National Aeronautics and Space Administration

Modified Record of Decision for NASA's Post-Shuttle Human Spaceflight Program and the Constellation Programmatic Environmental Impact Statement

Exploration Systems Mission Directorate
NASA Headquarters
Washington, DC

June 2011

MODIFIED RECORD OF DECISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
POST-SHUTTLE HUMAN SPACEFLIGHT PROGRAM
AND THE
CONSTELLATION PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Congress recently clarified direction for NASA's post-Shuttle program for human space flight and exploration, which was previously known as Constellation. This modified Record of Decision (ROD) documents NASA's consideration of possible changes in the environmental impacts resulting from directed changes in the Agency's proposed human spaceflight program. The primary focus of new Congressional and Presidential direction is to enable future human missions beyond low-Earth orbit, drawing on and continuing certain developmental work of the Constellation program, but eliminating some of its planned elements and specific objectives and discarding the "Constellation" moniker.

This document modifies the programmatic ROD issued on February 28, 2008 for NASA's post-Shuttle human spaceflight program. The 2008 ROD outlined NASA's proposed plan for implementing the *then current* Congressional and Presidential direction for human spaceflight (the Constellation Program) and was based on the analysis contained in the January 2008 Final Constellation Programmatic Environmental Impact Statement (PEIS). As mentioned above and discussed further below, Congressional and Presidential direction has changed somewhat. However, at the programmatic level and in the early stages of development, NASA anticipates its revised human spaceflight program will continue to use the same general technologies and facilities used for the Constellation program as analyzed in the 2008 PEIS.

Given the directed changes in NASA's post-Shuttle human spaceflight program, NASA has evaluated the extent to which the revised plan for NASA's human spaceflight program fits within the envelope of activities and impacts analyzed in the 2008 PEIS.

Background

In 2004 and 2005, Congress and the President provided initial direction for NASA's post-Shuttle human spaceflight program which led to several years of planning and work on human space flight and exploration capabilities that came to be known collectively as the Constellation Program. In the last few years, Congress and the President have revisited and revised their direction for NASA's post-Shuttle human spaceflight program, and Congress provided some of the most recent clarification of that direction in the NASA Authorization Act of 2010 (PL 111-267, Oct. 11, 2010). Congress reaffirmed that "The long term goal of the human space flight and exploration efforts of NASA shall be to expand permanent human presence beyond low-Earth orbit..." and provided some specific program direction, including utilization of capabilities and elements of the Constellation Program. Specifically, the Act directs NASA to:

- Develop a Space Launch System (SLS) as a follow-on launch vehicle to the Space Shuttle, with heavy-lift launch vehicle capabilities.

- Develop a Multi-Purpose Crew Vehicle (MPCV), "...which shall continue to advance development of the human safety features, designs, and systems in the Orion project."
- In developing the SLS and MPCV,
    - "to the extent practicable, utilize ... existing contracts, investments, workforce, industrial base, and capabilities from the Space Shuttle and Orion and Ares 1 projects, including ... Space Shuttle-derived components and Ares 1 components that use existing United States propulsion systems, including liquid fuel engines, external tank or tank-related capability, and solid rocket motor engines; and ... associated testing facilities, either in being or under construction as of the date of enactment of this Act."
    - "to the extent practicable, utilize ground-based manufacturing capability, ground testing activities, launch and operations infrastructure, and workforce expertise ... [and] minimize the modification and development of ground infrastructure and maximize the use of existing software, vehicle and mission operations processes...."
- Modernize infrastructure at the Kennedy Space Center and other facilities that is needed to enable processing, launch and operational support of the SLS and other launch vehicles.

Just as in 2008, the purpose of NASA's post-Shuttle human spaceflight program is to develop the flight systems and Earth-based ground infrastructure required to enable future human missions consistent with Congress' and the President's specific direction regarding human spaceflight.

