National Aeronautics and Space Administration
Washington, DC

NASA ADVISORY COUNCIL

Human Exploration and Operations Committee

January 12-13, 2015

Stennis Space Center
Mississippi

MEETING MINUTES

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Ken Bowersox, Chair

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Bette Siegel, Executive Secretary

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Meeting Minutes Prepared By
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NASA ADVISORY COUNCIL
Human Exploration and Operations Committee

NASA Stennis Space Center
Roy S. Estess Building
Logtown Conference Room 11161
Stennis Space Center, MS 39529-6000

PUBLIC MEETING
January 12-13, 2015

Monday, January 12, 2015

NAC HUMAN EXPLORATION AND OPERATIONS COMMITTEE / NAC SCIENCE COMMITTEE

JOINT MEETING

Call to Order and Welcome

Dr. Bette Siegel, Executive Secretary for the NASA Advisory Council (NAC) Human Exploration and Operations (HEO) Committee, called the public session of a joint meeting of the HEO Committee and the NAC Science Committee (SC) meeting to order at 1:00 p.m. She introduced Ms. Elaine Denning, SC Executive Secretary. It was announced that the meeting was a Federal Advisory Committee Act (FACA) meeting and, therefore, would be open to the public. Minutes would be taken and posted online. There would be an opportunity for the public to make comments towards the end of the meeting.

Opening Remarks and Member Introductions

Dr. Siegel introduced Mr. Ken Bowersox, HEO Committee Chair and Dr. David McComas, SC Chair. Mr. Bowersox and Dr. McComas welcomed everyone to the joint committee meeting. At Mr. Bowersox's request, the members from each committee introduced themselves. Dr. Robert Lindberg noted that he was sitting in for Dr. Gene Levy. Dr. McComas advised that there would be a joint dinner for the two committees. Mr. Bowersox explained that the reason for the joint meeting was to assess the state of interaction and cooperation between the Human Exploration and Operations Mission Directorate (HEOMD) and the Science Mission Directorate (SMD). This is based on a task assignment from the NASA Administrator, which, in pertinent part, states as follows:

> *Human and Robotic Mission Cooperation: Assess the current state of interaction and cooperation between the human spaceflight and robotic science mission organizations, including but not limited to use of ISS, suborbital reusable launch vehicles, and short duration orbital platforms/cubesats. Provide recommendations to improve process, utilization and outcomes as appropriate. As the capabilities for exploration (Space Launch System, Orion and ARM mission planning) mature and the Agency prepares to send humans to Mars in the 2030s, assess the opportunities for future collaboration to take advantage of the capabilities offered by both the NASA Human Exploration and*

Operations Mission Directorate and Science Mission Directorate, and provide recommendations to improve synergy between human and scientific exploration and advance Agency goals.

Welcome to NASA Stennis Space Center

Dr. McComas introduced Dr. Richard Gilbrech, Director, NASA Stennis Space Center (SSC or Stennis). Dr. Gilbrech welcomed everyone to Stennis. He stated that he has been with Stennis for 23 years. He explained that Stennis has a major role in rocket testing and a niche role in science. He described the recent RS-25 rocket engine test and noted that he is looking forward to the 4-engine test in 2016.

Dr. McComas thanked Dr. Gilbrech for hosting the meeting.

Overview Presentation of Human Exploration and Operations Mission Directorate/Science Mission Directorate Joint Activities

Dr. McComas introduced Dr. John M. Grunsfeld, Associate Administrator (AA), Science Mission Directorate (SMD), NASA Headquarters. Dr. Grunsfeld participated via video and teleconference from NASA Headquarters. He described how the SMD works with the rest of the Agency and noted that much of what the HEOMD does at NASA is in support of science. He reviewed the science-related objectives established for NASA in the National Aeronautics and Space Act. Dr. Grunsfeld noted that the Act contains elements of science and exploration, without explicitly mentioning human space flight. The early years of NASA involved a debate as to whether missions should be human-focused or more focused on science. Yuri Gagarin's flight changed the debate. Human space flight took on a predominant role when President Kennedy described the major goals of the 1960s for NASA: sending humans to the Moon and returning them safely, but science was still incorporated into NASA's early missions. Dr. Grunsfeld explained that NASA is now poised scientifically and technologically to answer the questions: Are we alone in the universe? Is human life sustainable on Earth? A slide was presented showing how NASA science is interconnected. Dr. Grunsfeld explained that NASA's four mission directorates are convenient budget bins and that the boundaries between the mission directorates are artificial. He likes to think of it in the following way: "One NASA".

Dr. Grunsfeld discussed the transition from Apollo to the Space Shuttle to the International Space Station (ISS). During that period, NASA was effective in leveraging human flight missions to support science. From the start, the Space Shuttle was envisioned as a transport system for deployment of space experiments and ISS materials. A chart was presented showing present day HEOMD and SMD joint activity areas. Those areas include science instruments flown on the ISS, the Mars Exploration Program, Planetary Protection, Space Communications and Navigation (SCaN), the Asteroid Redirect Mission (ARM), and the study of space radiation. Dr. Grunsfeld described several science projects. He presented a video showing the installation of RapidScat on the ISS. RapidScat is an instrument that measures ocean winds in support of climate studies and weather forecasting. The Cloud-Aerosol Transport System (CATS) is a light detection and ranging (LIDAR) instrument that uses the ISS as an affordable Earth science observing platform. It allows scientists to look at aerosols in clouds and is used to help predict climate change. Astrophysics instruments on the ISS also were described. The Neutron Star Interior Composition Explorer (NICER) is a large-area detector to obtain precise data on neutron star interiors and "star quakes." It will be carried to the ISS in the unpressurized trunk of a Space Exploration Technologies Corporation (SpaceX) Dragon capsule. The Cosmic Ray Energetics and Mass (CREAM) experiment will be flown to the ISS later in 2015. Dr. Grunsfeld also discussed ongoing lunar science. The Lunar

Reconnaissance Orbiter (LRO) is a joint mission that collects high-resolution imagery of the lunar surface.

Dr. Grunsfeld discussed HEOMD and SMD activities for future human exploration to Mars. The Mars 2020 rover will seek signs of life on Mars. The strategy is to follow the water. Dr. Grunsfeld described the Solar System Exploration Research Virtual Institute (SSERVI). The Planetary Protection Program was described, and Dr. Grunsfeld explained that it is important to establish restrictions to prevent contaminating Mars (forward protection) as well as restrictions to prevent return samples from contaminating Earth (backward protection). A workshop on planetary protection knowledge gaps for human extraterrestrial missions was described.

Dr. Grunsfeld also described joint communications work. The Space Communication and Communications Network (SCaN) provides most space communication services for SMD missions. It is actually three networks serving 70 active spacecraft, with over 20 more spacecraft planned within 5 years. The Lunar Laser Communications Demonstration (LLCD) was part of the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission.

SMD and HEO work in the study of extra-terrestrial samples was also covered. Astro-curation was described. Its purpose is to protect, preserve, and distribute samples from the Moon, Mars, and interplanetary space for study in support of solar system exploration. Cross-Agency leveraging examples from the Asteroid Redirect Mission (ARM) were described. These include SMD asteroid observations, Space Technology Mission Directorate (STMD) Solar Electric Propulsion (SEP) technology development, and full-scale testing of boulder extraction at NASA's Kennedy Space Center (KSC) Swamp Works.

