

**National Aeronautics and Space Administration
Washington, DC**

NASA ADVISORY COUNCIL

Human Exploration and Operations Committee

July 23-24, 2012

**Goddard Space Flight Center
Greenbelt, MD**

MEETING MINUTES

**Richard Kohrs
Chair**

**Bette Siegel
Executive Secretary**

**Human Exploration and Operations Committee
Goddard Spaceflight Center, Greenbelt MD
July 23-24, 2012
MEETING MINUTES
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**Human Exploration and Operations Committee
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Monday, July 23

Opening Remarks

Dr. Bette Siegel, Executive Secretary of the Human Exploration and Operations Committee (HEOC), called the meeting to order. She noted that this was a Federal Advisory Committee Act (FACA) meeting and open to the public; minutes would be taken and published. The HEOC would hold a joint meeting with the Science Committee in the afternoon. At the end of the meeting, there would be an opportunity for public comments.

Mr. Richard Kohrs, HEOC Chair, welcomed the members and attendees to the meeting and introduced two new members: Mr. James Odom and Ms. Shannon Bartell. He noted that at the last meeting, the Committee submitted four recommendations and has received answers from NASA on three of those—destination, international partnership, and Exploration Mission (EM)-2 mission objectives—and would discuss them with the Associate Administrator (AA) for the Human Exploration and Operations Mission Directorate (HEOMD), Mr. Bill Gerstenmaier, at this meeting.

Status of International Space Station (ISS)

Mr. Dan Hartman, Manager of Operations Integration, ISS Program, provided a status report on the ISS and plans for Intravehicular Activity/Extravehicular Activity (EVA) Environmental Control and Life Support Systems (ECLSS). He discussed the ISS flight plan and noted that the Station is in a heavy traffic pattern timeline—Soyuz arrival, overall crew rotation, Progress docking and undocking, and the H-II Transfer Vehicle (HTV)-3 docking. SpaceX is still planning on another flight in October, and the Orbital Sciences test flight is anticipated in December. On flight 48P, the Russians are testing a four-orbit rendezvous maneuver, which is a future capability that they are planning for the Soyuz. In response to a question, Mr. Hartman stated that crews are on six-month duration increments and typically, there is a five to five and a half month handover. The larger apparent “gaps” on the schedule graphic are because of a Soyuz that had to be taken out of commission due to the pressure issue. The next European launch is in March 2013. The Program has been using the Automated Transfer Vehicle (ATV)-3 extensively for reboost. The ATV stay is typically five to six months; the HTV stay is from one to three or four months. In response to a question regarding availability of ATV, Mr. Hartman noted that there have been discussions regarding the ATV supporting the Exploration Program in exchange for not providing supplies for ISS, but this is only in the discussion phase. The Program is working with the Russians on having a Progress capability for deorbit. They believe that with modifications to the Progress, deorbit could be accomplished with one vehicle, fully loaded. Those modifications are underway at Energia. In response to a question regarding the capability, Mr. Hartman indicated that there is enough delta V to deorbit, and using one modified Progress is the primary option.

Mr. Hartman discussed Increment 32 and noted that the crew will increase to six total. He reviewed the mission accomplishments over the last four months, again noting that there has been extensive vehicle traffic. SpaceX had a fully successful demonstration in May, achieving all mission objectives. Over the last increment, the ISS has averaged 35 hours/week for research. Several anomalies have been worked. Over

the next four months (through October) there will be more vehicle traffic, installation of MicroMeteoroid and Orbital Debris (MMOD) shields on the Service Module (SM), transition to the Water Recover System (WRS) reusable Advanced Recycle Filter Tank Assembly (ARFTA), and a number of new science investigations or equipment delivered by HTV-3 and 48P.

In terms of crew time utilization, the ISS is meeting the requirement on average, but not every week. At this point in the timeline, the average utilization rate is 37.1 hours/week. In response to a question regarding crew time dedicated to science, Mr. Hartman noted that the requirement is 35 hours/week, which is one crew member (or one-third of the U.S. Orbital Segment (USOS) crew). The plan is to go to a crew of four on the USOS. Mr. Hartman reviewed the research statistics. On expeditions 31/32, there were 201 investigations. There were a total of 1251 investigations through increment 28, and 191 more investigations on Expeditions 29/30. The numbers of researchers, the allocation of upmass for research, and the number of scientific publications have increased.

Dr. Pat Condon commented that informing the public of the value of the Station has been an important emphasis of NASA communications. Although the technical community understands the importance of the ISS, the public does not hear much about the Station and the research coming from it. He posed the question: What is NASA doing to get the public excited about Station? Mr. Mark Uhran, Assistant AA for ISS, responded that the weak public reaction is not because the communications program is weak. During the assembly period, the research was not robust; however, that has changed, and it is now a very robust program. Dr. Condon agreed that the technical community realizes that fact, but the general public is still not aware. Mr. Uhran responded that NASA has tried everything it could think of over the past decade and is open to new ideas. Ms. Nancy Budden observed that NASA used to have a very successful publication—"NASA Spinoffs"—and wondered if it was still around. Dr. Siegel indicated that it was, but she was not sure about the distribution. Mr. Hartman discussed some of the new research coming up on the HTV mission. In terms of educational outreach, almost one million students have been involved in ISS research, and over 41 million have participated in educational demonstrations performed by crewmembers onboard ISS.

Mr. Hartman reviewed and explained the total ISS consumables status to date as well as the US on orbit segment (USOS) status to date. Both are in good shape, although the USOS capability looks a little better than the total. In response to a question, he noted that his consumables chart did not show Progress vehicles coming every three to four months. The last Shuttle flight, STS-135, enabled the total on-orbit consumables capability to be the good shape that it is today.

Mr. Hartman discussed the status of the Enhanced Processing and Integrated Communications (EPIC) Project (an upgrade to the main processor board), the High Rate Communications System (HCRS) upgrades planned in July, and work on the Carbon Dioxide Removal Assembly (CDRA) and the Japanese Experiment Module (JEM) internal thermal system. The EPIC Project removed some constraints to payload operations and it was a major success story. The HCRS upgrades that will provide enhanced communications capability and will take the ISS into the advanced digital age. The crew on the ISS will be able to have more one-on-one video communications (similar to Skype) with researchers.

As noted earlier, the SpaceX mission was a complete success, and a considerable amount of cargo was returned on that mission. The early de-stow demonstration was successfully completed on June 2.

Mr. Hartman discussed the Orbital Sciences Demonstration Mission. The schedule has been sliding a little, but the program expects complete turnover of the launch pad at the end of this month. The test flight is scheduled for December 12. Orbital is performing a lot of safety reviews (similar to SpaceX) as well as final software testing.

Mr. Hartman reviewed the top program risks. The first three or four are all associated with cost or budget. The overlap in commercial crew and Soyuz launch services is not covered, and there are no dollars in the budget to order Soyuz for 2016. Other cost/budget risks are the ISS operations budget reduction and pension harmonization (contractor rates are expected to increase). The hardware is performing well, and the Program is doing a good job of training to operate the system optimally.

In response to a question regarding the biggest Russian risks, Mr. Hartman indicated that today, things are fairly stable, but the Russians would probably say their biggest risk is Micrometeoroid and Orbital Debris (MMOD), and they are planning to augment shielding on Progress and Soyuz to mitigate that risk. Mr. Hartman said that he didn't know about any pad issues. In response to a comment about the risk of single string crew capability with Soyuz, Mr. Uhran noted that the reason this is not considered a top program risk is because of system performance—Soyuz is the most reliable spacecraft in the world.

The Program's financial risk is in 2016 and 2017, and Mr. Gerstenmaier is taking the issue forward. NASA could not discuss those budget details with the HEOC at this time.

In response to a question from Mr. Holloway regarding the robustness of the system, Mr. Hartman indicated that NASA has done tremendous job of repositioning spares. CDRA is the only major system where there are not multiple spares. Consumables could be impacted if there is a transportation issue, but the Program has built in margin. Although ATV will go away, HTV's will go beyond the seven flights under contract, and the ISS should have the Commercial Resupply Services (CRS) in 2016 and 2017.

Mr. Hartman discussed the status of ECLSS and plans for its evolution. In response to a question, he noted that the Shuttle's absence doesn't create a water problem. The last Shuttle missions off-loaded a tremendous amount of water into a reserve pool. Mr. Kohrs suggested that it would be good to have chart that shows total water on board, and Mr. Hartman took an action to provide the Committee with that information. Consumption is based on two liters per day per crewmember. Mr. Hartman also reviewed the status of the Oxygen Generator Assembly (OGA), the CDRA, the Sabatier CO₂ Reduction Assembly, and the Major Constituent Analyzer (MCA). He discussed the status of ECLSS capabilities for exploration. The Program is engaged with the International Partners (IPs) to determine what kind of system is needed for the future. An ECLSS Roadmap has been developed. The current ISS activities align with the Roadmap recommendations, and activities are in work to improve systems.

Strategically, the Program is focusing on increasing utilization of ISS as a National Lab and as a testbed for exploration. It is looking at the year 2028 for "verification" purposes, and so far, there are no "show-stoppers" across the partnership.

In response to a question regarding bartering with the Russians for additional crew time for research work, Mr. Hartman indicated that the Program Managers have been in discussions regarding the best research utilization for a crew of six. The Russian side may not be fully utilized, and there could be some opportunity there. The Program is pursuing this possibility. Mr. Bejmuk congratulated Mr. Hartman on a good operations briefing. In response to his question about how the National Lab is doing and how much

research is being conducted, Mr. Hartman said that the Program office would be happy to brief the Committee on this topic. Dr. Siegel added that this could be put on the agenda for the next meeting.

Space Launch System (SLS)/Orion

Mr. William Hill, Assistant Deputy Associate Administrator for Exploration Systems Development (ESD), discussed ESD integration and schedule, the Level 1 requirements modifications, the status of Orion/Space Launch System (SLS)/Ground Systems Development and Operations (GSDO), and the verification and validation approach. He highlighted some recent and upcoming significant events, including delivery of the Orion Crew Module (CM) structure to Kennedy Space Center (KSC) in June to initiate assembly and integration in the Operations and Checkout (O&C) building. The GSDO System Requirements Review (SRR)/System Definition Review (SDR) was kicked off earlier this month. In FY 2013, ESD will be doing a "cross-program" SDR. At the integrated levels, the two major activities are the "scrub" of the Level 1 requirements from 21 to 17 and examination of a "waypoint" campaign that may factor into the Exploration Mission (EM)-2, which is the crewed flight. In response to a question, Mr. Hill noted that the program is currently only contracting for EM-1 and EM-2, which will use the 70 metric ton (MT) launch vehicle. NASA will need an advanced booster for the 130 MT vehicle, and has both liquid and solid candidates to develop that capability. He clarified that even with advanced propellant, a higher booster operating pressure will be needed.