To accomplish this new direction, NASA proposes to build upon work performed under the Constellation program and, utilizing generally the same resources and facilities, continue preparations for and implement the SLS, MPCV, and associated programs to develop a new class of exploration vehicles and the Earth-based infrastructure necessary to support their development and use in space exploration.

History of Constellation NEPA Activities

NASA prepared a programmatic environmental impact statement (PEIS) to analyze the overarching environmental impacts of NASA's post-Shuttle human spaceflight program. The PEIS addressed potential environmental impacts associated with the then proposed Constellation Program activities as projected through the early 2020s.

On September 26, 2006, NASA published a Notice of Intent (NOI) in the *Federal Register* (*FR*) (71 *FR* 56183) to prepare a PEIS and conduct scoping for the Constellation Program. Public input and comments on alternatives, potential environmental impacts and concerns were requested. A number of comments were received and were addressed in the Draft PEIS, ranging from launch and recovery operations impacts to socioeconomic impacts.

NASA issued a Notice of Availability (NOA) for the Draft PEIS on August 17, 2007 (72 *FR* 46218). The Draft PEIS was distributed to over 300 potentially interested Federal, state and local agencies; organizations; and individuals for review and comment and was made available on NASA's web site. In addition, NASA held public meetings to solicit comments on the Draft PEIS in Cocoa Beach, FL; Washington, DC; and Salt Lake City, UT. The comment period closed September 30, 2007, and NASA received a number of comments raising issues that

included the need for light management and bird strike monitoring plans at Kennedy Space Center (KSC), local impacts at the U.S. Army's White Sands Missile Range (WSMR), and a coastal zone consistency determination for Langley Research Center (LaRC). All comments were considered in developing the Final PEIS, and responses to all comments were prepared and included in the Final PEIS as Appendix B. NASA received an October 1, 2007 letter from the U.S. Environmental Protection Agency (EPA) indicating EPA's finding of no objection (i.e. LO – Lack of Objection) regarding the Draft PEIS.

NASA published its NOA for the Final PEIS on January 23, 2008 (73 *FR* 4013) initiating the 30-day "waiting period" and distributed the Final PEIS to over 300 potentially interested Federal, state, and local agencies; organizations; and individuals. In addition, NASA posted the Final PEIS on NASA's web site. Comments received during the waiting period were addressed in the 2008 ROD, which was issued February 28, 2008 and was also posted on NASA's website.

In addition to the 2008 Final PEIS and ROD, many additional NEPA documents have been prepared to provide more detailed analysis of specific elements of the Constellation Program. These more focused documents were incorporated by reference into, and tiered from, the Final PEIS and evaluated the impacts of such Constellation elements as development of the Orion spacecraft; construction, modification, and operation of infrastructure and test equipment at specific NASA facilities; and preparation and operation of a new drop zone for Orion and Ares parachute testing at Yuma Proving Ground. It was anticipated that such tiered NEPA documents would continue to be required and prepared for various aspects of NASA's human space flight and exploration program as the Constellation Program continued to mature and evolve.

Key Environmental Issues Addressed in the 2008 Final PEIS and the Anticipated Effect on Those Issues of Transitioning NASA's Post-Shuttle Human Spaceflight Program from the Constellation Program to the SLS, MPCV, and Associated Programs

The key environmental issues evaluated in the Final PEIS fell within five areas:

- Construction activities for modified or new facilities, focusing on modifications to test facilities and operational facilities.
- Major test activities, focusing on engine ground tests and flight tests for the Orion spacecraft and the Ares launch vehicles.
- Missions, focusing on mission launches utilizing Ares launch vehicles, and the return of the Orion spacecraft's Crew Module (CM) to Earth.
- Programmatic socioeconomic impacts.
- Cumulative impacts.

NASA evaluated these key environmental issues primarily as they apply to the following U.S. Government and commercial facilities: KSC, SSC, Michoud Assembly Facility (MAF), JSC, MSFC, John H. Glenn Research Center at Lewis Field and at Plum Brook Station, LaRC, Ames Research Center, WSTF, Dryden Flight Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, and Alliant Techsystems-Launch Systems Group (ATK) facilities at Clearfield and Promontory, UT.