The work of the Space Radiation Working Group (SRWG) was also described. It is a cross-Directorate, cross-Center group of subject matter experts. A chart showing the Launch Services 2015-2016 schedule was presented.

Dr. Grunsfeld introduced Mr. Craig Tupper, Director of Resource Management, SMD, NASA Headquarters. Mr. Tupper briefed the Committees on the costs that HEOMD and SMD are contributing toward collaborative activities.

Dr. Pat Condon complemented Dr. Grunsfeld for an excellent presentation and stated that he was impressed by the number of exciting things happening in the SMD. He noted that the HEOMD has struggled with the question of how to communicate the exciting things happening in the Directorate beyond the "geek" circle to the general public, and he asked Dr. Grunsfeld for suggestions. Dr. Grunsfeld responded that one thing he does is a "lunch and learn" with Congress. Dr. Douglas Duncan advised that the people who are best at communicating with the public are the people engaged in making movies and films. Dr. Grunsfeld cautioned that there are a number of limitations when working with the film industry as they often are not concerned with getting the "physics" right.

Dr. Janet Luhmann questioned whether enough attention was being paid to near-Earth survey missions. Dr. Grunsfeld responded that NASA tries to follow guidance from the scientific community but also uses priorities from national space policy. There are established budget guidelines for the identification of near-Earth objects (NEOs). He noted that the 2005 Brown Act required NASA to identify all NEOs 140 meters in diameter and larger by 2020. Funds for that mission, however, have not been appropriated. Dr. Harlan Spence remarked that the LRO was an example of synergy between HEOMD and SMD, the impetus for which was largely attributable to Michael Wargo, former Chief Exploration Scientist for

HEOMD. Dr. Grunsfeld stated that everyone in SMD is dedicated to that synergy. He added that NASA is trying to replicate the LRO model with Mars 2020.

Mr. Bowersox and Dr. McComas thanked Dr. Grunsfeld for his presentation.

Evolvable Mars Campaign

Mr. Bowersox introduced Mr. Jason Crusan who briefed the Committees on the Evolvable Mars Campaign (EMC). Mr. Crusan explained that most people think about exploration in terms of the Apollo Program, where there was a single destination. A better way to think about exploration today is using the example of the ISS, which does not have a single purpose; it serves multiple purposes, such as a testbed and a platform for economic development. That is how NASA is thinking about conducting exploration into deep space as well.

Mr. Crusan discussed the concept of "pioneering space," which he described as extending human presence beyond Earth for longer and longer time periods. He presented a quotation from President Obama's April 2010 speech on the subject:

> *"Fifty years after the creation of NASA, our goal is no longer just a destination to reach. Our goal is the capacity for people to work and learn and operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite. And in fulfilling this task, we will not only extend humanity's reach in space -- we will strengthen America's leadership here on Earth."*

Mr. Crusan explained that NASA Strategic Plan Objective 1.1 reflects the President's vision; it states: "Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, the benefits to humanity, and international collaborations." He stated that NASA's pioneering approach to exploration is the EMC. A slide on the EMC was presented. The slide showed three zones: Earth Reliant, Proving Ground, and Earth Independent. The slide also showed the trade space in three areas: across the board, cislunar, and Mars vicinity. A graphic entitled "Journey to Mars" was presented. It illustrated that Earth Reliant missions would last from 6 to 12 months and have a return time of hours, Proving Ground missions would last from 1 to 12 months and have return time of days, and Earth Independent missions would last from 2 to 3 years and have a return time of months.

Mr. Crusan discussed a chart showing principles for sustainable exploration. He explained that the principles have been modified based on the NAC's prior input. The principles are:

- implementable in the ***near-term with the buying power of current budgets*** and in the longer term with budgets commensurate with economic growth*;*
- ***exploration enables science*** **and science enables exploration***, leveraging robotic expertise for human exploration of the solar system;*
- application of ***high Technology Readiness Level*** (TRL) technologies for near term missions, while focusing sustained investments on ***technologies and capabilities*** to address challenges of future missions;
- ***near-term mission opportunities*** with a defined cadence of compelling and integrated human and robotic missions providing for an incremental buildup of capabilities for more complex missions over time;

- opportunities for ***U.S. commercial business*** to further enhance the experience and business base;
- ***multi-use, evolvable*** space infrastructure, minimizing unique major developments, with each mission leaving something behind to support subsequent missions; and
- substantial ***international and commercial participation***, leveraging current ISS and other partnerships.

Mr. Crusan explained that Mars provides the right "pull" for Proving Ground work. However, he noted, it is important to avoid the trap of a "boots on the surface of Mars" by a particular date. The Global Exploration Roadmap was discussed. It contains common goals and objectives that are shared by NASA and its international colleagues. A chart on commercial opportunities in space with NASA was discussed. Mr. Crusan described Strategic Knowledge Gaps (SKGs). He explained that an SKG is an unknown or incomplete data set that contributes risk or cost to future human missions to the Moon, Mars, or NEOs. SKG development is ongoing and jointly sponsored by HEOMD and SMD. Common themes for SKG's include radiation, regolith, reliability, and *in-situ* resource utilization.

Mr. Crusan explained that the EMC goal is to define a pioneering strategy and operational capabilities that can extend and sustain human presence in the solar system, including a human journey to explore the Mars system starting in the mid-2030s. A chart on EMC studies in fiscal year (FY) 14 was reviewed. Mr. Crusan discussed how the EMC's Proving Ground objectives enable Mars missions. A chart showing Exploration Upper Stage (EUS) and payload accommodation options was presented. ARM risk reduction for future Mars and deep space missions was discussed. The risk reduction includes development of sensor suites and proximity operations that can be used for both science and human spaceflight, enhanced interaction with uncooperative low gravity targets, and long-duration, high-power SEP.

Mr. Crusan described the "split mission" concept for getting to Mars. It would use SEP for pre-positioning both cargo and destination systems, while chemical propulsion would be used for crew transportation. FY15 forward study work includes launch vehicle development, concept development in coordination with SMD and STMD, habitation refinement, lunar polar volatiles, and SEP. Mars capabilities are being advanced by the Mars Curiosity rover; developments in Mars 2020; entry, descent, and landing (EDL) enhancement; and the development of inflatable habitats to be demonstrated at the ISS. Site selection is in the early stages, and a chart on the Mars site selection process was presented. He described a collaborative site selection study that SMD and HEOMD initiated in December 2014. A graphic on the technology path to pioneering Mars was shown. A chart on advancements in Mars capabilities was reviewed. Mr. Crusan described four requirements for a successful program: sustainability, agility, focus, and affordability. He explained that it is important to achieve a minimum once-per-year flight rate for SLS after 2022, within currently projected resources, and to engage partners to provide elements of the overall exploration architecture.

Dr. Condon stated that the HEO Committee has been reviewing the EMC approach and supports it because it makes sense in the current environment. However, he expressed concern that without a destination, it is much more difficult to generate a high degree of interest from the public and Congress. This is made more difficult because there is a high degree of "nebulousness" in identifying what NASA is trying to achieve.