Mr. Hill reviewed the 21 Level 1 requirements and the changes that brought that number to 17. The velocity requirement has been reduced from 11,500 m/s to 11,200 m/s to align with the tactical capability needs. NASA will need to develop technologies to achieve the 11,500 m/s strategic requirement. In response to a question, Mr. Hill explained that "tactical" refers to near-term; "strategic" is long term; "architectural" refers to longer term. As it relates to entry velocity requirements, tactical refers to EM-1 and EM-2; strategic refers to an asteroid or a Mars mission. The strategic lift capability can be achieved with an upper stage or advanced booster. Mr. Hill clarified the missions: Exploration Flight Test (EFT)-1 (in 2014), launching on a Delta Heavy, will carry Orion about 3000 miles and back and will achieve about 84 percent reentry velocity to test the heat shield; EM-1 (in 2017) will be an uncrewed mission around the moon; EM-2 (in 2021) will be the first crewed capability and notionally, will be a lunar orbit mission. EM-1 will have reduced capability; EM-2 will have a full-up Service Module (SM) for a lunar orbit; however, the program is also looking at a "waypoint" mission for this flight.

Mr. Hill showed the near-term program schedule leading to EM-1. EFT-1 is planned for the June 2014 timeframe; Orion will be completed earlier and wait for the Delta Heavy launch vehicle and launch complex availability. The critical path goes through the core stage, and the Program is in the process of definitizing that contract. With respect to the GSDO, work will include modifications to Pad B, outfitting the mobile launcher, and outfitting the Vehicle Assembly Building (VAB). Everything will be in place for EM-1 in 2017. The biggest challenge for GSDO is determining what the emergency egress at the pad will be. The Launch Abort System (LAS) is good from the pad up. In response to a question from Ms. Bartell, Mr. Hill noted that there is not a requirement for a lot of ground support people at the pad; however, when considering the emergency egress requirement, the Program is including the ground support personnel as well as crew.

In response to a question from Mr. Bejmuk regarding how well SLS and Orion are synchronized on major reviews, Mr. Hill explained that SLS and Orion are independent programs. The integrated part is covered under the ESD line, with annual "checkpoints"--instead of Preliminary Design Reviews (PDRs) and Critical Design Reviews (CDRs)--these will be full-up reviews.

Mr. Hill discussed the Orion accomplishments in further detail, including the CM final weld and delivery, the Orion test campaign, avionics components deliveries, and the parachute drop test. As noted earlier, EFT-1 will be on a Delta Heavy launch vehicle from Launch Complex 37. It will not be a full-up LAS test, but the LAS jettison motor will be used to pull the shroud from the module. The Delta IV upper stage will be used for the higher orbit, and Orion will return off the Pacific coast on its second orbit. In response to a question, Mr. Hill noted that Orion weighs about 25,000 lbs; the LAS and Orion total weight is about 33,000 lbs.

Mr. Hill provided an overview on the status of the SLS. He reviewed some of the recent accomplishments. The Program has Integrated Assessment Teams (IATs) working with the contractors to definitize the contracts. The SLS 70 mT vehicle uses the RS-25 core stage engines—the Space Shuttle Main Engines (SSMEs). The controller from the J-2X will be adapted to the RS-25. The Program is working toward the PDR this fall. The SLS Program is also providing the spacecraft adapter between the Delta and the Orion for EFT-1. In response to a question, Mr. Hill noted that the NASA has 16 SSMEs—enough for four missions before the restart of the line is necessary. The main propulsion system is being designed to add a fifth SSME in the center if it is needed for the longer term. Mr. Hill showed the evolutionary path from 70 mT to 105 mT. He noted that ESD will probably not need the 130 mT for crewed capability. In response to a question regarding the space available for any payloads on either the uncrewed or crewed flights, Mr. Hill responded that on the 2017 flight, there may be some capability to put payloads in Orion, but not a lot. On the 2021 flight, the payload capability will depend on the size of the crew; notionally, the Program is looking at four crewmembers.

Mr. Hill discussed philosophy for evolutionary upgrades. As advanced boosters are developed, they will be introduced for increased capabilities. Improvements will be made in affordability, reliability, and performance. Risk reduction is incorporated in the SLS design—in the boosters, the stages, the engines, and spacecraft payload adapter and fairing.

Mr. Hill reviewed the SLS element testing in detail. He stated that the program has a robust testing campaign next year on the J-2X. The Program will get it ready to go, then put it on the shelf. Other options are being examined. The Program is primarily using the J-2X now to maintain critical skills until the RS-25 line can be started. In response to a question from Mr. Kohrs, Mr. Hill stated that the Program plans to integrate the four Space Shuttle Main Engines (SSMEs) at the Michoud Assembly Facility (MAF) and test at the Stennis Space Center (SSC) with a full duration firing. They will run the test at 109, which was the level certified on Shuttle. He indicated he could provide more information on the propulsion system to the Committee if desired. SLS is being designed for a single engine out capability—this is the reason the program went to four engines. Mr. Kohrs observed that the SSMEs are most reliable engines ever built. In response to his comment, Mr. Hill indicated that the Program believes that it is properly balancing dollars and risk.

Mr. Hill discussed the status of the GSDO system and reviewed some notable recent accomplishments. In response to a question, he noted that NASA is using the mobile launcher intended for Ares-1, with modifications. The Program was able to get a head start on the crawler-transporter modifications to accommodate the heavier SLS/Orion vehicle and install more efficient motors. The initial phase of the Command & Control Technical Assessment is complete. For EFT-1, NASA is essentially relying on Lockheed Martin to do the full integration and own the system, and NASA will buy the data. Lockheed Martin is contracting directly with United Launch Alliance (ULA) for the Delta Heavy. The ground test article is being used as a pathfinder in the O&C building. The VAB is undergoing major renovations to support a new generation of rockets and spacecraft as well as multi-use capabilities. In response to a question from

Ms. Bartell regarding the pad and emergency egress, Mr. Hill noted that NASA is still going with the “clean pad” approach and is selecting the “elevator concept” rather than a fixed structure. Pad 39B is slated for SLS/Orion. If any other crewed vehicle is there, they may need to evolve to some type of structure. Cables have been replaced by fiber optics; this was a major conversion. In response to a question from Mr. Bejmuk regarding multi-user capabilities and future vehicles, Mr. Hill indicated that the Falcon 9 Heavy is being considered. Also, ULA may have the Atlas for some commercial crew providers. The 21st Century Launch Complex initiative is part of the ESD portfolio, and they are supposed to be investing in multi-use capability.

Mr. Hill described the Verification and Validation (V&V) approach. In response to a question from Mr. Kohrs regarding a master verification plan, he stated that each program (SLS and Orion) will have one. A question was raised regarding the lunar crewed mission and what the plan is for testing. Mr. Hill explained that those missions are currently notional. Once those missions are determined, NASA will conduct V&V from an integrated standpoint. However, the Program is not there yet. In response to a question from Mr. Bejmuk regarding what is currently baselined, Mr. Hill noted that EFT-1 is baselined; EM-1 and EM-2 are not yet baselined, primarily because of the budget. The 2017 flight is driven by the core stage; the 2021 flight is driven by the full-up Orion. The Program was not able to pull the schedule back because of the flat-line budget.

The programs are motivated to find areas where V&V can be common. A cross-program V&V task team has been set up. Using a notional example, Mr. Hill showed the overall approach for the 2017 requirements and the near term V&V approach leading toward future capabilities. In response to a question from Ms. Bartell regarding the “checkpoints” that play into an integrated CDR, Mr. Hill responded that on his V&V chart, those are individual CDRs. The criteria for the integrated activity (the checkpoint approach) have not been defined yet. The annual checkpoint is an attempt to collect everything from each program and take a look at it from an integrated standpoint. The approach is to leverage the cadre of people in each program and have them do the integrated activities, rather than put in a second layer of integration. Mr. Holloway questioned whether that concept would work; he observed that with three elements, it will be hard to get people to work on someone else’s program. In his opinion, NASA needs to have one organization/person in charge of making the three elements work together; giving it to one of the three elements will not work. Mr. Hill noted that the intent is to have NASA Headquarters be that organization/person, but that isn’t in place today. Mr. Bejmuk agreed with Mr. Holloway that NASA needs a single driving force to have everyone work together. Mr. Kohrs added that this gets back to the HEOC recommendation that NASA needs a strong systems integration organization to make the elements work together. Mr. Odom agreed that someone has to have the responsibility; it cannot be split three ways. It was noted that the HEOC has brought this issue up in the past, and continues to do so. Mr. Kohrs suggested that instead of an extra engine for SLS, perhaps the Program should consider using those funds for systems integration. Dr. Condon observed that if NASA’s approach doesn’t work, more resources will have to be expended in the future.

Mr. Hill emphasized that the organization is focused on the 2014 and 2017 flight tests. Mr. Gerstenmaier will not show the budget numbers beyond 2013. NASA has a budget request in for 2013, but it has not yet been appropriated. In response to a question from Mr. Malow, Mr. Hill indicated that the 2017 mission is included in the out-year profile; however, the 2021 mission is not in the profile yet because NASA is assuming flat-funding. The “tall pole” for Orion is the ECLSS, and the 2017 mission will have some of that. In response to a question, Mr. Hill stated that he believes there is margin in the plan. Mr. Bejmuk commented on the absence of sufficient public visibility for what NASA is doing. The Agency needs to do

more with respect to getting its message out. ISS may need a major breakthrough, such as a Salmonella or MRSA vaccine, before there is enough public attention.

Joint Meeting with Science Committee

The HEOC joint meeting with the NAC Science Committee was chaired by the Dr. David McComas. Mr. Jens Feeley, the Science Committee Executive Secretary, welcomed everyone to the joint meeting. After introductions, the AA for the Science Mission Directorate (SMD), Dr. John Grunsfeld, made a few opening remarks about Mars Exploration and the driving science questions. The “Mars Replan” includes a budget and a forward plan to explore Mars, including enabling technology. A team has been formed to lay out a framework, looking forward to the time when NASA can send humans to Mars. The Science Committee and the HEOC have common interests, such as entry data from the Mars Science Laboratory (MSL) and communications. The team will utilize the external community to develop some options. NASA wants broad public engagement. The successful landing of Curiosity will start a resurgence of interest in Mars. Since there are limited flight opportunities, the SMD and the HEOMD will look for synergy between science missions and human missions.

Mars—The Search for Life.