Impacts from Facility Modifications and New Construction

The Final PEIS discussed facility modifications at several NASA Centers, many of which were as minor as updating electrical systems and construction of internal walls. Projects involving new construction and/or major facility modifications were needed at KSC, MSFC, SSC, and WSTF. Impacts anticipated with new construction and/or major facility modifications included noise, dust and air emissions from construction equipment and activities, and generation of construction wastes; all of which would be principally within a Center's boundaries. The Final PEIS indicated potential impacts to biota and wetlands would be considered, and all construction activities would be performed in compliance with applicable licenses and permits. Likewise, the PEIS indicated modifications to historic properties at NASA Centers (*e.g.*, KSC, MSFC) could affect the character or historic integrity of such properties and appropriate consultations and mitigation would be implemented.

Some of the facility modification and construction discussed in the Final PEIS has been completed or started as part of the Constellation Program. NASA anticipates that the SLS, MPCV, and associated programs will utilize many of the same facilities planned for Constellation and, as currently defined, will not require any facility modifications or construction that will result in environmental impacts outside the scope of those analyzed in the Final PEIS.

Impacts from Test Activities

The Final PEIS discussed the environmental impacts of the extensive testing of components and integrated vehicles required for development of the Constellation Program's Ares launch vehicles and Orion spacecraft. The tests with the greatest potential to have environmental impacts include ground and flight tests of liquid fueled engines and solid rocket motors (SRM). These tests were planned for contractor facilities (SRM tests); several NASA Centers, primarily SSC (Upper Stage and Core Stage engine tests) and KSC (flight tests); and other government facilities, primarily at WSMR (Launch Abort System tests). Environmental impacts associated with test firing of SRMs would principally be expected to be air quality impacts and short-term, localized noise impacts. The impacts of liquid fueled engine testing at SSC would principally be short-term noise impacts. Testing of propulsion systems at MSFC would generate offsite noise at levels that may increase the nuisance impact due to longer test durations than current or past tests performed at MSFC; however, these tests would not result in health impacts to the public. No adverse impacts to wildlife or listed species are anticipated from test firings of liquid fueled engines or solid rocket motors. Flight tests at KSC would have essentially the same or lesser impacts as mission launches.

When the Final PEIS was prepared in 2008, all of the facilities listed were already performing activities of a similar nature to those proposed in support of the Constellation Program. Therefore, the impacts of these activities were expected to be similar to those already present from existing operations at those facilities. Some of the test activities discussed in the Final PEIS and tiered NEPA documents have already been completed as part of the Constellation Program.

NASA anticipates the SLS, MPCV, and associated programs will benefit from much of Constellation's completed work and, as currently defined, will not require any test activities that will result in environmental impacts outside the scope of those analyzed in the Final PEIS. Various launch vehicles are under consideration for the MPCV flight test program, including the

SLS or potentially U.S Air Force vehicles (e.g. Delta or Atlas vehicles) which would be launched from Cape Canaveral Air Force Station (CCAFS). As currently defined, such test flights would fall within the envelope of ongoing activity at CCAFS and within the scope of activities and environmental impacts already evaluated in the Final EIS and other NEPA documentation.

Impacts from Missions

The Final PEIS also evaluates impacts associated with operational missions, which include primarily launch activity impacts at KSC. Combustion products from burning solid propellant, in the Ares as planned under the Constellation Program and in the SLS as currently planned, would release hydrogen chloride (HCl), aluminum oxide (Al_2O_3), oxides of nitrogen, and particulate matter. The potential ground level effects of launch vehicle exhaust clouds, acidic deposition, and far-field impacts (more than a few kilometers from the launch pad) would be similar to the Space Shuttle and considered negligible.