Mr. Bowersox emphasized several points from the forward studies: the Space Launch System (SLS) has to be flown at least once a year; it is time to start thinking about the cislunar habitation module; and it might make sense to bring the transit habitation back into lunar distant retrograde orbit (LDRO) and to

use the DRO as a staging point for outbound missions. In response to a question from Mr. Bowersox, Mr. Crusan explained that several staging options are being studied. Mr. Bowersox stated that resource generation at Mars will be very important. Mr. Crusan agreed and noted that significantly greater water resources are believed to be on Mars than when Design Reference Architecture (DRA) 5.0 was generated. Obtaining resources from the Moon and from Martian moons is being considered. SEP and commonality of systems and capabilities are also important. In response to a question from Mr. Bowersox, Mr. Crusan stated that a series of SLSs will be required for bringing crew to Mars once the cargo has been pre-positioned. He added that another trade being considered is the propellants for the transit. They are looking at two staging options. One is a chemical liquid oxygen (LOX)-methane stage, the other is a hybrid chemical and electric propulsion stage.

Ms. Nancy Ann Budden observed that NASA has been working for decades on the concept of evolvable capabilities. She explained that it formerly was referred to as NASA's Capability Driven Framework for Human Spaceflight. She presented slides from that framework on common knowledge gaps.

Dr. McComas remarked that he had expected Mr. Crusan to describe the relationship between the EMC and the ARM. Mr. Crusan responded that each mission contributes in some way to overall capabilities and that the value of ARM is the advancement of those capabilities. Mr. William Gerstenmaier explained that the ARM mission has been extremely helpful. He noted that the advantage of using the DRO as a staging point for Mars did not become obvious until the ARM mission. He added that the SEP bus for Mars will be the same bus used for the ARM.

Mr. Malow remarked that recent data from Curiosity indicates that cosmic ray exposure during a six month trip to and from Mars may not exceed acceptable lifetime exposure levels for an astronaut. Mr. Bowersox noted that the subject would be briefed at a future joint Committee meeting. Dr. McComas stated that the radiation briefing is urgently needed as soon as possible because it is one of the most important drivers in the trade studies.

Mr. Bowersox and Dr. McComas thanked Mr. Crusan for his presentation.

Public Comments

Comments from the public were invited. Mr. Keven Miller commented that the presentations were terrific and that he found noteworthy Mr. Crusan's statement that at least an annual cadence for SLS is needed. Mr. Miller asserted that it is critical that each of those missions is prioritized. He asked whether there is a "processing place" for making those evaluations.

Joint HEOC/SC Discussion and Findings/Recommendations

Mr. Bowersox explained that the two Committees are supposed to review the joint work between SMD and HEOMD. He noted that the Committees are still in the data-gathering mode and have yet to hear about the work that has been done in the area of radiation.

Dr. Lindberg remarked that there is a need now for planetary protection to become engaged more broadly across the Agency. Dr. McComas suggested that a joint recommendation for the Planetary Protection Officer (PPO) to report directly to the Administrator could be helpful. Dr. Lindberg stated that planetary protection safety, mission assurance, and engineering requirements should be established in a level I NASA instruction document; currently, he explained, those requirements flow down from a

"characterization letter." Dr. Janet Luhmann recommended formalizing the assessment groups that are used by both HEOMD and SMD. Mr. Joseph Cuzzupoli requested that a library be established to hold the data that the HEO Committee needs to see to accomplish its work. Dr. Spence suggested that a "point person" be appointed to coordinate connections between SMD and HEOMD.

Dr. James Green noted that proposals will soon begin to be developed for the 2020 Decadal Study and that the average time from decadal study to flight is 17 years. He suggested that NASA support a proposal to include human spaceflight capability in a science mission, for example a space telescope. Dr. Bradley Peterson stated that the James Webb Space Telescope (JWST) represents the limit in size for assembling a telescope in space by unfolding. The size would be unlimited, however, for space telescopes assembled by humans in a zero-gravity environment.

Mr. Bowersox observed that there is a potential for involving university groups in work on the EMC. Dr. McComas stated that an Announcement of Opportunity (AO) can be used to get people interested. Dr. Condon remarked that there needs to be a resource plan that includes international partner resources and industry resources. He added that there also needs to be a communications strategy and plan. Ms. Shannon Bartell remarked that the presentations did not explain why the work being described was important to anyone but NASA. Mr. Malow stated that NASA must be doing something right, because it received $825 million (M) above what had been requested. Mr. Gerstenmaier explained that every major event is being examined to determine whether it is unique and whether it deserves a public-relations campaign. When the EMC document is finalized, there will be more public engagement on the campaign. He added that the charts shown by Mr. Crusan are used by speakers across the Agency.

Dr. Luhmann commented that when NASA is asked for the reason for human exploration, the answer is not as crisp as it should be. Ms. Bartell reported that people in her home town, Pumpkintown, South Carolina, have heard about Exploration Flight Test-1 (EFT-1). Mr. Gerstenmaier explained that the focus now is more on the journey. Mr. Michael Lopez-Alegria remarked that the EFT-1 campaign was very good, partly because it involved a launch. He observed that most people do not care about exploring space and that the people who do care are already following NASA. Mr. Jim Odom stated that the telescope construction concept is a potent idea for the SLS missions Dr. Carle Pieters remarked that the joint meetings have been valuable and should continue.

Adjournment

The joint meeting of the HEOC and SC was adjourned at 4:50 p.m.

Tuesday, January 13, 2015

HEO COMMITTEE MEETING

Dr. Siegel called the HEO Committee meeting to order in the Roy S. Estess Building Conference Center, Room 107, at 9:30 a.m. She welcomed everyone and noted that it was a public meeting and that minutes would be taken and posted online. The public would have an opportunity to make comments at the end of the meeting. Dr. Siegel introduced Mr. Ken Bowersox.

Status of the Human Exploration and Operations Mission Directorate

Mr. Bowersox introduced Mr. William Gerstenmaier, AA, HEOMD. Mr. Gerstenmaier presented a slide showing the ISS and the spacecraft that visit it. He noted that the ISS has been extended to at least 2024, and he explained that it provides benefits for both science and exploration. He stated that the ISS is driving a large portion of the launch market and accounted for 15 percent of the 90 launches in the past year. That happened because the ISS is able to take higher launch risks with cargo delivery versus flight crew missions.

Mr. Gerstenmaier reviewed the milestones status for Commercial Crew Integrated Capability (CCiCap) Space Act Agreements (SAAs) and Commercial Crew Transportation Capability (CCtCap) contracts. CCtCap contracts have been awarded to The Boeing Company (Boeing) and to SpaceX. He reported that Sierra Nevada Corporation (SNC) filed a protest because it had not been selected for an award under CCtCap. The protest was denied by the General Accounting Office (GAO). Mr. Gerstenmaier observed that this demonstrated that the overall selection process was healthy. He noted that NASA has obtained permission from the Court of Federal Claims to proceed with the two contracts that were awarded.

Mr. Gerstenmaier described collaborations on commercial space capabilities. The objective for the collaborations is to advance private-sector development capabilities so that the emerging products or services are commercially available to government and non-government customers. SAAs, with no exchange of funds, have been awarded to four companies. Those companies will be given access to NASA's spaceflight resources, including technical expertise, assessments, and lessons learned.