Dr. Doug McCuiston, Director of the Mars Exploration Program (MEP), explained the Program and how it is constructed. MEP was conceived in 2000 with a multiple decade horizon. It is a set of missions, beginning with Odyssey, having goals that are interrelated. Orbital missions fed locational missions like Spirit and Opportunity. Spirit and Opportunity helped determine the missions for the future, such as the instrumentation for the Mars Reconnaissance Orbiter (MRO). Phoenix was the first of the Scout missions; as the budget changed, Scout merged into Discovery. Discoveries from all of these missions help move the instrument suite and the location for Curiosity and Rover. Dr. McCuiston provided a brief update on several of these missions. Odyssey and MRO provide the majority of communication assets for MSL. The Odyssey reaction wheel loss was a significant issue, but it has no effect on MSL landing or safety; however, the loss does have an effect on how and when much of the information is obtained. With safehold modes, Odyssey doesn't see MSL until the Rover is on the surface. The Program has tested another phasing maneuver and will try to move Odyssey to cover MSL.

MRO is in place and will record the entire entry and landing process. The focus of the Mars Program Planning Group (MPPG) is 2015 and beyond. The 2013 budget requires some changes. Upon the report in August, one or more programmatic architectures will be defined to create a series of missions going forward within a 10-year timeframe.

The Program to date has been science driven; it will remain so, but more requirements from human exploration will be folded in. Decadal survey priorities come heavily into play, but budgets are at lower levels than ever envisioned by the survey team. The anchor point in the future is the early 2030s to have humans in the vicinity of Mars. MPPG's scope is not to determine the human exploration plan, but to inform HEO planning.

Dr. Condon observed that the formation of MPPG is exactly the right step to bridge the gap between ongoing activities and those activities that must take place to realize the President's challenge. It will be an adventure that spans several administrations. In order for it to come into reality, there must be public excitement at the level that keeps Congress excited about funding this effort. There is probably less than

one-half of one percent that knows about this challenge. How do we energize the public so that their excitement translates into action? What is the plan? Dr. McCuiston responded that that is an Agency responsibility, but the Program is taking advantage of the MSL landing. This event will reach people worldwide. Within that messaging opportunity, NASA will include what the future looks like in terms of both robotic and human exploration. Part of the MPPG charter is education and outreach. Dr. Grunsfeld added that the first step is landing on Mars—that will have worldwide public outreach. The MSL landing will be as significant as Apollo 11 was. The challenge is that NASA must campaign every year for funds. Dr. Condon agreed that it is an Agency mission, and asked whether someone has been given responsibility to craft the message and generate public interest. Dr. Grunsfeld noted that the AA for the Office of Communications, Mr. David Weaver, is fully engaged. He has an excellent staff and will be working with the Program people. Dr. Condon opined that there needs to be a campaign for the communications part. It is as important as the MPPG. NASA needs clear vision, clear focus, a clear destination, and the pieces to get there.

Dr. McCuiston continued with his presentation. The MPPG work is intended to influence the FY2014 budget process. MPPG is focusing on 2018-2020 as the next opportunity. The options are consistent with the priorities of the 2011 NRC Decadal Survey. Enabling technologies are a critical part of a future Mars Program. The need for decelerators is important to both robotic and human exploration. MSL has a radiation detector that will provide important data for human exploration. Dr. McCuiston reviewed the MEP reformulation timeline. It has been a regular process which is reaching its end. The international community is still very interested in staying engaged with NASA for Mars exploration. He explained the scientific advantage of a strategic technology investment, for example, in refining the capabilities for the landing ellipse. Strategic alignment enables these types of advances.

In response to a question from Dr. Hinnners on how to get back on a cooperative relationship track with the European Space Agency (ESA), Dr. McCuiston replied that NASA could be a reliable partner for the 2016 ESA mission by providing instrumentation for a potential rover. Once NASA starts building trust again, the Agency can discuss larger cooperations in the future; however, NASA and ESA may not go back to a 50/50 relationship. Dr. Grunsfeld noted that NASA is still partners with ESA on other programs. The Mars case highlights the fundamental way that ESA funds missions versus the way that the U.S. funds missions. This is one of the risks on any large program where partners have significant contributions. NASA has an ability to fund short term contributions, but it is difficult to commit to large, longer term missions. Also, it is easier to cooperate on projects versus programs. In response to a question regarding outreach, Dr. McCuiston indicated that NASA does have MSL outreach on major media outlets, such as CNN. There are local events at public libraries, where experience has shown that this is a very effective way to reach across America. NASA is working on a number of outreach initiatives.

Mars Program Planning Group

Mr. Orlando Figueroa discussed MPPG science implementation approaches, the Lunar Planetary Institute (LPI) workshop, the synergy with human exploration, the opportunity for technology infusion, and public engagement. The MPPG is delivering options on a new architecture (a sequence of interconnected missions) to NASA, with particular attention to the 2018/2020 opportunities that follow MSL. The options reflect a science-driven approach, a closer collaboration among SMD, HEOMD, the Office of the Chief Technologist (OCT) and the Office of the Chief Scientist (OCS), and educational and public engagement opportunities. Collaboration with HEOMD will also be responsive to the President's challenge of human travel to Mars in the 2030s.

The MEP has been extraordinarily successful. It validates the strategic program approach as opposed to a collection of disconnected missions. The missions are coupled scientifically, technologically, and operationally. They follow an overarching theme and an overall program strategy.

Mr. Figueroa reviewed the National Research Council (NRC) recommendations. The NRC Decadal Survey recommendation for Mars Exploration is sample return. Mars Sample Return (MSR) is complex and the concepts assessed by the NRC carried a large price tag. The overall mission has been broken into a number of discrete elements launched in different opportunities. MSR is a campaign that spans nearly a decade to keep budgets manageable; however, this requires a decade-long commitment to deliver all the elements. MPPG embarked on an evaluation and assessment of alternatives to MSR and alternative MSR implementation approaches. Mr. Figueroa discussed the MPPG Core Team and approach. It is supported by groups within SMD, HEOMD, and OCT. Key community experts have been identified.

MPPG developed a series of figures of merit to guide the mission and architecture options within programmatic constraints. The President's FY13 MEP budget narrows the trade space for what can be afforded in 2018. The current rover options are not credible for 2018 within the budget constraints. A 2018 orbiter meets the constraints with significant re-profile adjustments. Some key things need to occur before the end of this calendar year in order for a 2018 rover to remain realistic.

Mr. Figueroa discussed the scientific pathway options within the trade space. The scientific pathway continues to focus along "signs of ancient life" and sample return options. Pathway A (the one closest to the Decadal Survey recommendation) commences MSR using existing data, and sample return is implemented at a pace that is consistent with available resources. Pathway B undertakes multi-site investigations employing surface and orbital investigations. Pathway C includes credible approaches to sample return that trade science for lower costs. Dr. Hinners commented that in terms of risk reduction philosophy, spreading out missions make a lot of sense. Mr. Figueroa noted that one of the figures of merit captured this philosophy. Moving forward, the Agency should take Entry, Descent, and Landing (EDL) capability into consideration. The ESA connection would be engineering support, but the International Traffic in Arms Regulation (ITAR) becomes an issue. If more than one opportunity is skipped, program capability and EDL would be affected. Dr. Grunsfeld noted that one could fly a mission that would test aero-science and would provide important information about EDL. Mr. Figueroa indicated that the MPPG has the flexibility to look at all these approaches. In response to a question, he noted that in the 2022 timeframe, NASA needs to start thinking seriously about replacing the communication infrastructure.

Mr. Figueroa discussed the Mars Concepts and Approaches Workshop at LPI in June 2012. The workshop was organized by LPI for the community to discuss ideas and approaches for Mars exploration. It included near-term and longer-term timeframes. The LPI workshop was of most benefit to MPPG in that it provided creative and catalytic ideas for lower cost mission concepts, synergistic technologies, key environmental measurements and approaches for investigating modern environments for habitability, and student experiments that could be manifested on smallsats. Mr. Figueroa used the 2018 orbiter followed by a 2020/22 surface mission as an example to illustrate how the MPPG identified options. All of these are being defined well enough for the Aerospace Corporation to perform dependable cost estimates.

Dr. Michele Gates discussed the synergies with human exploration. The MPPG started with the President's challenge of sending humans to the Mars system in the 2030s. This provides a convenient intersection for assessing the robotic and human space programs. The MPPG conducted architectural trade studies of humans to the Mars system using risk as a differentiator. From a risk posture perspective,

preliminary analysis suggests that there are increased risks to the crew in a Mars orbit-only mission due to galactic cosmic radiation and issues associated with behavioral health. Understanding the risks to the crew of landing, living, and then ascending from Mars orbit requires additional investigation and systems development. Robotic missions can play an important role in reducing human mission risk. Three areas of human exploration and science shared benefits are: useful measurements, technology demonstrations, and opportunities for missions of joint benefit.

The Precursor Strategic Analysis Group (P-SAG) was chartered by NASA HQ as a special analysis group of the Mars Exploration Planning and Analysis Group (MEPAG) and the Small Bodies Analysis Group (SBAG). The P-SAG is in the process of generating an integrated strategy, beginning with ISS and the Human Research Program risk mitigation. ISS extension will enable deep space testing and early operations. Measurement, technology development, and risk mitigation feed into the human exploration roadmap. There are opportunities to demonstrate human scale technologies on robotic missions. Timescales for the “roadmap intersection” are still under development.

As an alternative to astronauts retrieving samples from Mars orbit, MPPG also studied the concept of using a Solar Electric Propulsion (SEP)-enabled vehicle to deliver samples to lunar orbit for crew retrieval. This approach is feasible and provides an additional measure of safety and planetary protection as well as mass savings from the lack of a robotic Earth-reentry vehicle from Mars. In response to a question from Dr. Hinnners, Dr. Gates stated that one effect of having crew is that the samples can be assessed from a safety standpoint. The idea is to telerobotically remove the sample from the capsule, and if in order, bring the canister back to the crew module for visual inspection and return it with the crew on Orion.

Mr. Figueroa discussed technology development. Enabling technologies are a critical part of the MEP. Relevant technology areas of collaboration are: technology areas related to EDL, communication, and the Mars Ascent Vehicle (MAV). Both early missions and mid to late missions represent cross-technology opportunities.

There is a lot of opportunity for public engagement. The Mars Forum represented an experiment in public engagement. Its purpose was to engage the public in Mars exploration and the re-planning effort. The MPPG is currently in the process of providing technical background and information to the Forum.

In response to questions from Dr. Condon, Mr. Figueroa indicated that each option would list the opportunities and challenges and would identify technologies needed. The MPPG has received input from non-NASA communities. It would be difficult to fit more external interaction and review into the schedule, but members of the team are going out into the community to get a “sanity check.” Dr. Grunsfeld added that the reason the August timeframe is important is because that is when the MPPG results need to get into the budget submission and affect decisions going forward. The Administration is very strong on science, but there are still budget pressures. Mr. Malow observed that the Agency is faced with the classic problem: the 2013 budget request had a shortfall. The final resolution on the budget (about \$200M) may not come until November or December. The Agency faces the problem of how to dovetail all of that into the 2014 request, knowing that the Office of Management and Budget (OMB) was critical about the decision on the 2013 budget. This problem will be made even more delicate this year.

