities required to implement NASA's new exploration program. In FY 2012, the ETD Program, which was an element of the ERD Theme in FY 2011, will be transferred to the Office of the Chief Technologist.

The life support, habitation, and extra-vehicular Activity elements of ETD will remain in the AES program because these capabilities are critical to crew safety and the success of future vehicle production and human spaceflight missions. It is important that these areas be managed in concert with the associated vehicle development, and closely overseen by human spaceflight personnel. Undersea and field analogs as well as ISS flight tests that simulate human exploration missions will also remain in AES because they have strong ties to future exploration success validating operational concepts for exploring the Moon, near Earth asteroids, and Mars.

HRP investigates and mitigates the highest risks to astronaut health and performance to support NASA human exploration missions. Through its projects, HRP conducts fundamental and applied research on the human system to provide countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. As astronauts journey beyond LEO, they will be exposed to microgravity, radiation, and isolation for long periods of time. Keeping crews healthy and productive during long missions will require new technologies and capabilities. To accomplish this, NASA studies how the space environment, close quarters, heavy workloads, and prolonged time away from home contribute to stress, and then develops technologies that can prevent or mitigate these effects. In addition, the Agency is developing innovative exploration systems to provide basic needs such as oxygen, water, food, and shelter that can operate dependably for at least a year.

AES develops and demonstrates prototype systems for life support, habitation, and EVA that will enable NASA to conduct future human missions beyond LEO, while reducing risk and lifecycle cost. AES demonstrates these systems in ground test beds, Earth-based field and underwater tests, and ISS flight experiments.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**299.2**	**-**	**211.4**	**214.3**	**211.2**	**207.5**	**203.7**
Human Research Program	146.3	-	143.3	143.8	143.0	142.0	140.9
Advanced Explorations Systems	152.9	-	68.1	70.5	68.2	65.5	62.8

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Human Research Program

During FY 2012, HRP will support approximately 15 to 20 biomedical flight experiments on the ISS and deliver the next-generation space biomedical ultrasound device to enhance the ISS' human research facility capability. Other activities include development of a training program for ultrasound diagnosis of fractures and evaluation of blood analysis technology for astronaut health monitoring. In addition, the program will provide a preliminary recommendation regarding the use of bisphosphonates in conjunction with a routine in-flight exercise program to reduce bone loss. HRP projects will deliver an enhanced design tool for vehicle radiation shielding assessments and release the second version of an acute radiation risk model. In the area of behavioral health and performance, researchers will complete a sleep-wake actigraphy report on the ISS crew. In order to support its research requirements, HRP will release two NASA research announcements addressing space radiation health risks and human physiological changes associated with space flight.

Advanced Explorations Systems

In FY 2012, AES will use a ground test bed to demonstrate the reliability of life support system components, and a portable life support system for an advanced space suit will be tested in a vacuum chamber. Ground-based analog field tests and underwater tests will validate a prototype Space Exploration Vehicle and Deep Space Habitat, and demonstrate operational concepts for exploring the surfaces of near-Earth asteroids with humans and robots.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**	
Objective 1.1.2	**Advance engineering, technology, and research capabilities on the ISS.**	
Performance Goal 1.1.2.2	***Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.***	
APG 1.1.2.2: ERD-12-1	Conduct flight definition review for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	Advanced Explorations Systems
APG 1.1.2.2: ERD-12-2	Deliver at least four physical sciences payloads for launch to the ISS.	Advanced Explorations Systems
APG 1.1.2.2: ERD-12-3	Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**	
Objective 1.3.2	**Develop a robust biomedical research portfolio to mitigate space human health risks.**	
Performance Goal 1.3.2.1	***Develop technologies that enable biomedical research and mitigate space human health risks associated with human space exploration missions.***	
APG 1.3.2.1: ERD-12-4	Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research
Performance Goal 1.3.2.2	***Perform research to ensure that future human crews are protected from the deleterious effects of space radiation.***	
APG 1.3.2.2: ERD-12-5	Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events during exploration missions.	Human Research
Performance Goal 1.3.2.3	***Develop exploration medical capabilities for long-duration space missions.***	
APG 1.3.2.3: ERD-12-6	Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Human Research

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 1.3.3	**Identify hazards, opportunities, and potential destinations, to support future safe and successful human space exploration missions.**	
Performance Goal 1.3.3.1	***Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.***	
APG 1.3.3.1: ERD-12-7	In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Advanced Explorations Systems
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**	
Outcome 3.3	**Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.**	
Objective 3.3.2	**Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.**	
Performance Goal 3.3.2.1	***Develop advanced spacesuits to improve the ability of astronauts to conduct Extra-Vehicular Activity (EVA) operations in space including assembly and service of in -space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.***	
APG 3.3.2.1: ERD-12-9	Initiate tests of Extra-Vehicular Activity (EVA) Portable Life Support System (PLSS) technologies in a vacuum chamber environment.	Advanced Explorations Systems