A slide was presented showing the Orion spacecraft after its return from space on EFT-1. Mr. Gerstenmaier remarked that the test flight was tremendously successful.

Mr. Gerstenmaier discussed the EMC. He explained that its goal is to define a pioneering strategy and operational capabilities that can extend and sustain human presence in the solar system, including a human journey to explore the Mars system starting in the mid-2030s. The "Journey to Mars" slide was presented. Mr. Gerstenmaier discussed Design Reference Architecture (DRA) 5.0 for the human exploration of Mars. He remarked that it is the basis for the EMC, although it is not how NASA would do Mars today. He noted that DRA 5.0 envisions nuclear propulsion and that it now looks like lunar resources can play a very strong role in going to Mars. The big question is how readily available those resources will be and whether they can be extracted. Mr. Gerstenmaier discussed the ARM and explained that it has led to several benefits applicable to the EMC: using Solar Electric Propulsion (SEP) to move large masses in space; using lunar vicinity and a LDRO as a staging point; and understanding the advantages of a split mission concept where cargo is pre-positioned before sending crew. Mr. Gerstenmaier noted that NASA is not ready for another design reference mission or pathway; rather, there is a need to better understand the trades and the framework– ongoing work that the EMC is conducting. Mr. Gerstenmaier reviewed the principles for sustainable exploration. Mr. Bowersox noted that changes to the principles had been made with input from the NAC. He remarked that for a program to be sustainable, it must be communicated. Mr. Gerstenmaier requested the NAC's advice and assistance in articulating "A Plan for the Plan," covering sustainability, agility, focus, and affordability. He reviewed the quotation from President Obama's April 2010 speech on Pioneering Space.

Mr. Bowersox asked about potential problems with hyperbolic rendezvous. Mr. Gerstenmaier reported that the advantages and disadvantages of using a hyperbolic rendezvous are being studied by universities as part of the senior design process, which is not funded by NASA. Mr. Joseph Cuzzupoli

noted that President Kennedy had given NASA an objective, not a plan: to land on the Moon and return safely. Mr. Gerstenmaier responded that the ultimate objectives are Mars and creating a sustainable human presence in the solar system. He added that history shows that building an evolvable plan is the "smart way of going." Mr. Cuzzupoli agreed with the approach on developing capabilities and advised it was time to begin to develop a lander. In response to a question from Mr. Bowersox, Mr. Gerstenmaier stated that the auditors are asking the wrong questions and that the question should be whether NASA is building an affordable vehicle that can be modified for different missions at a reasonable cost.

Mr. Bowersox thanked Mr. Gerstenmaier for his presentation.

Asteroid Redirect Mission Update

Mr. Bowersox introduced Dr. Michele Gates, Program Director for NASA's Asteroid Redirect Mission. She introduced Mr. Lindley Johnson, Program Executive of the NEO Program, who addressed the Committee later in the presentation.

Dr. Gates described the key ARM contributions that would be made in the Proving Ground toward enabling Mars missions. NASA will demonstrate SLS and Orion in deep space, use LDRO as a staging point for moving large cargo masses, conduct deep space extravehicular activities (EVAs), and use SEP systems for moving large masses in interplanetary space. Long-duration, deep space habitation systems would be demonstrated, and there would be an opportunity to learn to operate with reduced logistics capability. Dr. Gates discussed the Split Mission Concept for getting to Mars. SEP would pre-deploy cargo to Mars orbit in a 2- to 3-year transit. Crew would be launched and join up with the habitation module in cislunar space, and proceed to Mars via chemical propulsion in a 6- to 9-month transit. The habitat module would return to a staging point in cislunar space for refurbishment. The crew would return to Earth in Orion. She presented a slide showing an overview of the Asteroid Redirect Crewed Mission.

Dr. Gates described a potential trajectory for a mission to an approximately 4-meter asteroid designated 2009 BD. She discussed crewed-mission design considerations. Contingency trajectory planning for a Proving Ground mission was discussed. Dr. Gates explained that auxiliary thrusters could complete the mission if Orion's main engine failed, although the mission duration would be longer than a nominal mission. The Mission Kit Concept for EVA suits was discussed. A slide was presented showing four kits to enable Orion-based EVA capability. Dr. Gates reviewed progress made in 2014 on the ARM Crewed Mission. She discussed a chart on the Automated Rendezvous and Docking Common Specification. A chart on modified Advanced Crew Escape Suit (ACES) feasibility testing was reviewed. Mr. Lopez-Alegria remarked that he was impressed with work done on the suits and asked whether thermal and micrometeoroid and orbital debris (MMOD) analysis had been performed. Dr. Gates responded that she would provide that information.

Dr. Gates described Neutral Buoyancy Laboratory (NBL) test results on worksite stabilization. She reviewed a chart assessing Option A and Option B for the ARM Crewed Mission.

The key findings of the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) were reviewed. A chart was shown on the capabilities that the ARM robotic-vehicle reference design can provide for docked vehicles. Dr. Gates described the ARM's three main segments: identify, redirect, and explore. She reviewed charts showing accomplishments since July 2014. The current objectives of the

ARM were reviewed. The primary objectives are: (1) conduct a human exploration mission to an asteroid in the mid-2020s, and (2) demonstrate an advanced SEP system.

Mr. Johnson described the status of the asteroid identification and characterization project for the asteroid capture and redirect missions. Near Earth Objects (NEO) radar observations in 2014 were discussed. He reported that while several new potential candidates had been identified in 2014, none could be validated as completely within the target parameters for the proposed mission. Charts characterizing asteroid candidates for Option A and for Option B were reviewed. Mr. Johnson discussed a recent report by the Small Bodies Assessment Group (SBAG) ARM Special Action Team (SAT) on the ARM's science potential. Mr. Bowersox remarked that it would be helpful to separate the asteroid identification effort from the ARM. Mr. Johnson replied that asteroid identification funding is separate from the ARM and is a separate line item in SMD's budget.

Dr. Gates provided an overview of Robotic Capture Mission Option A and Option B. Risk reduction activities for both options were discussed. Graphs assessing Robotic Capture Mission launch date flexibility were presented. In response to a question from Mr. Lopez-Alegria, Dr. Gates explained that the graphs show the orbits for the three most feasible candidates for returning mass to lunar orbit by 2025, and that other NEOs would become viable candidates if the mission date changes. Dr. Gates described the next steps:

- Complete assessing the budget and complexity differences versus the extensibility advantage in option A/B decision;
- Continue asteroid observations and enhancements;
- Continue high power, long life SEP system technology demonstration activities;
- Continue human spaceflight system development and technology maturation;
- For selected robotic mission capture concept, refine independent technical risk, schedule, and cost assessment; and
- Hold Mission Concept Review –scheduled for March 24, 2015.

Mr. Bowersox thanked Dr. Gates and Mr. Johnson for their presentation.

Status of the Exploration Systems Development Division

Mr. Bowersox introduced Mr. William Hill, Deputy AA for Exploration Systems Development (ESD), HEOMD. Mr. Hill discussed President Obama's 2010 speech. He explained that the emerging Exploration Strategy is based on the speech and implements NASA's first strategic objective: "Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration." He stated that NASA is in the business of pioneering space, which is about the journey, not the destination. The "Journey to Mars" slide was shown.