Dr. McComas asked about how many ideas came from the broader discussion, and how much of the plan represents things that have been on the table for awhile. Mr. Figueroa replied that about half came from the LPI workshop. Low cost approaches were invited, and the community responded. The rovers and

orbiters are being analyzed for cost estimates; the others have a “basis of estimate.” The time envelope will be examined; specifically, just what is realistic. The risk increases exponentially as we move into next year.

Joint Robotic Precursor Activity (JRPA)

Dr. Victoria Friedensen, the JRPA Manager, discussed the plan for the JRPA that will start in FY 2013. The JRPA’s goal is to inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration while maximizing benefits to both science and exploration. An integrated set of priorities are being developed. NASA wants to develop instruments that would be placed on NASA and non-NASA missions that would inform human spaceflight planning. HEOMD devoted \$18M in FY12 funding to start these activities. It represents the continuation of a long relationship between science and exploration. Past successes include the Lunar Reconnaissance Orbiter (LRO), the Lunar Mapping and Modeling Project (LMMP), and MSL payloads. In addition, there have been joint analysis groups and personnel exchanges. Science and Exploration have a successful history in executing co-funded projects.

The JRPA activity flows through the strategic plans of both SMD and HEOMD. JRPA received approval from OMB last November. Work is focused on defining areas that would most benefit from joint investment, such as Strategic Knowledge Gaps (SKGs). The JRPA would like to build up to a Mission of Opportunity or a full flight opportunity to a specific destination.

The FY13 President’s Budget Request called for a joint program office funded by Science and Exploration and managed from Headquarters. This is the JRPA. Dr. Friedensen reviewed the ground rules for the joint program. It is a collaborative approach for science and exploration, and the budget must be negotiated by the team. The JRPA recognizes the Planetary Science Decadal Survey guidance—that it is vital to maintain the science focus of peer-reviewed missions and not to incorporate human exploration requirements after the mission has been selected and development has begun. The criteria for determining priorities are the relevance to human spaceflight’s SKGs for potential human destinations. The SKGs will translate to sets of measurements that will be used to guide instrument, mission, and Research and Analysis (R&A) investments and potential collaborations with international partners. The JRPA team will develop prioritized proposals for funding specific activities. The JRPA Steering Committee will comment and concur on the plans and allocations. Once scope is assigned, each Directorate is responsible for that scope.

Dr. Mike Wargo, the Chief Exploration Scientist, discussed the SKGs, which have become the basis for on-going planning. An SKG is what one needs to know before one can safely and effectively explore beyond low Earth Orbit (LEO) at various destinations. This includes when one needs to know it, and at what fidelity level. The intention is to identify knowledge to prepare for human exploration at the target location. Dr. Wargo explained how the analysis and assessment groups were able to do that. Refinement of SKGs relates to priorities, e.g., what does one need to know before human exploration, and what are the things that could change the architecture?

Dr. Wargo discussed the kinds of things that should be part of the JPRA. The Human Spaceflight Architecture Team (HAT) was working on a refinement of the architecture for transportation that needed additional information on what was going to be done at the destination. HAT Destination Leads were asked to identify data or information needed that would reduce risk, increase effectiveness, and aid in planning and design. For some destinations, the needed knowledge was well identified, e.g., for the Moon, and

there was a good starting point in the Lunar Exploration Roadmap. The MEPAG had been identifying pertinent measurements, and one of the goals was preparation for human exploration. These SKGs will become the foundation for an international set of SKGs. It will be used as a way to coordinate activities. In the same way, the SKGs that are not being filled become opportunities. Also, the SKGs will form the basis for near-term Agency investments in robotic precursor missions and activities through Announcements of Opportunity (AOs).

There are common themes across destinations, such as the three “Rs” for enabling human missions (radiation, regolith, and reliability), geotechnical properties, volatiles, propulsion-induced ejecta, in-situ resource utilization, operability, the plasma environment, and human health and performance. The scope was limited to those things that could be learned through precursor activities. Filling the SKGs requires a well-balanced research portfolio.

Based on the draft version of the SKGs created by the HAT Destination Leads, specific action teams—from the Lunar Exploration Analysis Group (LEAG), the MEPAG, and the SBAG--were engaged to “vet” and refine the draft SKGs. The next step is to integrate results of the LEAG, MEPAG, and SBAG. The schedule will be negotiated with the Science Assessment Team (SAT) chair and the chairs of the analysis/assessment groups.

A Strategic Knowledge Gap Assessment Team (SKGAT) has been formed to begin the process of identifying, prioritizing, and time phasing the international set of SKGs, tied to the Global Exploration Roadmap. Dr. Wargo leads the team with international participants. The prioritization criteria and methodology have been formulated, and test cases for prioritization are being run. The prioritized international set of SKGs will be incorporated into the next revision of the Global Exploration Roadmap. Mr. Gerstenmaier has involvement at the Senior Agency Management level.

In response to a question from Mr. Odom regarding the top two or three international SKGs, Dr. Friedensen indicated that Near Earth Objects (NEOs) have the most profound information gap. She discussed the proposed initial JPRA portfolio. Several pre-existing projects were included: the LMMP, the Radiation Assessment Detector (RAD) on MSL, and the NASA Lunar Science Institute (NLSI). Two HEOMD-funded Advanced Exploration Systems (AES) projects were also well-aligned with the JPRA objectives: improvement to Goldstone radar capabilities to image Near Earth Asteroids (NEAs) and the lunar ice prospecting payload project (RESOLVE). HEOMD obligations consume much of the available instrument/mission line through FY14. The goal for FY15 is to dedicate those funds to a new flight opportunity. There are several collaborative R&A activities. FY12 focused on SKGs within HEOMD and internationally; FY13 will include an analysis of alternatives for robotic mission proposals to potential destinations.

Considerable effort is needed to ensure a good start in FY13. SMD and HEOMD have different priorities regarding competition. AES has a responsibility to employ NASA civil servants, which limits procurement dollars and competition decisions. Instrument or mission decisions will need to be made in early 2013.

Discussion and Recommendations on Joint Activities with Science Committee

There were some questions and comments regarding the need to employ NASA civil servants and the potential of excluding great ideas from the community. Dr. Friedensen agreed that in the next R&A, it would be interesting to engage the broad science community. However, there is a significant amount of workforce at the Centers that need to be employed. AES is trying to balance the issue constructively,

without diminishing the contributions of the broader community. It was noted that all federal agencies are being asked by the Administration to fully utilize internal resources. Dr. Hinners observed that in the 1970s, NASA went through a period when selections were made non-competitively; he encouraged the program to not limit to the efforts to internal investigators. Dr. Wargo noted that the best example of collaboration between human exploration and science was the LRO. NASA knew it needed the best from the science community, so there was a free and open competition. The Program office knows how to balance leveraging the civil servants and using the science community. Everyone is concerned with getting the best missions and executions.

Dr. McComas suggested discussing any recommendations within the individual Committees, and he adjourned the joint session.

Status of Forming Subcommittee on Space and Life Science/Center for Advancement of Science in Space (CASIS)

Dr. D. Marshall Porterfield, the incoming Director of the new Space Life and Physical Sciences Research and Applications (SLPSRA) Division in HEOMD, discussed the SLPSRA programs, the status of the new HEO research subcommittee, and the status of the ISS National Lab management organization. He noted that the main driving force behind this activity was the NRC Report on Life and Physical Sciences. ISS is a key stepping stone for human exploration and can address some SKGs.

Space life sciences and physical sciences were zeroed from the NASA budget in the 2004 timeframe, and the Human Research Program (HRP) became more limited in scope, primarily due to Agency constraints associated with Constellation. Previously, it had a budget of about \$900M per year. In addition to the loss of support for the next generation of innovators in the community, there was an associated loss of public understanding about science in human space exploration. Dr. Porterfield made it a goal to re-establish research and application connections with the community, and the SLPSRA organization has been formulated to execute high quality, high value research and application activities in the areas of space life sciences, physical sciences, and human research. In response to a question from Dr. Condon on how research handled by this division is categorized, Dr. Porterfield stated that the research can be basic or exploratory; however, the Division focuses more on translational (applied) research rather than foundational (basic) research.

Space Life Sciences includes research in radiation, biophysics, and fundamental biological processes. The HRP is more focused on investigating and mitigating risks to crew health and performance to enable safe, reliable human exploration. The fundamental physics program is focused on fluids, thermal, and combustion systems. The materials science area is one of highest impact for translation to the National Lab model. Dr. Longnecker observed that this area complements what was dismantled previously in NASA. In fact, the HRP was precluded from doing work at Countermeasure Readiness Levels (CRLs) 1-3. That research can now be done. Part of the discussion with HRP is to move it back to connections with fundamental model systems.

The recommendation for the Subcommittee was made at the March 2012 NASA Advisory Council (NAC) meeting. It was accepted by NASA, and the Division is working to develop this Subcommittee. Dr. Porterfield requested HEOC members contact Dr. Longnecker or himself if anyone had any ideas about candidates for the Subcommittee. Dr. Siegel confirmed that approval for this Subcommittee has been made. Mr. Kohrs noted that action needs to be taken to appoint Dr. Longnecker as Chair.

The Subcommittee's near-term objective will be to advise on the tactical implementation of strategic guidance, such as that from the NRC. The composition of the Subcommittee should consist of individuals that would support long-range exploration and research objectives, understand space life and physical sciences content, and represent a breadth of perspectives. The Subcommittee would meet two or three times per year.

Last August, CASIS was awarded a Cooperative Agreement to manage non-NASA utilization of the ISS. CASIS has very limited scope and perspective in terms of spaceflight research, and oversight by NASA is necessary. A CASIS ad hoc science team identified some key areas that they thought would be worthy of translational investment. One of those was bone health. In addition, CASIS claims they have some pharmaceutical interest. Primary funding from NASA is for infrastructure and organization; CASIS is responsible for bringing investment support, and they are trying to fund some exploratory research. In response to a question on how CASIS works, Dr. Porterfield replied that CASIS would act as an intermediary to facilitate commercial experimentation with non-NASA funding. Mr. Malow commented that previous to CASIS, industry would have gone directly to NASA. In response to his question, Dr. Porterfield indicated that private companies are not prohibited from going directly through NASA. Mr. Holloway noted that the CASIS job appears to be to "recruit" ISS utilization, or to "sell" ISS to industry researchers. Dr. Porterfield agreed that CASIS is supposed to be a "promotion group" for ISS for all non-NASA use. There is multi-user hardware or other developed infrastructure that is already being paid for by ISS that would be available for non-NASA users. In addition, NASA provides the upmass. Some of the HEOC members were interested in getting a copy of the Cooperative Agreement between NASA and CASIS, and Dr. Siegel agreed to follow up on the request.