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**146.3**	**-**	**143.3**	**143.8**	**143.0**	**142.0**	**140.9**
Human Research Program	146.3	-	143.3	143.8	143.0	142.0	140.9

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Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

Program Overview

HRP is focused on investigating and mitigating the highest risks to human health and performance in order to enable safe, reliable, and productive human space exploration. The HRP budget enables NASA to resolve health risks in order for humans to safely live and work on missions in the inner solar system. HRP conducts research, develops countermeasures, and undertakes technology development to address human health risks in space and ensure compliance with NASA's health, medical, human performance, and environmental standards. The risks examined by HRP include health concerns from space radiation exposure, behavioral health, and team cohesion challenges associated with confinement and isolation, ensuring vehicle functions are properly designed for efficient human interface in space, and providing for emergency medical care in space. HRP also studies the effects of microgravity on the human body including rapid muscle atrophy, bone loss, neurovestibular system changes that produce motion sickness, significant fluid shifts that affect intracranial pressure, visual changes, cardiovascular function, blood volume, and orthostatic intolerance.

HRP activities are designed to:

- Develop human health capabilities, countermeasures, and technologies in support of human space exploration;

- Enable the definition and improvement of human spaceflight medical, environmental and human factors standards;

- Develop technologies to reduce medical and environmental risks within spacecraft and mission resource limitations;

- Ensure maintenance of Agency core human health competencies that are necessary to enable risk reduction in the areas of space medicine;

- Leverage resources to apply space technology to practical applications on the ground; and

- Develop national and international collaborations that support NASA goals with organizations such as the National Space Biomedical Research Institute (NSBRI), National Institute of Health (NIH), Department of Education, Department of Defense (DoD), European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA), Centre National d'Etudes Spatiales (CNES), German Aerospace Center (DLR), Canadian Space Agency (CSA), Italian Space Agency (ASI), and potentially others.

Plans For FY 2012

The ISS Medical project (ISSMP) will maximize the opportunity provided by the ISS for human health and performance evaluations during long duration missions. ISSMP will use the ISS to understand the significant effects of long duration space flight on the human body. In FY 2012, this project will support approximately 15 to 20 biomedical flight experiments per each ISS six month mission and will deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.

The Space Radiation projects will continue using the NASA Space Radiation Laboratory at Brookhaven National Laboratory to evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. These efforts will enable more accurate predictions of risks and facilitate longer stays in space. In FY 2012, space radiation research will shift emphasis and begin evaluating central nervous system and degenerative tissue risks, deliver an enhanced design tool for vehicle radiation shielding assessments, and release the second version of the acute radiation risk model.

The HRP Exploration Medical Capability project will strive to meet the level of care standards for space exploration missions by testing the next generation of medical care and crew health maintenance technologies. HRP will develop a training program for ultrasound diagnosis of fractures, evaluate blood analysis technology for astronaut health monitoring, and ensure human health and performance data is captured, maintained, and usable.

The Human Health and Countermeasure (HHC) project will perform research studies to reduce crew health risks during missions and long-term health risks after missions, including cardiac structure and function and bone demineralization monitoring and mitigation techniques. This project will provide a preliminary recommendation on the use of bisphosphonates in conjunction with a routine inflight exercise program in order to reduce bone loss. The HHC project will also provide a final report on the effects of microgravity on shuttle crew task performance.

The Space Human Factor and Habitability project will research nutrition requirements for long-duration missions, provide a final report of spinal elongation flight studies, recommend permissible lunar dust exposure limit standards, and design and test a software tool to support the crew's ability to optimally function during space missions. This project will also continue studying the exercise regimes necessary to maintain the astronauts' physical health in space, EVA system standards to maintain the astronaut's health outside of the space vehicles, and the pharmacological and nutritional health requirements for human space missions.

The Behavioral Health and Performance project will use ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythms, medication side effects, fatigue, team cohesion, and training protocols. In FY 2012, behavioral health and performance researchers will complete a sleep-wake actigraphy report on crew members.

To support its research requirements in FY 2012, the program will release two NASA research announcements: one addressing space radiation health risks, and the other a joint NASA/ NSBRI research solicitation focused on human physiological changes associated with spaceflight.

Project Descriptions and Explanation of Changes

Exploration Medical Capability

The Exploration Medical Capability (ExMC) project is responsible for identifying and testing next generation medical care and crew health maintenance technologies during exploration missions. The ExMC project is also responsible for the evolution of exploration health care options based on past experience, anticipated needs, and input from flight surgeons and crew offices.

The major deliverables from this project are identifying the requirements for medical equipment and clinical care capabilities, developing remote medical technologies, and assessing the medical requirements for each mission.