Mr. Hill discussed the Exploration Upper Stage (EUS) and variations for accommodating payloads. Mr. Cuzzupoli remarked that the first and second stages are the most important parts. He added that it should be emphasized that the two stages would be common for all missions. Mr. Hill described work that would be accomplished in the Proving Ground in cislunar space. SLS and Orion would be demonstrated in deep space. LDRO would be demonstrated as a staging point for large cargo masses on route to Mars. Deep space EVA's would be conducted with sample handling. SEP systems would be

demonstrated to move large masses in interplanetary space. *In-situ* resource utilization would be demonstrated in microgravity. Long-duration, deep space habitation systems would be demonstrated.

Mr. Hill presented a graphic showing how Orion is designed to operate beyond low-Earth orbit (LEO). He explained that Orion would be able to sustain crew for nearly a week in a depressurized cabin. In response to a question from Mr. Bowersox, Mr. Hill stated that the suit used would be the Advanced Crew Escape Suit (ACES). Mr. Bowersox noted that consumables would be needed for an open-loop suit and stated that meeting the 1-week requirement with the current suit would be difficult. In response to a question from Mr. Bowersox, Mr. Gerstenmaier explained that Orion is a capsule with an emergency capability and that there would be no need, therefore, for a separate habitation module. A slide was presented showing how Orion's development benefits the Commercial Crew Program (CCP).

Mr. Hill discussed the successful EFT-1 flight. A video on the flight was presented. Mr. Hill summarized the mission success criteria and the flight test objectives. The current estimate is that 85 out of 87 flight test objectives will have been met. Mr. Hill noted that the module up-righting system did not work as well as expected. The Orion has been returned to KSC and is in great shape. The data and data quality from the flight were described. Charts on the flight performance were reviewed. Mr. Hill remarked that they learned when the launch was cancelled and had to be rescheduled that they had good procedures for recycling the launch. The consumable usage during the test flight was discussed. Mr. Hill remarked that everything had been over-predicted. He described and presented slides on the recovery process. It took 7.5 hours to get the module into the recovery ship. The Post-Flight Plan was discussed. Charts on 2014 accomplishments and major milestones for 2015 were presented. Mr. Hill concluded his presentation with a chart showing a schematic for the EM-1 uncrewed mission of Orion to LDRO planned for 2017. Mr. Gerstenmaier commented that the 2017 date could not be met, and Mr. Hill stated that the date on the chart should be changed to 2018. In response to a question from Mr. Lopez-Alegria, Mr. Gerstenmaier explained that the "plus-up" added to the President's budget would provide additional reserve and margin for the unknown unknowns and would help prevent the schedule from slipping; however, it would not cause the schedule to advance. He noted that some additional funding may be applied to the EUS. Mr. Bowersox confirmed that the current plan was to obtain the EUS by 2024-2025. Mr. Gerstenmaier stated that he would ascertain the assumption for the Earth's gravity escape performance for the robotic spacecraft launch on the SLS. He added that consistency in the budget would help overall and that it is difficult to plan otherwise.

In response to a question from Mr. Bowersox, Mr. Hill explained that if the second stage is not ready for Exploration Mission-2 (EM-2), the mission will just fly to lunar orbit. Mr. Bowersox confirmed that EM-2 would be the first flight test with life-support systems and that it would also have crew on it. Mr. Gerstenmaier explained that testing the life support systems on the ground and on the ISS would provide an adequate basis for putting the crew on the first flight without any additional flight testing. Mr. Bowersox summarized that the SLS program team would like to apply funds currently intended for human rating the Interim Cryogenic Propulsion Stage (ICPS) to development of the EUS.

Mr. Bowersox thanked Mr. Hill for his presentation.

Status of the International Space Station

Mr. Bowersox introduced Mr. Sam Scimemi, Director for ISS, who briefed the Committee on the status of the ISS. Mr. Scimemi explained that NASA and the Nation have four goals for the Station: advance benefits to humanity through research, enable long-duration human space flight beyond LEO, enable the commercial market in LEO, and provide the basis for international human space flight leadership and partnerships. He described major differences between the ISS and Mars missions and stated that the ISS is critical to closing the gap between LEO and long-duration spaceflight. The ISS is needed to mitigate 21 of the 30 human health risks anticipated on exploration missions. Necessary research will not be sufficiently mature until the mid-2020s. He discussed the Human Research Program's (HRP's) path to risk reduction. He stated that NASA probably would never be able to mitigate risk from intergalactic cosmic rays and that that risk would have to be accepted.

The upcoming ISS One-Year Mission was described. In 2015, Astronaut Scott Kelly and Cosmonaut Mikhail Kornienko will be launched to the ISS for 12 months—the longest mission ever assigned to a U.S. astronaut. Mr. Kelly's twin brother, retired Astronaut Mark Kelly, will be included in the study. The twins provide an unprecedented opportunity to research the effects of space flight on twin genetic makeup and to better understand the impacts of space flight on the human body.

Mr. Scimemi reviewed a graphic showing exploration flight testing on the ISS. He discussed the ISS role in the development of the commercial market. Vehicle launches to the ISS account for approximately 15 percent of the global launch market. Development and operations of the ISS domestic commercial cargo providers, SpaceX and Orbital Sciences Corporation (Orbital), have stimulated the global competition in launch services. Private companies are now using the ISS to stimulate broader commercial use of the LEO environment. The Center for the Advancement of Science in Space (CASIS) manages the U.S. National Laboratory on the Space Station and has significantly expanded the commercial use of the ISS through private partnerships. Mr. Scimemi explained that NASA and CASIS have the same objectives. He noted that extending the Space Station to at least 2024 enables maturation of the commercial market in LEO. A slide showing the logos of all the companies having business on the Space Station was presented. He described a LEO Commercialization Workshop held in December 2014; it produced these findings:

- Need for routine and regular access to ISS;
- More clarification on insurance, intellectual property rights, cross-waivers, and government and non-government use of materials developed on ISS;
- Potential government incentives, which could include free trade/tax free zones;
- Recommendation for NASA to include commercialization in a strategic plan; and
- NASA should not be in competition with industry.

Materials from the workshop are available at:
http://www.nasa.gov/directorates/heo/LEO_commercialization.

In response to a question from a Committee member, Mr. Scimemi explained that CASIS imposes no intellectual property requirements other than government imposed requirements. The government has licensing rights for items in which the government has made significant investments; however, NASA has never exercised that right.

An ISS Flight Plan chart was presented showing crew rotations, port utilization, and launch schedules through August 2016. The Soyuz 40 and 41 crew members and highlights from Increments 41 and 42 were described, including three U.S. EVAs.

The status of total ISS consumables and consumables on the U.S. Orbital Segment (USOS) were discussed. Mr. Gerstenmaier explained that the loss of Orbital (Orb)-3 from the explosion of Orbital's Antares rocket and destruction of its Cygnus cargo carrier has put a lot of criticality on the next two SpaceX resupply flights. Nothing irreplaceable was lost. However, some science had to be rescheduled. He noted that SpaceX has been incredibly supportive in accommodating requests for manifest changes. A new design requirement to carry water had to be given to SpaceX. Previously, only Orbital had been given that task. Mr. Gerstenmaier explained that the overall response demonstrates that NASA's cargo resupply philosophy is sound. He noted that Orbital, for a long period of time, is not going to be as reliable as other providers. Orbital has proposed a recovery plan for Orb-4 and has acquired an Atlas 5 for its next delivery. Orb-5 may be flown on an Atlas or transitioned to an upgraded Antares launch vehicle. Mr. Scimemi noted that sufficient space research work is onboard the ISS for the crew to remain busy. In response to a question from Mr. Bowersox, Mr. Scimemi explained that Russia and the U.S. generally provide their own food on their own supply vehicles unless there is a specific request. In response to a question from Ms. Bartell, Mr. Scimemi explained that Orbital earned a partial payment when it hit the ignition button for Orb-3. An additional payment would have been earned if the supplies had been delivered.