Dr. Condon raised a question regarding how to best get the word out about the results of investment in ISS and whether CASIS has a role in that communication. Dr. Porterfield stated that CASIS has defined some education and outreach as part of their model. Mr. Kohrs observed that CASIS (which is the "National Lab") has had a slow start. Dr. Longnecker added that so far, CASIS has flown no experiments in the National Lab. There are four Principal Investigators that are jointly funded by the National Institutes of Health (NIH) and NASA, but they are not under the National Lab.

In response to a comment, Dr. Porterfield noted that there are some innovative education and outreach projects that are important to the life and physical sciences program. He indicated that he would be going to KSC to review some assets there and look at the SLS lab facilities.

The HEOC requested an update on CASIS activities at its next meeting.

Mr. Holloway asked Dr. Porterfield to summarize the recent conference in Denver. Dr. Porterfield reported that a component of that conference was the CASIS facilities. CASIS provided an update on where they are on their research and put together a catalog of commercial providers that could work with companies to provide support for commercial activities on ISS. There were about 400 to 500 attendees at the conference, although NASA attendance was severely limited.

Discussion/Recommendations

The Committee discussed communication and outreach. There were several comments related to NASA finding a better way to communicate to the American people what the results of the nation's investment in the ISS. It must interest the average person. Most people don't know about the things from the space program that affect their daily lives. Sometimes the public does not focus attention on a NASA program

until they discover it is going away—for example, when Hubble was in danger of shutting down and the end of the Shuttle. The HEOC recognized that if NASA is to communicate its relevance to people, there are a couple of opportunities now: ISS and Mars. However, the outreach needs to be done in a proactive way. It appears that each NASA organization is promoting what it does; all of the outreach activities need to be tied together.

Mr. Uhran noted that there is a standard policy that two percent of a program's budget must be dedicated to education and outreach. Also, the Hubble Space Telescope Science Institute (STSI) is chartered with that mission for Hubble and does it exceptionally well. NASA has the same intent with CASIS. He noted that Mr. Miles O'Brien was identified in the CASIS proposal as part of the team that would do outreach, but that was not implemented. Dr. Longnecker added that he chaired the review of the National Space Biomedical and Research Institute (NSBRI), which also has a budget for education and public outreach.

Mr. Kohrs observed that there is a fairly active NAC Committee—the Education and Outreach Committee—that is focused on communication and outreach. That Committee is trying to get a handle on all that is going on.

The HEOC discussed whether they should have a recommendation on this topic and decided to request having the head of NASA's education and outreach organization on the next HEOC agenda to talk about how all the groups within NASA are communicating. Dr. Siegel took an action to arrange this, as well as getting a report on what is being done within HEOMD.

With respect to Mars, Dr. Condon was pleased to see that the MPPG has been formed. He observed that they reference the President's challenge in April 2010, but it has taken two years for the group to form. This is necessary but not sufficient. The real proof will be what happens when the options are presented. However, NASA is starting to take the need to define a mission seriously. Mr. Kohrs observed that the HAT was Mr. Doug Cooke's response to the President's challenge. Now that the Agency has the budget, they are more serious; however, he noted that there was no schedule or cost cited in the MPPG activity.

Ms. Budden commented that the gaps between science and exploration aren't new, but this is the first time the science and exploration communities are really focused on working together, and it is a very positive sign. About a year ago, the Exploration organization came up with a list of capability needs (very similar to the MPPG list) irrespective of destination. Dr. Siegel noted that list was incorporated into the capability-driven roadmap. The OCT is using the NRC report to guide technology. Mr. Holloway opined that it will take something unique and different to get people's attention. At one time, James Cameron wanted to fly to ISS and do an EVA with a new camera. It will take something like that to spur interest. A reporter might do it, if it is the right kind of person. It was noted that Miles O'Brien had that idea, but it was dropped from the CASIS proposal.

The HEOC discussed the AES activity. Mr. Kohrs observed that the last time the AES was before the Committee, they talked about technology. At this meeting, they did not discuss robotics. He questioned whether the AES activity is a "jobs program" to keep civil servants busy. Mr. Uhran responded that NASA was given the requirement to put civil servants to work, and the bulk of that action is in AES. Dr. Siegel added that the intent is to perform "skunk works" and use in-house personnel. The HEOC decided not to formulate a recommendation on this topic at this time.

The HEOC discussed integration across SLS, Orion, and GSDO. The Committee felt that there doesn't appear to be sufficient integration across the three programs. It agreed that there shouldn't be a

bureaucratic entity on top as integrator, but there must be an organization and person in charge. Mr. Odom observed that NASA is on a collision course with the flat budget—eventually hardware will have to be built, and a “bump” in the funding profile will be needed. The more the schedule slips, the higher the probability of cancelation. In his opinion, NASA is not spending enough money at the right time to ever get off the ground. Dr. Siegel reminded the Committee that any recommendations must be actionable by NASA.

Mr. Bejmuk offered to draft a recommendation on integration for consideration by the Committee on the following day. Dr. Siegel noted the action to hear from the outreach people at the next meeting.

Public Comments

Mr. Chris Gilbert, visiting scholar at the Space Policy Institute, expressed his opinion that the continued expectation of international cooperation to further the goals of the human space exploration program is unrealistic in the foreseeable future and introduces additional risk into the program. In the absence of viable international contributions needed to enable international exploration missions in cis-lunar space, there is a risk that Congress might decide to cancel the existing U.S. program. Mr. Gilbert suggested that NASA should attempt to mitigate this risk by crafting a U.S. program which identifies basic exploration objectives achievable with a domestic program of reduced scope and budget, but which sustains key U.S. exploration capabilities, and enables initial missions to be carried out until such time that international partners can make a meaningful contribution. Mr. Gilbert also expressed his opinion that the U.S. government should, as a matter of urgency, implement a strategic initiative to attract and secure the political involvement of international partners.

Tuesday, July 24

HEOMD Overview

Mr. William Gerstenmaier, Associate Administrator for HEOMD, gave a brief overview of activities underway in the Directorate. Progress is being made on the solid rocket motors for SLS. Acoustic tests on Orion have gone very well. The program has been able to do a significant number of robotic activities on the external part of ISS. For ISS, the intent is to focus on research and utilization. SpaceX’s Dragon is scheduled to fly again in October. Orbital Sciences is doing well on their activity also. The pacing factor for them is the pad activity at Wallops Flight Facility (WFF). The demonstration flight is scheduled for the end of the year. Expendable Launch Vehicle (ELV) support has been going well as has the Deep Space Network.

The recent SpaceX demonstration went extremely well. NASA is still reviewing the post-flight reports. SpaceX is ready to begin regular flights to the Station. NASA will be watching the progress carefully. Mr. Kohrs agreed that the discipline in the process needs to continue.

There has been a considerable amount of J-2X engine testing (for the third stage of SLS), and the performance numbers look very good. The plan is to run the J-2X for certification of the upper stage and start phasing in the effort on the buildable Shuttle engines. NASA is actively working to keep the industry’s workforce stable and moving forward through this period.

Soyuz has been very serviceable. As expected, there is a lot of dependence on the Russians. Their main concern is continuing to be able to recover from problems, such as the vehicle overpressurization. The

Russians have been very open about their activities, and NASA is watching carefully. They plan to build one vehicle ahead of schedule, and that should add to the robustness.

The Orion EFT is now at KSC and is undergoing processing for a launch in 2014. This has been a strong motivator for the KSC team, and the systems are moving forward. The Program is looking ahead; it will not shortchange the development activity. Time will be taken to put the right design into place. For example, the extra effort on the friction stir weld to assure the tooling and process was worth the trade on schedule.

Mr. Gerstenmaier showed the top level milestone schedule. There will be a Boeing PDR in the December timeframe. First drawings for SLS will drop next month, and long-lead items are being purchased. A configured SLS is targeted to be delivered to Stennis Space Center (SSC) in August 2016. NASA received the “go” for SLS in September 2011; the contract and the contractor are in place, and the team has moved ahead and is starting to build to a solid plan. Everyone is starting to see the urgency to fly in 2017. In response to a question from Mr. Kohrs, Mr. Gerstenmaier stated that the EM-3 and -4 will probably be 105 mT. The booster contracts will begin in FY2013. To go to 105 mT, a better propellant or an upper stage is needed. With respect to SLS Program life cycle, NASA is following NPR 7120.5. The Baseline Program Plan (the Agency commitment) is ready to be signed.

This is a very busy time on ISS. The Progress vehicle was supposed to dock again last night, but that didn't happen. This maneuver was a higher risk, demonstration capability. There are no collision concerns with the HTV. The HTV-3 will berth on Friday, and the Russians will attempt to re-rendezvous on Sunday. The next Progress launch is in August; two spacewalks are planned for August as well. The crew is doing a lot of research—most of the focus is on combustion activities and fluid flow experiments. HTV-3 is carrying some interesting research. The Program is trying to reduce the research flight lead-time dramatically—for example, to only a couple months for students. The Station Program has been realigned to focus on research and get it to ISS in an effective manner. In response to a question, Mr. Gerstenmaier noted that the Directorate has some funds for research. The Space Station Program has covered some facilities maintenance which frees up dollars for research—for example, removal of CO₂ from the amine system. Everyone is looking forward to the Mars missions where crews need to be more autonomous, such as running procedures on their own without talking to the ground.

On the communications side, Mr. Gerstenmaier discussed updates on the Tracking and Data Relay Satellite (TDRS)-K. The latest contract is fixed-price with Boeing. It is essentially the same TDRS flown before, but there is some non-recurring engineering associated with obsolescence. NASA will obtain TDRS-K, -L, and -M under this contract, although TDRS-M does not yet have a launch vehicle. The TDRS system will be kept through the 2020 timeframe. In December, the launch vehicle will be an Atlas V 401.

The Launch Services Program (LSP) next flight is in August from Cape Canaveral. HEOMD has established a plan with the SMD for launching several medium-class missions in the future. The program was able to fill in the medium-class gap with the last Delta-IIs and surplus hardware. New providers will not only provide cargo to Station, but will pick up some science payloads.

Mr. Holloway asked Mr. Gerstenmaier to summarize his state of view of the National Lab/CASIS. Mr. Gerstenmaier responded that NASA awarded a Cooperative Agreement to CASIS and the activity started last year. To date, the primary focus has been getting the Board of Directors in place. CASIS has been operating with an interim board, most of whom are from Space Florida. CASIS has sent out a research announcement for protein crystal growth. In addition, they have done a very good survey of all of the life

sciences activity in space. The leading industry scientists in the country reviewed about 400 papers. Scientists and venture capitalists were brought together to examine the findings for commercial benefit or of interest to industry in general. The group discovered that NASA finds very interesting phenomena, but doesn't pursue it far enough for a commercial company to make an investment. A CASIS research grant is driving the question on the commercial feasibility of protein crystal growth to fruition. Mr. Gerstenmaier indicated that the Chief Scientist could present the survey findings to the HEOC if they are interested. In response to a question, he indicated that NASA is still doing Memoranda of Understanding (MOUs) with NIH for research, but the intent is to hand those off to CASIS. CASIS has been a little slower getting started than NASA would have liked, but is now moving forward. He reiterated that NASA pays for the launch, the operations on orbit, and return. This National Lab will be very important for ISS; it will provide a mechanism by which companies can bring space-based research forward. NASA funding for CASIS is about \$15M/year, which is for the institutional infrastructure. It is estimated that CASIS will be able to bring research interests together to utilize 50 percent of Station.