Human Health Countermeasures

The Human Health Countermeasures (HHC) project provides the biomedical expertise for the development and assessment of medical standards, vehicle and spacesuit standards dictated by human physiological needs, and develops biomedical countermeasures that ensure the maintenance of crew health.

The major deliverables for the HHC project are input for the refinement of health and medical standards, validated human health prescriptions, validated exercise system requirements, EVA injury and decompression sickness prevention standards, integrated physiological countermeasures, and criteria for the Agency fitness for duty and crew selection/retention standards. The project also supports biomedical core laboratories that provide the expertise to enable the development of medical standards, the assessment of the risks to crew health and performance, and the validation of countermeasures.

Behavioral Health and Performance

The Behavioral Health and Performance (BHP) project identifies and characterizes the behavior and performance risks associated with training, living, and working in space, and returning to Earth. The major deliverables for the BHP project consists of: recommendations for NASA medical standards; development of operational tools and technology to prevent performance degradation, human errors or failures during critical operations resulting from sleep loss, circadian de-synchronization, fatigue or work overload; deterioration of morale and motivation; interpersonal conflicts or lack of team cohesion, coordination, and communication; team and individual decision-making; performance readiness factors (fatigue, cognition, and emotional readiness); behavioral health disorders; and individual selection and crew assignments.

Space Human Factors and Habitability

The Space Human Factors and Habitability project consists of three main areas:

- Space Human Factors Engineering validates models for predicting the effects of interface designs on human performance, methods for measuring human and human-system performance, and design concepts for, and evaluations of, advanced crew interfaces and habitability systems.

- Advanced Environmental Health research assesses the acute and long-term health impacts of targeted pollutants in the environment including lunar dust, microorganisms, and atmospheric contaminants.

- Advanced Food Technology provides a safe, nutritious, and acceptable food system to maintain crew health and performance. Technology development addresses nutritional, psychological, safety, and acceptability requirements while minimizing mass, volume, waste, power, and trace gas emissions.

Space Radiation Health

The Space Radiation Health project performs investigations to assure that crews can safely live and work in a space radiation environment without exceeding the acceptable exposure limits during and after missions. The major deliverables for the Space Radiation project include inputs to standards for radiation health, habitability, and environments, requirements for radiation protection, early technology development for monitoring equipment, caution, and warning models, and tools to assess and predict risks due to space radiation exposure, and strategies to mitigate exposure effects.

ISS Medical Project

ISSMP provides planning, integration, and implementation services for HRP research tasks and evaluates activities requiring access to space or related flight resources on the ISS, Shuttle, Soyuz, Progress, or other spaceflight vehicles and platforms. This includes support to related pre-flight and post-flight activities.

ISSMP services include operations and sustaining engineering for HRP flight hardware, experiment integration and operation including individual research tasks and on-orbit validation of next generation on-orbit equipment, medical operations, procedures and crew training concepts, and operation and sustaining engineering for the Telescience Support Center, which provides real-time operations and data services to all HRP flight experiments. This project integrates HRP-approved flight activities and interfaces with external implementing organizations, such as the ISS Payloads Office and international partners to accomplish the HRP's objectives.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research	None
Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events during exploration missions.	Human Research	
Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Human Research	

Program Management

HRP is managed by the Human Research Program Office, located at the Johnson Space Center (JSC) with support from Ames Research Center, Glenn Research Center, Langley Research Center and Kennedy Space Center.

Acquisition Strategy

In FY 2012, two NASA Research Announcements (NRAs) will be used to further efforts in human research. The Space Radiation NRA will focus on better understanding and reducing risks that crews could face from space radiation on exploration missions. The Joint NASA/NSBRI NRA to support crew health and performance in space exploration missions will focus on: bone loss; cardiovascular alterations; human performance factors, sleep, and chronobiology; muscle alterations and atrophy; neurobehavioral and psychosocial factors; nutrition, physical fitness, and rehabilitation; sensorimotor adaptation; smart medical systems; biomedical technology development; and analog bed rest investigations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Peer Panel Reviews	02/2010	Peer review of NASA Research Announcements	02/2011
Quality	External Independent Reviews	12/2010	Review of Research Projects Gaps and Tasks	12/2011
Quality	External Independent Reviews	02/2009	Program Implementation Review	08/2012
Quality	National Academies	06/2008	The Institute of Medicine will review the "NASA Research on Human Health Risks"	06/2013

Mission Directorate:	**Exploration**
Theme:	**Exploration Research and Development**
Program:	**Advanced Explorations Systems**

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**152.9**	**-**	**68.1**	**70.5**	**68.2**	**65.5**	**62.8**
Advanced Explorations Systems	152.9	-	68.1	70.5	68.2	65.5	62.8

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Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Advanced Explorations Systems

Program Overview

AES develops and demonstrates prototype systems for life support, habitation, and EVA that will enable NASA to conduct future human missions beyond LEO, while reducing risk and lifecycle cost. AES focuses on advanced development of flight system concepts. This includes a Deep Space Habitat where the crew would live during transit on long missions and a Space Exploration Vehicle that would allow the crew to closely approach an asteroid, explore its surface, and conduct EVAs. AES demonstrates these systems in ground test beds, Earth-based field and underwater tests, and on-board ISS flight experiments.