Mr. Scimemi discussed a graph showing the utilization of crew time on Increments 41 and 42. He noted that, to date, there has been only about 1.5 years of productive, on-orbit laboratory time spent in microgravity research on the ISS. He acknowledged that the NASA community is impatient for research results. ISS research statistics were reviewed. A chart summarizing research conducted during Increments 41 and 42 was presented. Mr. Scimemi noted that RapidScat was launched on SpaceX-4 and within days was producing operational data products on sea surface winds for use in weather forecasting worldwide. He described the Alpha Magnetic Spectrometer (AMS) on the ISS. The AMS is designed to measure indications of antimatter in cosmic rays and search for evidence of dark matter. Recent results are consistent with the existence of dark matter in the space surrounding our galaxy, but additional data must be collected to rule out other possible explanations for the data collected by AMS.

Mr. Bowersox thanked Mr. Scimemi for his presentation.

Lessons Learned from Commercial Orbital Transportation Services

Mr. Bowersox introduced Mr. Alan Lindenmoyer. Mr. Lindenmoyer presented by telephone from NASA's Kennedy Space Center. He discussed how the Commercial Orbital Transportation Services (COTS) Program management was designed and executed. He explained that the U.S. Space Exploration Policy of 2004 called for NASA to retire the Space Shuttle in 2010 and extend human presence across the solar system, starting with a human return to the Moon. The Shuttle retirement created a gap in NASA's ability to meet U.S. obligations to service the ISS with crew and supplies prior to the availability of the new Ares and Orion launch vehicles and spacecraft. NASA challenged U.S. industry to develop cargo and crew transportation capabilities to meet those obligations and to open new markets in LEO. The intent was to establish non-traditional partnerships under NASA's other transactions authority, rather than use Federal Acquisition Regulation (FAR) contracts, since there was no acquisition of goods or services.

The Commercial Crew & Cargo Program (C3P) Office (C3PO) was established at NASA's Johnson Space Center (JSC) in November 2005. The Formulation Authorization Document (FAD) provided that the C3P consists of demonstration projects executed using SAAs. It further provided that NASA would not take ownership of any flight or ground systems, and therefore, the Program would not be bound by Program and Project requirements defined within NPR 7120.5C, although those requirements would be used as a guide for developing processes for providing insight to NASA. The goals were to use investments to stimulate the commercial space industry, facilitate U.S. private industry demonstration of cargo and crew space transportation capabilities, and create a market other than the government for commercial space transportation services. The strategy was to use competitively awarded SAAs to offer seed money and technical support to industry partners. NASA would accept the risk that capabilities might not materialize. The backup option would be to revert to NASA and international partners for those capabilities. The initial budget for the program was $500M. That was augmented in FY11 with an additional $288M. Those funds were applied to risk-reduction milestones, including additional ground testing and an additional flight test of Orbital's Antares launch vehicle.

Mr. Lindenmoyer reviewed the C3PO organization chart. He explained that requirements had been streamlined to minimize administrative expenses and maximize funding to commercial partners, while maintaining a good balance of oversight and insight. He noted that program management, administration, and technical support expenses were less than five percent of the initial budget. ISS visiting-vehicle integration costs were covered by the ISS Program.

Mr. Lindenmoyer described the Program oversight and insight. Oversight applies to official government approval and direction. NASA oversight was limited to assessment and approval of a series of fixed milestone payments listed in the SAA based on pre-negotiated objective success criteria. NASA also provided formal verification approval of ISS Interface Requirements in preparation for issuing a Certification of Flight Readiness. Data deliverables were limited to information NASA needed to conduct milestone completion assessments and ISS integration. Insight refers to information to discern project performance status. NASA insight was accomplished through day-to-day interactions between the commercial partner and the NASA Project Executive team and through Quarterly Program Reviews held with the NASA program manager. A COTS Advisory Team of subject matter experts from across the Agency were activated on a part-time, as needed basis to conduct Technical Interchange Meetings when requested by the partner and to assist the Program with milestone reviews. Internal NASA insight was accomplished by having the C3PO formally report to the NASA Exploration Systems Mission Directorate (ESMD) AA at Quarterly Program Management Reviews along with all other ESMD programs. Mr. Bowersox noted that the advisory teams provided assistance and advice to the partners.

In response to a question from Mr. Bowersox, Mr. Lindenmoyer explained that the cost models in use prior to the COTS program showed that the products would have been three to ten times more expensive using classical Federal contracting methods. In response to another question from Mr. Bowersox, Mr. Lindenmoyer explained that human safety requirements were met by consolidating all NASA requirements into one document and imposing that as a requirement for anything involving integration with the ISS. Ms. Bartell clarified that the NASA safety requirements did not extend to ground systems or to standard engineering practices. Mr. Lindenmoyer stated that the companies' proposals were evaluated on how well they complied with standard engineering practices; however, the companies were allowed to use their own judgment. Ms. Bartell explained that that is part of a cultural change that NASA must accept in order to obtain commercial benefits. In response to a question from Mr. Bowersox, Mr. Lindenmoyer stated that the savings came from minimizing requirements on the partner (enabled by SAA vs FAR contract) and not having to comply with traditional program

management requirements (7120) including not having a standing review board which enabled a small Government oversight and administration team. He explained that there is a direct correlation between the numbers of "shall" statements that NASA writes and the cost to close those requirements. Mr. Cuzzupoli remarked that the Program resembled the old "Skunk Works" and that eliminating the FAR system can eliminate costs tremendously. Ms. Bartell observed that the Program benefitted from having firm clear direction that was supported throughout the Agency over the entire process, even though some people disagreed with it.

Mr. Bowersox asked Mr. Lindenmoyer to identify commercial candidates for EMC and future exploration. Mr. Lindenmoyer stated that a Request for Information (RFI) had been issued to industry asking how industry could help with NASA's exploration goals. The responses indicated that potential commercial areas are new pressure suits, logistics support, satellite servicing, deep space deliveries using SEP, *in-situ* resources, deep space communication, new methane engines, and propellant depots.

Mr. Lindenmoyer concluded his presentation by observing that the COTS Program has proven to be a successful, cost-effective new way for NASA to do business with commercial industry. It can be a model for other programs but requires careful consideration of goals, objectives, and programmatic risk. He noted that the Program has been favorably reviewed and audited by the GAO, the Inspector General (IG), the NAC, and the Aerospace Safety Advisory Panel (ASAP).

Mr. Bowersox thanked Mr. Lindenmoyer for his presentation and stated that he and his team should be very proud of that work that made the Program a success. Ms. Bartell concurred.