Mr. Bejmuk asked Mr. Gerstenmaier to talk more about the integration between SLS, Orion, and GSDO. Mr. Gerstenmaier noted that all three programs sit in Mr. Dumbacher's office, and he is responsible for the integration. However, he acknowledged that HEOMD needs to do more work in that area formally to ensure the interfaces are clear and crisp. Also, he needs to make sure Mr. Dumbacher has the right infrastructure to manage the interfaces. Development is spread out due to the funding profile, but requirements needs to be identified as soon as possible. There is a danger to making the integration process overly onerous—it needs the right balance.

In response to a question about General Motors (GM) working with NASA, Mr. Gerstenmaier acknowledged that GM has worked with NASA on robonauts to reduce the wear and tear on humans that have to do repetitive activity; however he noted that he has not heard much about this from a public relations standpoint.

Mr. Bejmuk observed that we are 12 days from landing on Mars and it would seem like NASA should be talking to the public everyday to generate and maintain excitement about the mission, and he hasn't seen any of that. Mr. Gerstenmaier replied that the SMD has a huge activity planned, with virtual locations around the country to follow the landing, a Web interface, etc. Dr. Grunsfeld can provide details. HEOMD is flying a radiation detector on MSL. For the first time, we have measured galactic background radiation in transit, and we know that we have a radiation problem for human transport. HEOMD will also be able to see what radiation is on the surface. The heat shield that is on the entry vehicle will provide some entry data that will help with precision landing in future. Dr. Condon observed that the HEOC understands that there is a lot of information in the public domain, but it appears to be directed at those who are already interested in what NASA is doing. The Agency needs to reach "ordinary" folks, and communicate the exciting things to people who are not "space geeks." Dr. Longnecker commented that there are mobile apps and things on twitter, and we also need to make sure we are not reflecting the older generation prism. Ms. Bartell added that the target audience should be 12-year-olds, and NASA is not reaching that audience as much as it should.

With respect to SLS and Orion, Mr. Malow noted an article that laid out the context about the Martian moon, L2, and asteroids. It appears that missions are more affordable as long as there is no landing. Mr. Gerstenmaier agreed that there are some advantages if there is no landing, such as avoiding EDL; however, there is also the problem that if the mission is only an orbit, the return would be at an inopportune time, and there would be a big penalty in terms of delta V and time. A non-landing mission may be cheaper

from a hardware standpoint, but more difficult on humans both physically and psychologically. One needs to look at it from an overall mission view. There would be a similar problem with an asteroid.

It was noted that the NRC Decadal Report suggested that sample return from Mars could be done by the U.S. alone. Mr. Gerstenmaier observed that international cooperation on ISS allowed the U.S. to build Station. There are some real advantages to international partnerships, and not only from a resource standpoint. Political “buy-in” can serve the program well, and we need to factor that into our thinking. Mr. Gerstenmaier admitted that he had strong biases—it can certainly be done faster if the money and the commitment is there, but cooperation creates a stronger base to build upon. Mr. Malow added that another advantage to the international program is that it does somewhat insulate the program from budget instability.

Joint Meeting with Audit, Finance & Analysis and Commercial Space Committees

Commercial Orbital Transportation Services (COTS)/Commercial Crew Development (CCD)

Mr. Phil McAlister, via telecom, discussed the status of Commercial Cargo, Commercial Crew Development Round 2 (CCDev2), and the acquisition strategy and Commercial Crew Integrated Capability (CCiCap) for the Commercial Crew Program (CCP).

The SpaceX flight, completed this past May, was very challenging technically, but all of the test objectives were successfully accomplished. The final milestone (the post-flight report) is planned for August; if successful, NASA will make final payment and the Space Act Agreement (SAA) will be concluded. In response to a question, Mr. McAlister noted that the original SAA was \$287M; in 2010, an additional amount was allocated for risk reduction activities, bringing the total to \$396M. Orbital Sciences has five milestones yet to complete. There have been some challenges, primarily associated with the pad at WFF. It is not entirely without risk, and Orbital is slipping its first (test) flight from mid to late October. The full demonstration mission will occur about three months later. Orbital's original SAA was \$180m; the final total was \$288.

NASA awarded Cargo Resupply Services (CRS) contracts to both SpaceX and Orbital in 2008, and has already started payments for the long lead items, consistent with commercial launch vehicle contracts. For both SpaceX and Orbital, five missions are in the flow. Mission dates will be finalized as the contractors demonstrate mission and production progress.

Mr. McAlister stated that industry is making significant progress on multiple crew transportation system designs. The CCDev2 funded partners are Blue Origin, Boeing, Sierra Nevada, and SpaceX. SpaceX has completed all of its funded milestones. The Sierra Nevada drop test is in December. By the end of the calendar year, all funded partners will be complete. In response to a question regarding how the decision was made for the funding amounts, Mr. McAlister stated that this is explained in the selection statement. The amounts did not reflect the quality of the proposals in any way. NASA wanted to make multiple awards and left it up to the companies to propose their content and the specific amounts they wanted to receive. NASA wanted to ensure the best portfolio for the funding available. Mr. McAlister indicated that he could provide a copy of the selection statement to the Committee. In response to another question regarding the escape systems, Mr. McAlister noted that all four funded partners have their own escape system, but that he could not discuss the next round, which is still in “blackout.” He did add that NASA gave industry a

considerable time for CCDev2, and industry made the technical solution decision. With regard to the unfunded partners, ULA is finished and ATK is just about to complete their agreement; Excalibur will be completed next month.

Mr. McAlister discussed the program objectives and attributes for the CCP. He emphasized that the objective of the Program is “to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS.” This objective was rolled out in 2010 and continues to guide the program. The CCP was not set up to be tailored just to NASA needs. The Agency was not told to develop an ISS crew transportation capability; it was told to facilitate a U.S. space transportation capability with the goal of safe, reliable, and cost effective access to LEO and ISS.

For CCP, NASA wanted performance-based milestone payments, a fixed government investment, industry financial investment, contractor-retained intellectual property, high-level objectives, relief from the requirement for an approved accounting system, competition, and human rating certification. The spacecraft will have to receive NASA certification prior to any operational flight. Mr. Bejmuk commented that if only high-level objectives are mandated, but human rating is required by NASA, it is not clear how the providers could be expected to do this unless the human rating requirements are part of the high-level objectives. Mr. McAlister explained that “only high level objectives” was the intent in 2010, but the Program has moved off this attribute because it was not compatible with the human rating objective. However, it wanted to keep the spirit of the high-level objectives philosophy, so NASA has not dictated a high level of performance requirements; they are primarily safety objectives. There are only 650 requirements in all the documentation, where the Space Shuttle had thousands. Overall, NASA has tried to articulate the requirements down to Level 2. Mr. Holloway observed that strategically, it appears to be a good plan, but the biggest problem is the need to have a method whereby NASA can verify that the contractor has built a vehicle that meets those requirements. Mr. McAlister agreed, and noted that in order to do that certification, NASA will need to have a Federal Acquisition Regulation (FAR)-based contract for V&V. Also, NASA personnel will be collocated with the providers and will have extensive insight into the providers’ processes. The Program agrees that it will need a FAR-based certification contract.

Mr. Bejmuk opined that if NASA doesn’t let the requirements at the beginning, it will not be successful later during certification. Mr. McAlister noted that the original strategy was to baseline the requirements, while recognizing that NASA is the ultimate arbiter of whether or not the providers meet the requirements. The Agency has recognized that some risk is associated with this approach and is now taking some action to address that risk. NASA is working with the providers to ensure that they understand and are working to the requirements. Mr. McAlister indicated that he would address risk mitigation later in his briefing. In response to a question from Ms. Bartell, he explained although there are some performance requirements that provide guidance on the mission, the majority of the requirements are safety requirements. Those safety requirements are integral to the mission that is going to be performed, which is the ISS mission. In response to Mr. Holloway’s observation that NASA has not developed a human-rated system since Shuttle, Mr. McAlister stated that the human rating requirements for the CCP have gone through several revisions already and are presently on Rev C.

Mr. McAlister compared features for cost plus contracts versus SAAs, noting that that FAR-based requirements could be waived under a cost plus contract, but that is harder to do than under a SAA. He explained the proposed change in strategy. The early 2012 strategy was to do CCDev element design under SAAs and CCiCap under SAAs with optional milestones; then there would be a NASA certification

phase under a NASA FAR-based contract. Industry can move fast under CCIcap with SAAs and will be making decisions about design. If NASA waits until 2015 for certification, the cost for making any changes in design can be large. NASA began to consider ways to mitigate the risk of difference between the providers' designs and NASA's requirements. It was generally agreed that waiting until 2015 for certification produces a lot of risk. The proposed revised certification strategy is to start the first part of certification (to align with NASA certification requirements) under a "Certification Products Contract" (CPC) starting in 2013 that would run in parallel with the CCIcap SAA. The CPC would lead into a full certification contract (the second part of certification that would include at least one crewed mission) after CCIcap. Mr. McAlister emphasized that this is a proposed concept and is not yet baselined. The intent is to mitigate risk associated with early design decisions by having a "part 1" certification.

There were a number of questions from the Committee members on the certification strategy. In response to a question, Mr. McAlister stated that NASA is anticipating awarding the CCIcap SAAs in July/August 2012. If the revised certification strategy is approved, NASA would let the RFP for the CPC contracts (FAR-based) with an award early in CY 2013. The SAAs and the contracts would run in parallel; however, NASA would need to ensure that it would not be altering the competitive landscape downstream. Mr. McAlister indicated that he anticipated award of multiple CPC contracts, but they would not tied to CCIcap. For example a company could propose for a CPC contract without being a CCIcap provider. Mr. Hanisee noted that there are currently four funded providers and three unfunded providers. He questioned whether the operational timeline for ISS (2020) and two NASA flights per year (for crew rotation) would give companies enough opportunity to recoup their investment if the initial operating capability for commercial crew is in 2017. Mr. McAlister stated that NASA has agreement with Congress to have up to 2.5 awards under CCIcap, but the Agency has not determined what the partial funding will be. NASA does not want to select down to one provider at this phase. Because the Agency wants to minimize the cost risk in the service phase, it wants to maximize the competition in this phase. Mr. McAlister noted that the ISS is not "scheduled for de-activation." The policy is to operate ISS at least until 2020 and potentially beyond. It is up to the provider to decide the business case based on that policy. In response to a question, Mr. McAlister indicated that NASA has not baselined the type of contract that would be employed for CPC; the Program has not yet gone forward with the procurement strategy. Under that contract, NASA would be buying specific data deliverables, e.g., a hazard report, an alternate standards report, a certification report, etc. There would be products that would allow NASA to provide feedback on requirements.