The Final PEIS indicated that each Ares V launch under the Constellation Program would be expected to generate noise, including vibration and ground waves, in excess of that experienced with the Space Shuttle and likely of the magnitude of or exceeding that of the Saturn V. As currently defined, NASA anticipates that SLS impacts would be similar and within the envelope of Ares V impacts presented in the Final PEIS. Noise modeling for the Ares V (which encompasses SLS) resulted in calculated noise values at the city of Titusville and at the KSC Visitor Center/Industrial Area that are much lower and significantly shorter in duration than the exposure threshold. A hearing conservation program would not be required because the exposure threshold would not be exceeded. As noted in the Final PEIS, the potential for structural damage to close-in buildings from launches exists, and NASA has procedures in place to evaluate such damage and provide for compensation, if warranted.

Sonic booms are associated with ascending launch vehicles and jettisoned launch vehicle components. The Final PEIS indicated the magnitude and location of Constellation sonic booms would be similar to those experienced with the Space Shuttle. SLS sonic booms are expected to be similar. The exact location of the sonic boom footprint would be mission specific and would occur over the open ocean.

All launches would be expected to result in a temporary startle response from nearby birds and other wildlife, and potential fish kills in nearby impoundments; however, similar to the Space Shuttle, no long-term adverse impacts to wildlife or fish populations would be expected. Surface water quality near the launch area could be affected by the launch exhaust cloud; however, long-term adverse impacts would not be expected.

Processing and launch activities would generate waste streams from propellant servicing, and launch and recovery operations. The Final PEIS indicated processing SRMs for Ares launch vehicles would be very similar to ongoing operations for the Space Shuttle fleet. The same is true for any SRMs used by SLS. All waste management activities would be within current permit requirements.

The results of a launch area accident, including extreme heat, fire, flying debris, and HCl deposition could damage adjacent terrestrial and marine biota within the impact region. As explained in Section 5 of the Final PEIS, mitigation measures and protective actions have or will be implemented to minimize or eliminate potential impacts to terrestrial and marine biota in the

area. As experienced in the past, damaged vegetation would be expected to re-grow within the same growing season and no lingering effects would be expected to be present.

NASA's Range Safety Policy is designed to protect the public, employees, and high-value equipment, and is focused on the understanding and mitigation (as appropriate) of risk. Potential impacts from catastrophic incidents involving launch vehicles are assessed as part of the overall Range Safety evaluation for each launch, and KSC can make launch-specific operations or access adjustments, as appropriate, to mitigate the risk of potential launch accident impacts.

As discussed in the Final PEIS, Ares I First Stage and the Ares V solid rocket boosters (SRB) would be jettisoned during ascent and recovered from the Atlantic Ocean using the same processes used for the Space Shuttle. The same is anticipated for SLS; however, the Constellation Program was, and the SLS program is, studying the possibility of not recovering the spent SRBs for certain missions. Other jettisoned sections would splash down through targeted atmospheric entry into the ocean and not be recovered. Potential environmental impacts from similar Space Shuttle operations have been demonstrated as negligible.

The Final PEIS indicated the landing site for the return of the Orion crew module would most likely be a site in the Pacific Ocean, off the western coast of the U.S. The return would result in a sonic boom that would occur over the open ocean, the magnitude of which would be expected to remain well below the magnitude of sonic booms from Space Shuttle atmospheric entries. Recovery operations for the crew module would be performed at government or contractor facilities near the western coast of the U.S. The same plan and expected impacts apply to the MPCV crew module.

The Final PEIS indicated that if the Orion CM were to have a catastrophic failure during atmospheric entry, the primary terrestrial hazard would be from falling debris over the open ocean. The same applies to the MPCV crew module. Prior to a planned atmospheric entry, NASA would ensure that Notices to Mariners and Notices to Airmen (NOTAM) are issued for the return corridor to reduce the risk to aircraft and surface vessels.