The Committee considered a proposed recommendation for NASA to examine and change Agency documents that unnecessarily affect the cost of programs. Ms. Bartell advised against asking the Agency to conduct a complete review of every document. Mr. Gerstenmaier stated that 7120 has improved project performance. Mr. Bowersox remarked that 7120 is a great document and that the problem is tailoring it.

Public comments

Mr. Bowersox invited comments from the public. There were no comments.

Discussion and Recommendations

Mr. Bowers reviewed the task given to the NAC by the Administrator on the capability driven framework:

> *Capability driven framework for future human exploration: Review NASA's plans both for evolving the Capability Driven Framework (CDF) and in the effective communication of it to stakeholders. Advising on the CDF for human exploration will be needed in light of the National Research Council report expected in May 2014, this report includes future use of the International Space Station (ISS) in its extended life. NASA is advancing the CDF to define the capabilities we will need as we move from "Earth-dependent" to "Earth-independent" (as we will need to be for a Mars expedition). This will include the use of ISS and its extended lifetime to mature and demonstrate exploration capabilities. This also will include the use of cis-lunar space as a "proving ground" for deep space exploration capabilities. The Asteroid Redirect Mission (ARM), both robotic and human encounter elements are a part of this evolution.*

Ms. Budden stated that it might be good to say that the Committee still supported the capability-driven framework. Mr. Bowersox discussed the NAC's finding on the endorsement of the Human Exploration Strategy. He explained that the NAC had concerns over the funding and the flexible approach. NASA, at the NAC's request, has agreed to perform a study on what should be the minimal flight rate for SLS.

Topics for future Committee consideration were reviewed. The Committee's work plan through the summer of 2015 was discussed. Mr. Bowersox summarized and reviewed results from the fact finding on NPR 7120.5C. He explained that its requirements are levied by numerous stakeholders. Tailoring the requirements is a difficult process that is frequently avoided when it is simpler to satisfy a requirement that adds little value. Ms. Bartell explained that 7120 represents NASA's requirements on how to manage a program. She indicated that there is a need to streamline the tailoring process and make it clear. Mr. Bowersox noted that the FAR also affects the cost of NASA programs. He reminded the Committee that economic models indicated that COTS would have cost three to ten times as much as it did if it had been subject to 7120 and the FAR. In response to a question from Mr. Cuzzupoli, Mr. Bowersox explained that commercial crew contracts are subject to 7120.

The Committee considered a proposed recommendation for NASA to examine and change Agency documents that unnecessarily affect the cost of programs. Ms. Bartell advised against asking the Agency to conduct a complete review of every document. Mr. Gerstenmaier stated that 7120 has improved project performance. Mr. Bowersox remarked that 7120 is a great document and that the problem is tailoring it. Mr. Gerstenmaier noted there may be a culture problem because some program managers want their programs to be important enough to be covered by 7120. Ms. Bartell advised that 7120 needs to be "tailorable" in a timely manner with fewer levels required for approval. After further discussion, the Committee approved the following recommendation:

TITLE: Focus on Affordable Program Management Recommendation: The NAC recommends that NASA take action to make programs and projects more affordable by:
1. Examining the current approach for tailoring mandatory NASA management requirements and making changes to expedite the resolution of tailoring requests.
2. Working with groups that are currently conducting separate reviews of programs to minimize the number and maximize the benefit of reviews and reviewing groups.

MAJOR REASONS FOR PROPOSING THE RECOMMENDATION: The affordability of NASA's programs is a potential barrier to the achievement of NASA's strategic goals. Some program costs, are within NASA's purview to control, such as internal program management requirements and various program or project reviews which are mandated by various NASA groups. During data gathering efforts by the Human Exploration and Operations Committee on his topic, two specific areas were consistently mentioned by program managers who were interviewed – difficulty of tailoring management requirements, and the overhead of supporting numerous external and internal program reviews.
CONSEQUENCES OF NO ACTION ON THE PROPOSED RECOMMENDATION: Difficulty or delay in achieving NASA's strategic goals due to program costs which are higher than necessary.
Proposed NAC Recommendation January, 2015

Dr. David Longnecker presented a proposed finding from the Research Subcommittee. The finding endorsed the HEOMD's effort to broaden participation in the NASA research community as evidenced by the recent NASA Research Announcement in Space Biology, in which 75 percent of the submitted proposals were from Principal Investigators (PIs) new to space biology, and 62 percent of the awards

were to new PIs. Mr. Bowersox suggested that presenting the finding to the NAC as a Committee finding for the AA would be more appropriate than a NAC finding for Mr. Bolden. Mr. Longnecker concurred.

NASA Advisory Council- Committee Finding Human Exploration and Operations Committee

Finding to NASA Associate Administrator for Human Exploration and Operations Mission Directorate

Name of Committee: Human Exploration and Operations Committee
Chair of Committee: Mr. Kenneth Bowersox
Date of Council Public Deliberation: January 15, 2015

Short Title of Finding: Expanding the NASA Research Community

Finding: The Human Exploration and Operations Committee endorses the NASA Human Exploration and Operations Mission Directorate effort to broaden participation in the NASA research community evidenced by the recent NASA Research Announcement in Space Biology, in which 75% of the submitted proposals were from principal investigators new to Space Biology, and 62% of the awards were to new principal investigators. This result followed a year of effort at major scientific conferences to publicize the opportunity to conduct biological research on the International Space Station. Broadening the community and engaging the best new ideas for research from the nation's scientists will greatly strengthen the foundations of space research and enhance the productivity of NASA's investments. NASA should continue to seek to bring in new investigators, within the limits of its available resources, and continue to track this metric.

Dr. Condon applauded Mr. Gerstenmaier and his team for incredible work under difficult circumstances. Ms. Budden thanked Mr. Bowersox and Dr. Siegel for their efforts in making the Committee meeting a success. Mr. Bowersox thanked Dr. Siegel and Ms. Shawanda Robinson for their support to the Committee.

Adjournment

The meeting was adjourned at 5:30 p.m.

NASA ADVISORY COUNCIL
Human Exploration and Operations Committee

NASA Stennis Space Center
Roy S. Estess Building
Logtown Conference Room 11161
Stennis Space Center, MS 39529-6000

PUBLIC MEETING AGENDA
January 12-13, 2015

Monday, January 12

NAC HUMAN EXPLORATION & OPERATIONS COMMITTEE / NAC SCIENCE COMMITTEE

JOINT MEETING

1:00 – 1:02 pm	Call to Order & Welcome	Dr. Bette Siegel Ms. Elaine Denning
1:02 – 1:25	Opening Remarks & Member Introductions	Mr. Kenneth Bowersox Dr. David McComas
1:25 – 1:30	Welcome to NASA Stennis Space Center	Dr. Richard Gilbrech
1: 30 – 2:30	Overview Presentation of HEOMD/SMD Joint Activities	Dr. John Grunsfeld Mr. Craig Tupper
2:30 – 3:40	Evolvable Mars Campaign	Mr. Jason Crusan
3:40 – 3:50	***BREAK***	
3:50 – 3:55	Public Comments	
3:55 – 5:20	Joint HEOC/SC Discussion and Findings/Recommendations	
5:20 – 5:30	Next Steps and Closing Remarks	Mr. Bowersox Dr. McComas
5:30	***ADJOURN Joint Meeting***	