Mr. McAlister reviewed the reasons why commercial crew is desirable at this time. NASA's budget is extremely constrained and COTS and CCDev have shown to be a way to change the cost equation. Although human spaceflight is hard, it is well understood technology and no "breakthroughs" are needed. There is a strong and mature industrial base, and there is a strong potential for customers other than the U.S. government. Also, there is the decision to extend the ISS to at least 2020.

Mr. McAlister did not discuss CCIcap because it is still in competition black out.

In response to a question about the budget for the CCP, Mr. McAlister stated that the budget request in 2012 was \$850M, with a flat funding profile in the out-years; in 2012, the budget was reduced to \$406M. It is very hard to say what one-year funding reduction would do to a five-year development schedule. If there is less budget next year, it will slow the schedule, but programmatic impacts would depend on how the budget goes in the out-years.

Committee members made several comments on the CCP budget and the certification program. Mr. McAlister agreed with Mr. Holloway that NASA will need to have an ongoing rigorous certification program. In response to Mr. Malow's comments about the budget, Mr. McAlister said the if the budgetary "high water" mark in 2013 is in the \$550 M range, NASA cannot say at this point whether or not the 2017 operational date will slip. It is likely that NASA will be able to achieve 2017 with the budgets in 2013, but that will be dependent on the partners' progress and future budgets. Once there is an appropriation and NASA does its assessment, the operational dates may change. Mr. McAlister stated that he believed NASA is reflecting risk appropriately. He said that it is his belief that NASA will be flying astronauts in LEO for many years to come. The Agency would like to maintain competition as long as possible--all the way through the certification phase. In response to Mr. Bejmuk's comment about a tourism policy for ISS, Mr. McAlister indicated that there is not such an activity currently underway, but NASA will have to start addressing that topic at some point. In response to question regarding the certification plan for parts, Mr. McAlister stated that the program has not yet "flushed out" whether the certification will be at the subsystem level or total vehicle. He indicated that he would come back and talk to the Committees about that at a later date.

Ms. Patti Grace Smith, Chair of the Commercial Space Committee, thanked Mr. McAlister for his presentation. She noted that her Committee appreciates how NASA is approaching the SAAs for the development phase and the certification phase.

Overview of Contracting Options

Mr. William McNally, also via telecom, discussed options in terms of contract type. He stated that the objective is to select the right contract type that results in reasonable contractor risk and provides incentive for efficient and economical performance. The "bottom line" is optimum balance between risk and reward. Some of the things that should be considered when selecting a contract type for a particular acquisition are the program objectives, the level of risk, and the market for the requirement. Mr. McNally reviewed some of the risk factors in selecting the contract type. Contract types are available on a continuum from cost plus fixed fee/level of effort, where the government is taking most of the risk, to a firm fixed price where the contractor is taking more risk. Mr. Kohrs asked Mr. McNally to explain his assertion that Cost Plus –Award Fee (CPAF) contracts are hard to objectively evaluate. He explained that under an award fee arrangement, the most of the criteria that are evaluated are subjective, rather than a specific, measurable objective such as a delivery date. In response to a comment from Mr. Holloway regarding objective criteria, Mr. McNally noted that if objective criteria can be developed, a performance incentive arrangement would be more appropriate than an award fee arrangement.

One of the first determinations is whether the acquisition is more appropriate for the fixed price-type family of contracts or the cost reimbursable-type family of contracts. Mr. McNally discussed the characteristics of both families of contracts. Mr. Holloway commented that a responsible contractor would bid more on a fixed price-type contract than a cost-type contract. If a contractor is motivated to constrain cost under a fixed price contract, one worries about that contractor cutting corners along the way. Mr. McNally responded that it depends on competition, how firm the requirement is, and what outcome is expected.

Mr. McNally discussed the considerations for using a firm fixed price contract for commercial buys. One needs to determine the best fit to program goals, scope of work, and attributes by assessing several factors—the length of the performance period, the flexibility for offerors to propose content within their risk posture, the level of product maturity, the stability of government requirements, the extent of open communications to ensure understanding of requirements, and adequate incentives to promote satisfactory performance. He noted that one of the things NASA does in its acquisitions is communicate with industry

about the proposed contract type arrangement. The Agency likes to get comments back from industry before making a firm decision on acquisition strategy.

One of the concerns mentioned by Mr. Kohrs was what happens if, on a firm fixed price contract, the contractor doesn't perform and just walks away. Mr. McNally noted that in that situation, a contractor must return all the payments made under the contract, but, of course, the government doesn't get what it wants. Many factors must be considered when choosing the contract type. Mr. Hanisee again brought up the question about how a company could possibly recoup the upfront investment they must make under a firm fixed price contract when NASA's plan is for only two crew replacement flights per year through 2020. Mr. McNally agreed that one of the things that should be considered in the strategy is the quantity for the firm fixed price. The more "seats" NASA can put forward, the more that could help the contractor with recouping non-recurring costs. Mr. Hanisee agreed that if NASA is prepared to offer a certain number of seats, it could work. This is done under CRS—NASA looks at how much it must put out as a minimum to get the best prices from industry. Mr. Bejmuk observed that NASA should determine, before the competition, how long ISS will continue. Also, NASA needs to consider a policy for access of tourists on commercial spacecraft to the U.S. side of ISS. Currently, all of this type of business appears to go to the Russian side because they can do it.

Before continuing with the discussion period, Dr. Siegel reminded members that discussions should not be specific during the combined Committee session. NASA wants to avoid a "particular matter" that would raise conflict of interest issues with some of the Commercial Space Committee members.

Mr. Jeffrey Steinhoff, an Audit and Finance Committee member, observed that from listening to the two speakers, it is clear there is a lot of R&D in this effort. It would be surprising that a company that would develop a high level R&D capability would not have a good accounting system. With respect to what NASA is buying, it is complex. NASA appears to be providing a lot of flexibility to contractors. How does one price and measure that? If the contractor is at risk, he will not bankrupt himself. It appears that much of what NASA would be buying here would be more appropriate under some type of cost contract, perhaps with incentives. Based on the characteristics of the acquisition, it does not seem like firm fixed price would be a good fit. Dr. Condon added that "risk" depends on what kind of risk one is talking about. The contractor may be assuming the cost risk, but the government assumes a risk in terms of getting the product or service it wants. There may be a point at which shortcuts are taken in order to come in on cost. If there is minimum government surveillance, there is even greater risk on the part of the government. Everyone needs to understand the kind of risk each party is assuming. Fixed price is not risk free.

The Committee members discussed certification further. Mr. Holloway observed that if the government is going to verify certification, it cannot be done with minimum surveillance. Mr. Bejmuk expressed his opinion with regard to the attributes. He noted that Mr. McAlister said that on the CCP SSAs, only the high level objectives are mandated. However, before transition to operations, NASA must perform certification. There appears to be a disconnect in the logic—the contractor is encouraged to perform his design with only high level requirements, but then must meet NASA certification. How will NASA work within this dilemma? Ms. Bartell noted that the 1100 series of requirements came from the CCP office. The providers under the SAAs have those documents and are developing requirements matrices. NASA's feedback on whether it agrees that they are meeting them or not is where that second contract piece is need—the CPC.

With respect to performance-based requirements, Ms. Patti Grace Smith, the Commercial Space Committee Chair, recounted some of her experience at the FAA. In the FAA, an agency that is totally FAR-

based, there was a healthy exchange on whether performance-based requirements could be used. The FAA demonstrated that it is possible. Ms. Bartell noted that the Shuttle Program and the LSP are on opposite ends of the spectrum in terms of oversight. The CCDev2 SAA is somewhere in between those two. The real question comes in certification—what does certification really mean, and how does NASA know that it has been accomplished?

Mr. William Campbell from the Audit, Finance and Analysis Committee also noted that this effort looks like R&D. He observed that a number of years ago, the Navy got into a huge difficulty in trying to buy R&D with a firm fixed price contract. Mr. Malow cited a few examples from his Association of Universities for Research in Astronomy (AURA) experience. AURA has had to build large telescopes at the cutting edge of R&D. Most of those contracts were fixed price, but just because the contract is fixed-price, it doesn't mean that the buyer is going to get the instrument that it contracted for.

Mr. Odom agreed with everything that had been said relative to the complexity of ISS hardware. The cargo part is hard enough. If NASA will be doing the indemnification for NASA astronauts under the CCP, it needs to ensure that the effort is done right.

Mr. Lon Levin from the Commercial Space Committee shared some of the group's skepticism. However, he stated that he believes NASA and country was faced with the situation of too little money, and needed to come up with a system to get the best value. NASA is proceeding with an approach that needs to be watched carefully, but these providers want to be in business and want to meet NASA's certification requirements. However, NASA needs to be very clear about what the certification requirements are. One reason that we can cautiously hope that it will work is that it has been done before—the technology has been used for many years. Everyone needs to look at basic facts—not much budget and well understood technology—and NASA and its commercial partners need to come up with a way to continue to get astronauts to LEO as quickly as possible.

Mr. Holloway opined that a lot of work needs to be done to simplify the requirements to a smaller set, such as consider using the providers' own standards if compatible. His primary concern was whether there is enough insight to verify that the design, testing, and operation has been done correctly to commit NASA's astronauts to the system. He stated that he was not convinced that NASA has it all figured out.

Mr. Steve Oswald agreed with Dr. Condon—there is no “free lunch.” For example if a provider is required to be ISO certified, that comes with a cost. NASA's challenge is to pick what is important to the Agency. The inclination will be to go into a lot of detail because that is the NASA experience. Mr. Hanisee commented that he is not questioning the CCDev program. NASA is using competition and SAAs to solve a budgetary problem. The question is: What is the contract method that will be most successful at the end of the line? He agreed with the other HEOC members that the flight safety certification will be a “big deal” to these providers. It should be under some type of cost reimbursable contract.

Mr. Bejmuk again expressed his concern about the schedule and the funding profile for the program. Mr. Kohrs commented that what would make the program more successful would be to extend the ISS to 2028. With regard to funding and budget, Mr. Levin observed that NASA is asking the providers contribute their own funds, and they have their own expectation on return on investment. He shared some of the members' skepticism about the schedule, but noted that whether the providers will be successful or not is about the multiple revenue stream. These companies not only intend to provide human spaceflight, but expect to carry other payloads. Because it is being done differently, it takes on different expectations. The less

money the companies need from Congress, the less it will slow them down. Mr. Holloway suggested that perhaps the question is how to make the attributes of the contract applicable to the effort so that NASA gets what it wants at the end.