Socioeconomic Impacts

As discussed in the Final PEIS, the distribution of work related to the Constellation Program reflected NASA's intention to productively use personnel, facilities, and resources from across the Agency to accomplish NASA's human space flight and exploration initiative. Assignments aligned the work to be performed with the capabilities of the individual NASA Centers. The diversity of projects would vary considerably; however, it was NASA's intent, to the extent practicable, to retain a major socioeconomic footprint at each Center. In addition, NASA remains committed to a strategy to maintain current civil servant workforce levels, to the extent practicable, and provide funding to preserve the critical and unique capabilities provided by each NASA Center. Although new Congressional and presidential direction requires cancellation of certain elements of the Constellation Program, NASA will apply the same philosophy it used for Constellation as it continues work on human spaceflight under the SLS, MPCV, and associated programs.

Cumulative Impacts

The principal activities associated with NASA's post-Shuttle human spaceflight program that would result in environmental impacts include liquid fueled engine and SRM tests, launches, construction of new facilities, modifications of existing facilities, and other direct actions. In

addition, there may be secondary impacts associated with the support infrastructure (*e.g.*, structures, utilities, and roads). Each NASA Center has other ongoing programs that would be managed concurrently with NASA's human spaceflight program. It is reasonable to expect that these programs would entail many activities similar to those anticipated in support of human spaceflight. Such activities would be evaluated for environmental impacts by the sponsoring program or affected Center(s) and would be subject to separate NEPA review and documentation, as appropriate. The projected cumulative environmental impacts of implementing NASA's post-Shuttle human spaceflight program are principally the secondary impacts associated with the workforce that would support the program at each respective facility. The Constellation workforce socioeconomic impacts were addressed previously in Section B.4.1.1. of the Final PEIS, and the SLS and MPCV socioeconomic impacts would be similar but smaller in scale.

With respect to Ozone Depleting Substances (ODS) and global warming, the cumulative impact of the Constellation Program through the year 2020 was expected to be negligible, and the same is true for the SLS, MPCV and associated programs. It was estimated that the annual emissions of HCl and Al_2O_3 from Constellation launch vehicles (and thus SLS and MPCV, under which fewer launches are anticipated) would induce less than 0.0012 percent of the estimated annual global average ozone reduction for corresponding years.

The production of the SRMs currently requires the use of hydrochlorofluorocarbons (HCFC 141b), an ozone depleting substance (ODS), and the Ares I Upper Stage and Ares V Core Stage liquid oxygen/liquid hydrogen tanks were expected to also require the use of HCFC 141b blown foam insulation. SLS may also require the use of this insulation. NASA intends to develop cryoinsulation replacements that do not contain HCFC 141b. NASA will continue to use relatively small amounts of HCFC 141b-blown foam for use in research and development replacement activities. In addition, small quantities of HCFC 141b foam may be used to fill test holes in foam insulation on the exterior surface of SRBs.

The global warming potential for many greenhouse gases (expressed in metric tons of carbon dioxide [CO_2] equivalent) have been developed to allow comparisons of heat trapping in the atmosphere. The principal source of carbon emissions that would be associated with the Constellation Program (and by inference, SLS and MPCV) would be from NASA's energy use in support of the programs. Launches also would contribute to the production of carbon monoxide and CO_2. The total global warming potential of emissions from the Constellation Program were expected to total less than 0.004 percent of the annual U.S. carbon emissions over the 2009 to 2020 time period. SLS and MPCV program emissions are expected to be even lower.

Summary of the Analysis

Activities associated with NASA's post-Shuttle human spaceflight program (previously Constellation and currently SLS, MPCV and associated programs) that would result in potential environmental impacts include liquid fueled engine and SRM tests, launches, construction of new facilities, modifications of existing facilities, and other direct actions. In addition, there may be secondary impacts associated with the support infrastructure (*e.g.*, structures, utilities, and roads) such as wastes, impacts to water, noise, and air emissions, as well as the socioeconomic impacts of the workforce on the surrounding communities and region.