Tuesday, January 13

NAC HEO COMMITIEE MEETING

9:30 – 9:40 am	Call to Order, Welcome & Opening Remarks	Dr. Siegel & Mr. Bowersox
9: 40 – 10:40	Status of the Human Exploration and Operations Mission Directorate	Mr. William Gerstenmaier
10:40 – 11:40	Asteroid Redirect Mission Update	Dr. Michele Gates Mr. Lindley Johnson
11:40 – 12:40	***LUNCH***	
12:40 – 1:40	Status of the Exploration Systems Development Division	Mr. William Hill
1:40 – 2:00	***BREAK***	
2:00 – 3:00	Status of the International Space Station	Mr. Sam Scimemi
3:00 – 4:00	Lessons Learned from Commercial Orbital Transportation Services	Mr. Alan Lindenmoyer
4:00 – 4:05	Public Comments	
4:05 – 5:30	Discussion and Recommendations	
5:30	Adjourn	

Human Exploration and Operations Committee Membership
January 2015

Mr. Ken Bowersox *Chair*	Former NASA astronaut and retired U.S. Navy Captain
Dr. Bette Siegel *Executive Secretary*	NASA Headquarters
Ms. Shannon Bartell	Former Director of Safety & Mission Assurance, KSC
Ms. Nancy Ann Budden	Director for Special Operations Technology, Office of the Secretary of Defense
Dr. Leroy Chiao	Former NASA Astronaut and ISS Commander
Dr. Stephen "Pat" Condon	Aerospace Consultant, former Commander of the Ogden Air Logistics Center, the Arnold Engineering Development Center, and the Air Force Armament Laboratory
Mr. Joseph Cuzzupoli	Former Assistant Apollo Program Manager, Rockwell, and Manager of the Space Shuttle Orbiter Project
Mr. Tommy Holloway	Former Space Shuttle and ISS Program Manager
Mr. Lon Levin	President, SkySevenVentures
Dr. David E. Longnecker	Director, Health Care Affairs, Association of American Medical Colleges (AAMC), member of the National Academy of Sciences Institute of Medicine (IOM)
Mr. Michael Lopez-Alegria	Former NASA astronaut and retired U.S. Navy Captain, President of the Commercial Spaceflight Federation
Mr. Richard Malow	Distinguished Advisor at the Association of University for Research in Astronomy (AURA)
Mr. James Odom	Former NASA Associate Administrator for Space Station Freedom
Mr. Bob Sieck	Former Space Shuttle Launch Director
Mr. James Voss	Former NASA astronaut and retired U.S. Army Colonel, Scholar in Residence, Department of Aerospace Engineering Sciences, University of Colorado, Boulder

Human Exploration and Operations Committee
Stennis Space Center
Mississippi

January 12-13, 2015

MEETING ATTENDEES

HEO Committee Members:

Bowersox, Ken, *Chair*	U.S. Navy *(Ret.)*
Siegel, Bette, *Executive Secretary*	NASA Headquarters
Bartell, Shannon	Aerospace Consultant
Budden, Nancy Ann	DoD
Condon, Stephen "Pat"	Aerospace Consultant
Cuzzupoli, Joseph	Aerospace Consultant
Longnecker, David *(via telecon)*	AAMC
Lopez-Alegria, Michael	Commercial Spaceflight Federation
Malow, Richard *(via telecon)*	AURA
Odom, James	Aerospace Consultant

NASA Attendees:

Bussey, Ben	NASA Headquarters
Crusan, Jason	NASA Headquarters
Denning, Elaine	NASA Headquarters
Gerstenmaier, William	NASA Headquarters
Grunsfeld, John (via telecom)	NASA Headquarters
Scimemi, Sam	NASA Headquarters
Shawanda Robinson	NASA Headquarters
Siegel, Bette	NASA Headquarters
Tupper, Craig (via telecom)	NASA Headquarters
Smith, Erin	NASA Headquarters
Williams, Greg	NASA Headquarters
Woods, Dan	NASA Headquarters

Science Committee Members

Duncan, Douglas	Science Committee (UCO)
Green, James	Science Committee (UCO)
Hagan, Maura	Science Committee (NCAR)
Lindberg, Robert	Science Committee (U VA)
Luhmann, Janet	Science Committee (U CA)
McComas, David	Science Committee (SwRI)
Pieters, Carle *(via telecon)*	Science Committee (Brown U)

Peterson, Bradley	Science Committee (Ohio State U)
Robinson, Mark	Science Committee (AZ State U)
Running, Steve	Science Committee (U Montana)
Spence, Harlan	Science Committee (U NM)
Zimmermann, Joan	Zantech IT

Other Attendees:

Frankel, David	PB Frankel, LLC
Zimmermann, Joan	Zantech IT

WebEx Attendees, Joint Meeting January 12, 2015:

1) Alexandra Witze
2) Allison Rose-Sonnesyn
3) Altonell Mumford
4) Ashley Edwards
5) Betsy Bugel
6) Carle Pieters
7) Chris Gilbert
8) Dan Leone
9) David Hermeck
10) David Longnecker
11) Duane Ratliff
12) James Dean
13) Jason Kalirai
14) John Guidi
15) Kathryn Flanagan
16) Kevin Miller
17) Marcia Smith
18) Meredith McKay
19) Nicole Hermann
20) Paula Wamsley
21) Richard Irving
22) Richard Passmore
23) Robert Zimmerman
24) Stephanie Schierholz
25) Jstout
26) Carol Galica
27) Albert Sofge
28) Louis Barbier

WebEx Attendees, HEO Committee Meeting, January 13, 2015

1) Albert Sofge
2) Altonell Mumford
3) Amy Svitak
4) Ann Zulkosky
5) Bill Mackey
6) Chris Gilbert
7) David Longnecker
8) Douglas Craig
9) Jeff Foust
10) John Rummel
11) Joshua Buck
12) Kevin
13) Marcia Smith
14) Michele Gates
15) Marguerite Broadwell
16) Meredith McKay
17) Nicole Hermann
18) Richard Irving
19) Richard Passmore
20) Stephen Clark
21) Tommy Holloway
22) Gregory Mann
23) Joe Cassady
24) Mike
25) Stephanie Schierholz
26) Katelyn Kuh
27) Chris Loghry
28) Jason Davis
29) David
30) Michael Gazarik
31) E. Belte
32) William Hill
33) Ashley Edwards
34) Joshn Manning
35) Rachael Kraft
36) Jeffrey Newmark
37) Sandra Graham
38) Shari L Kamm
39) Abigail Sheffer
40) Alan Lindenmoyer
41) Stephen C. Smith

Human Exploration and Operations Committee
Stennis Space Center
Mississippi

January 12-13, 2015

LIST OF PRESENTATION MATERIAL

1) Science and Human Exploration and Operations Joint Activities [Grunsfeld]
2) Evolvable Mars Campaign [Crusan]
3) International Space Station [Scimemi]
4) NASA's Capability Driven Roadmap for Human Spaceflight [Olson]
5) Commercial Orbital Transportation Services (COTS) Program Management [Lindenmoyer]
6) Human Exploration and Operations [Gerstenmaier]
7) Asteroid Redirect Mission Update [Gates]
8) Journey to Mars [Hill]