The Committees agreed to adjourn the Joint Session and continue discussions separately.

Deliberations/Recommendations

The Committee discussed whether or not to make another recommendation on the CCP regarding the contract type, and decided not to do so. Instead, the suggestion was made to have an agenda item at the next meeting that presents how NASA is going to implement certification. By the next meeting, NASA will have selected the companies for CCiCap. Mr. McAlister should report on how those companies are responding to the requirements and their plan for surveillance and verification. Also, the Committee would like to understand how much first hand knowledge NASA will have about the process—the test program, how they close out anomalies, etc. Mr. Kohrs stated that overall, the HEOC wants to hear what the contractors' plans are and what NASA's plans are. The Committee did not have a recommendation at this time, but wants to dig deeper on verification and certification, both on the contractor side and the NASA side. It is not clear that the requirements have been levied properly on the CCP contractors.

Mr. Holloway noted that the Committee may want to look at the latest revision to NPR 7120.5 (Program and Project Management Processes). It would be helpful to get a "redline" version so that the HEOC can see what changes have been made. Dr. Siegel said that she would check with the Office of Chief Engineer and try to get a redline copy for the Committee.

Dr. Malow noted that the Committee talked a lot about how to engage the public. He posed the following questions: Is there some way that NASA could start to think about opening the door to Station for non-astronauts? Is there any opportunity under the CCP?

The Committee discussed the proposed recommendation on **SLS/Orion/GSDO Integration** that was drafted by Mr. Bejmuk:

Recommendation: Integration between SLS, Orion, and Ground Systems programs requires definition and implementation. A small team of experienced integrators, led by an empowered, accountable, and responsible leader, should be established to ensure adequate integration of the three programs.

Rationale: Integration at the HQ level appears to be insufficient to ensure technical, schedule, and cost performance of the system composed of the three separate programs.

Consequence of No Action: Absent adequate integration of the three programs, design and configuration disconnects will be identified late, resulting in cost overruns, schedule slips, and risk to mission.

The HEOC agreed that this recommendation should go forward to the NAC.

The Committee had a few comments on the MPPG. Ms. Budden noted that there have been a number of prior reports and documentation on this subject, and the MPPG should be using them. Mr. Holloway observed that there appears to be a lot of focus on keeping civil servants engaged to retain workforce

capability within NASA. Mr. Kohrs added that through the JRPA project, the AES is moving forward on high-TRL hardware that is needed for exploration.

With regard to Mars sample return, the Committee was concerned about NASA's outreach and publicity. As mentioned earlier, the HEOC would like to hear from the Office of Communications as well as HEOMD on what they are doing to get NASA accomplishments out to the public. Also, how is NASA measuring results?

Mr. Malow noted that the funding rate for the CCP is running at about two-thirds of the budget request, and it will be a stretch to make 2017. The business model almost requires that Station be around beyond 2020. SMD and HEOD seem to be working together collaboratively on the JPRA.

Mr. Bejmuk proposed a Finding on Commercial Crew "Design Attributes" vs. "Human Rating Certification": The commercial crew partners were mandated only "high-level objectives" under the SAA mechanism. Yet, prior to transition to commercial crew operations, their spacecraft will be required to receive "human rating certification." There seems to be a disconnect between a liberal set of "design-to" mandates and a strict certification to requirements. The Committee discussed this, and decided to request a briefing from Mr. McAlister at the next meeting instead of taking a Finding forward to the NAC at this time.

The Committee was also concerned that NASA doesn't have enough funding to do commercial crew in a timely manner. Mr. Holloway opined that NASA's biggest risk in the human spaceflight business is that it will be cancelled, like Constellation was cancelled. In his opinion, NASA is trying to do too much with too little. Mr. Kohrs stated that in his view, the budget is inadequate to meet the schedule.

In summary, the plan for next meeting is to hear about the requirements for commercial crew and get a briefing from the outreach group. Before the next meeting, the Committee will look at NPR 7120.5. Dr. Siegel took the action to provide a copy to the Committee members.

There were no public comments, and the meeting was adjourned.

**NASA ADVISORY COUNCIL
HUMAN EXPLORATION AND OPERATIONS COMMITTEE
GODDARD SPACE FLIGHT CENTER
BUILDING 1, ROOM E100D
GREENBELT, MD 20770**

**MEETING
JULY 23, 2012**

- 9:30-9:35 AM** **Call to Order and Opening Remarks**
- Dick Kohrs
- Bette Siegel
- 9:35-10:45 AM** **Status of International Space Station and Plans for Intravehicular Activity/
Extravehicular Activity Environmental Control and Life Support Systems**
- Dan Hartman
- 10:45-11:00 AM** **BREAK**
- 11:00AM-12:00 PM** **Space Launch System/Orion**
- William Hill
- 12:00-1:00 PM** **LUNCH**
- BEGIN JOINT MEETING WITH SCIENCE COMMITTEE*
- 1:00-1:05 PM** **Call to Order/Joint Meeting with Science Committee**
- 1:05-2:00 PM** **Status of Mars Program Planning Group**
- Orlando Figueroa and Michele Gates
- 2:00-3:00 PM** **Joint Robotic Precursor Activities**
- Victoria Friedensen and Mike Wargo
- 3:00-3:30 PM** **Discussion and Recommendations on Joint Activities with Science
Committee**
- Adjourn Joint Meeting with Science Committee*
- 3:30-4:00 PM** **BREAK**
- 4:00-4:20 PM** **Status of Forming Subcommittee on Space and Life Science/Center for
Advancement of Science in Space (CASIS)**
- Marshall Porterfield
- 4:20-5:30 PM** **Discussion/Recommendations**
- 5:30-5:40 PM** **Public Comments**
- 5:40 PM** **ADJOURN**

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**MEETING
JULY 24, 2012**

- 8:45 AM** **Call to Order and Opening Remarks**
- Dick Kohrs
 - Bette Siegel
- 8:45-9:45 AM** **Status of the Human Exploration and Operations Mission Directorate**
- Bill Gerstenmaier
- 9:45-10:00 AM** **BREAK to Meet with Other Committees**
- BEGIN JOINT MEETING WITH AUDIT, FINANCE & ANALYSIS AND COMMERCIAL SPACE COMMITTEES*
- 10:00-10:45 AM** **Commercial Orbital Transportation Services/Commercial Crew Development**
- Phil McAlister
- 10:45-11:45 AM** **Overview of Contracting Options**
- William McNally
- 11:45-12:00 PM** **BREAK**
- 12:00-1:00 PM** **Discussion**
- ADJOURN JOINT MEETING WITH AUDIT, FINANCE & ANALYSIS AND COMMERCIAL SPACE COMMITTEES*
- 1:00-1:55 PM** **Deliberation/Recommendation/Working Lunch**
- 1:55-2:00 PM** **Public Comments**
- 2:00 PM** **ADJOURN**

HUMAN EXPLORATION AND OPERATIONS COMMITTEE MEMBERSHIP
July 2012

Mr. Richard Kohrs Former Deputy Director of the NASA Space Shuttle Program and Director of
Space
Chair Station Freedom

Mr. Bohdan I. Bejmuk Aerospace Consultant, former Space Shuttle Orbiter Program Director, Boeing
Co-Chair

Dr. Bette Siegel NASA Headquarters
Executive Secretary

Ms. Shannon Bartell Former Kennedy Space Center Safety & Mission Assurance Director

Ms. Nancy Ann Budden Director for Special Operations Technology, Office of the Secretary of Defense

Dr. Leroy Chiao Former NASA Astronaut and International Space Station 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 International Space Station Program Manager

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. Richard Malow Distinguished Advisor at the Association of Universities for Research in Astronomy
(AURA)

Mr. James Odom Former NASA Associate Administrator for Space Station Freedom

Mr. Bob Sieck Former Space Shuttle Launch Director

**NASA ADVISORY COUNCIL
HUMAN EXPLORATION OPERATIONS COMMITTEE
Goddard Space Flight Center, Greenbelt, MD
July 23-24, 2012**

MEETING ATTENDEES

Committee Members:

Kohrs, Richard (Chair)
Bejmuk, Bohdan (Co-Chair)
Siegel, Bette (Executive Secretary)
Bartell, Shannon
Budden, Nancy Ann
Condon, Stephen "Pat"
Holloway, Tommy
Longnecker, David
Malow, Richard
Odom, James

NASA Attendees:

Bolen, John D.
Chabot, Valerie
Feeley, Jens
Figueroa, Orlando
Friedensen, Victoria
Gates, Michele
Geldzahler, Barry
Gerstenmaier, William
Grunsfeld, John
Hartman, Dan
Hill, William
Lewis, Ruthan
McCuiston, Doug
Porterfield, D. Marshall
Robinson, Shawanda
Uhran, Mark
Vondrak, Richard
Wargo, Michael
Williams, Greg
Wright, Michael

Other Attendees:

Barton, Michael—National Academies
Campbell, William—Audit, Finance and Analysis Committee
Frankel, Paula—PB Frankel, LLC/Zantech
 Gilbert, Chris—Space Policy Institute
Hanisee, Robert—Audit, Finance and Analysis Committee
Hinners, Noel—Science Committee
 Humphrey, Glenn—Lexmark International
Kovacs, Leslie—United Launch Alliance
Levin, Lon—Commercial Space Committee
McComas, David—Science Committee
Oswald, Steve—Commercial Space Committee
Smith, Patti Grace—Commercial Space Committee
 Steinhoff, Jeffrey—Commercial Space Committee

Attendees/Participants via WebEx or Telecon:

Antone, Letisha
Arcuri, Bronson
Bryant, Rita
Ellis, Michael
Fagedes, Keven

Leone, Dan
McAlister, Phil
McNally, William
Mitchell, Rashawn
Palinkas, Michael
Seas, Antonios
Smith, Janice
Zigler, Troy

**NASA ADVISORY COUNCIL
HUMAN EXPLORATION OPERATIONS COMMITTEE
Goddard Space Flight Center, Greenbelt, MD
July 23-24, 2012**

LIST OF PRESENTATION MATERIAL

- 1) International Space Station Program Status [Hartman]
- 2) Status of ESD, Orion, SLS, and GSDO [Hill]
- 3) MARS—The Search for Life [McCouston]
- 4) Mars Program Planning Group [Figueroa/Gates]
- 5) Joint Robotic Precursor Activity: Providing Strategic Knowledge to Inform Future Exploration [Wargo/Friedensen]
- 6) Life and Physical Sciences Division [Porterfield]
- 7) Human Exploration & Operations Mission Directorate Updates [Gerstenmaier]
- 8) Commercial Spaceflight Status Briefing [McAlister]
- 9) Overview of Contracting Options [McNally]