Since the SLS, MPCV and associated programs, as currently defined (like the previously planned Constellation Program), would be largely built upon the ongoing SSP and existing infrastructure, the potential environmental impacts would be expected to be very similar to the current impacts associated with the SSP and existing facilities. Program-related activities at the respective sites would largely be expected to be similar to ongoing operations at those sites and therefore have similar environmental impacts.

At NASA Centers, implementation of SLS, MPCV and associated programs (like Constellation) would not involve major new construction or new types of activities with the potential for substantial environmental impacts. The proposed activities are expected to be similar in nature and magnitude to ongoing activities at the respective Centers.

The mitigation measures outlined and discussed in the 2008 Final PEIS and ROD remain applicable to NASA's post-Shuttle human spaceflight program and will be implemented for SLS, MPCV, and associated programs as they were committed to for Constellation.

Incomplete or Unavailable Information

As the 2008 Final PEIS and ROD emphasized for Constellation, the SLS, MPCV, and associated programs are in the early design stages; therefore, it is reasonable to expect that there will be changes to plans and designs as the programs mature. The changes could include modification to the MPCV spacecraft and the SLS launch vehicle; the locations where development and testing occurs as well as their timing; and/or a change in the number of launches from the anticipated baselines.

Several key aspects of the Constellation Program were not sufficiently defined to be thoroughly evaluated in the Final PEIS. The 2008 PEIS and ROD indicated future Program activities would be subject to NEPA review and documentation, tiered off the Final PEIS, as appropriate. Several tiered documents were prepared following publication of the Final PEIS as the Constellation Program matured. This approach remains applicable to NASA's post-Shuttle human spaceflight program that is now evolving from the Constellation Program to the currently defined SLS and MPCV programs. As currently defined, the proposed SLS, MPCV, and associated programs are very similar to elements of the Constellation Program and fit within the envelope of the activities and potential environmental effects analyzed in the 2008 Final PEIS. However, the programs will become better defined as they mature and NASA's overall post-Shuttle human spaceflight program will undoubtedly continue to evolve. Just as with Constellation, as NASA's current post-Shuttle human spaceflight programs mature and specific proposed actions become more fully defined, additional environmental analyses and documentation will be prepared, as appropriate.

Conclusion

Based on CEQ regulations, specifically 40 CFR 1502.9(c)(1), the two situations in which an agency must issue a supplemental EIS are: (i) Substantial changes in the proposed action that are relevant to environmental concerns or (ii) significant new circumstances or information relevant to environmental concerns associated with the proposed action. Using these criteria, NASA has evaluated the changes to its planned post-Shuttle human spaceflight program required by the congressionally directed transition from Constellation to SLS, MPCV, and associated programs. Based upon this evaluation, NASA has concluded that there are no substantial changes relevant to environmental concerns associated with the evolution of NASA's post-Shuttle human

spaceflight program from Constellation (and particularly its Orion and Ares elements) to MPCV, SLS, and associated programs. NASA has further concluded there are no significant new circumstances or information relevant to environmental concerns associated with this evolution of NASA's post-Shuttle human spaceflight program. The 2008 Final PEIS continues to provide an appropriate programmatic analysis of the environmental impacts associated with the major elements of NASA's post-Shuttle human spaceflight program. As was done when the program was evolving under the Constellation label, NASA's post-Shuttle human spaceflight program will continue to produce tiered or supplemental NEPA documentation, as appropriate, throughout the continuing evolution and implementation of the program.

DECISION

Based upon all of the foregoing, including consideration of the 2008 Final PEIS and the 2008 ROD, it is my decision to continue development and implementation of NASA's evolving post-Shuttle human spaceflight program, including the SLS, MPCV, and associated programs outlined in the 2010 NASA Authorization Act.

William H Gerst

26 July 2011

William Gerstenmaier
Associate Administrator
Space Operations Mission Directorate
NASA Headquarters,
Washington, DC

Date

for Douglas Cooke
Associate Administrator
Exploration Systems Mission Directorate
NASA Headquarters,
Washington, DC

29 July 2011

Date