AES uses innovative approaches for the rapid development of system concepts, such as small, focused teams of NASA engineers and technologists working with industry partners to gain hands-on experience. AES will pilot these processes to improve the affordability of future exploration programs.

Plans For FY 2012

In FY 2012, AES will use a ground test bed to demonstrate the reliability of life support system components. A portable life support system for an advanced space suit will be tested in a vacuum chamber. Ground-based analog field tests and underwater tests will be used to validate a prototype Space Exploration Vehicle and Deep Space Habitat, and to demonstrate operational concepts for exploring the surfaces of near-Earth asteroids with humans and robots.

Project Descriptions and Explanation of Changes

Advanced Life Support Ground Test Bed

This project will integrate advanced life support system components in a ground test bed to demonstrate their reliability for life support systems that recycle air, water, and waste in order to minimize consumables, which are critical capabilities for long-duration missions.

EVA Flight Demonstration

Building on current EVA technology projects, NASA will work with industry and academia to develop advanced space suits to improve the ability of astronauts to assemble and service in-space systems, and to explore the surfaces of the Moon, Mars, and small bodies. An advanced technology space suit and a suit port designed to enable rapid ingress and egress from habitats will be demonstrated on the ISS.

Advanced Exploration Systems Development

This project will use innovative approaches to develop prototype systems for a Deep Space Habitat where the crew will live during transit on long missions, and a Space Exploration Vehicle that will allow the crew to closely approach an asteroid, explore the surface, and conduct EVA. The operation of these systems will be demonstrated in desert field tests and underwater tests to simulate the low-gravity environment of an asteroid.

Joint Robotics Program

ERD in ESMD, working closely with the Planetary Science Division of the Science Mission Directorate (SMD), will develop instruments for SMD and international missions to destinations relevant to human exploration beyond LEO. These precursor activities will strive to characterize the engineering boundary conditions of representative exploration environments, identify hazards, and assess resources. These activities will provide knowledge to inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration. ESMD will also fund a small Research and Analysis effort with the goal of turning the data gathered by these instruments, as well as the data of other SMD instruments and missions, into strategic knowledge in support of human spaceflight planning and systems development. Many of these research and analyses activities will be jointly conducted with SMD to maximize the mutual benefit to both science and exploration objectives, as was done with the highly successful Lunar Reconnaissance Orbiter mission. ESMD will also maintain a small study effort to plan for future precursor activities to further enable and reduce the risk associated with human exploration.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Advanced Explorations Systems

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conduct flight definition review for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	Advanced Explorations Systems	
Deliver at least four physical sciences payloads for launch to the ISS.	Advanced Explorations Systems	
Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems	
In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Advanced Explorations Systems	

Program Management

The program management for this program has not been assigned.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Advanced Life Support Ground Test Bed	JSC	JSC, MSFC, ARC	
EVA Flight Demonstration	JSC	JSC	
Advanced Exploration Systems Development	JSC	JSC, KSC, LaRC, GRC	

Acquisition Strategy

All projects are managed at NASA Centers, which issue competitive contracts for research and development support. Advanced life support component technologies and subsystems will be competitively selected for integration with an in-house ground test bed.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	National Academies	10/2007	Assessment of program effectiveness and technical quality	TBD

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
System Requirements	Prototype systems may not meet requirements for human exploration missions.	Conduct architectural studies to identify the probable capabilities required to meet the requirements for human exploration missions. Flight system designers who will use the prototype systems must endorse technical performance goals.
Development Progress	Project delays preventing on time delivery of prototype systems to support the development of flight systems.	Progress towards technical milestones will be the key decision criterion for project continuation.
Transition into Flight Programs	Lack of commitment from flight system designers to incorporate completed prototype systems into their missions.	Develop a transition plan with agreement from flight programs to incorporate prototype systems into mission designs.

Mission Directorate:	Exploration
Theme:	ESMD Civil Service Labor and Expenses

Theme Overview

This Theme contains labor funding, both salary and benefits, for civil service employees at NASA's field centers who are assigned to work on projects in the Exploration Systems Mission Directorate. These funds support the critical skills and capabilities required to provide the technology development and space flight missions, as outlined in the other themes, within this mission area.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**338.7**	**348.2**	**363.6**	**381.1**	**399.4**
ESMD Civil Service Labor and Expenses	0.0	-	338.7	348.2	363.6	381.1	399.4