National Aeronautics and Space Administration
Washington, DC

NASA ADVISORY COUNCIL

Human Exploration and Operations Committee

November 29-30, 2017

Kennedy Space Center
Debus Conference Facility
Cape Canaveral, Florida

MEETING MINUTES

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Kenneth Bowersox, Chair

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Bette Siegel, Executive Secretary

Human Exploration and Operations Committee Meeting
Kennedy Space Center
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NASA Advisory Council
Human Exploration and Operations Committee Meeting
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Thursday, November 29, 2017

Call to Order, Welcome, & Opening Remarks

Dr. Bette Siegel, Executive Secretary for the NASA Advisory Council (NAC or Council) Human Exploration and Operations (HEO) Committee, called the session of the HEO Committee to order at 10:30 a.m. She announced that the meeting was a Federal Advisory Committee Act (FACA) meeting and, therefore, would be open to the public. Minutes would be taken and posted online, along with the presentations. Dr. Siegel explained that there would be an opportunity for the public to make comments towards the end of the meeting, and she requested that all questions and comments be held until that time.

Dr. Siegel introduced the Committee chair, Mr. Kenneth Bowersox. Mr. Bowersox welcomed everyone to the meeting.

Welcome to Kennedy Space Center

Mr. Bowersox introduced Mr. Robert Cabana, Director, NASA Kennedy Space Center (KSC). Mr. Cabana noted that employee morale at KSC is "outstanding," property prices are going up, and jobs are available, as evidenced by the fact that contractors are "stealing" employees from each other. He noted that he is disappointed when travelling around the country to hear people ask whether NASA is still in business. In response to a question about damages to KSC from hurricanes, he reported that Hurricane Matthew was the strongest hurricane to ever hit Cape Canaveral and caused over $100 Million (M) in damages. Hurricane Irma, however, adversely affected more employees.

Mr. Cabana explained that KSC has become a multi-user space facility. He presented slides showing KSC's facilities, and he described the transition to the Launch Services Program (LSP), which procures vehicles for NASA science missions. Mr. Cabana discussed work being performed at KSC under Space Act Agreements (SAAs). Boeing's Starliner spacecraft for commercial crew is being built in the company's Commercial Crew and Cargo Processing Facility (C3PF) at KSC. SpaceX has signed an agreement to take over maintenance responsibility for Pad 39A, which the company is renovating to launch its Falcon rockets and Dragon modules. Blue Origin is constructing a large facility at Exploration Park on NASA land managed by Space Florida and will be launching from Pad 36. Mr. Cabana presented a slide showing the many companies now located at KSC. He described the new, almost completed KSC headquarters building. It was supposed to have been completed in December 2017; however completion has slipped. It is expected to save NASA $6 M per year in operating expenses.

Mr. Cabana discussed work being performed on Crawler Transporter-2. He explained that it had been built in the early 1960s for the Apollo missions and will be usable for the next 30 years. It will carry vehicles for Mars. Mr. Cabana noted that Crawler Transporter-1 remains available; however, it lacks the capacity to carry the heavy weight of the Space Launch System (SLS). He described work being performed in the Vertical Assembly Building (VAB) and on Launch Complex 39B. He discussed work required for the Mobile Launch Platform (MLP). It will be ready in March or April 2018. Obtaining a second mobile launcher may be more feasible than extending the existing launcher's height for later SLS flights.

Ms. Shannon Bartell asked Mr. Cabana to discuss skill retention at KSC. He responded that the Center had recently received authority to offer a $25,000 buyout to employees. Also, Acting Administrator Mr. Robert Lightfoot authorized a temporary increase in the ceiling on the number of civil servants. The most critical skill where depth is lacking is software engineers. "They are hard to come by and get paid a lot," he explained.

Mr. Bowersox thanked Mr. Cabana for his presentation.

Human Exploration and Operations Overview

Mr. Bowersox introduced Mr. William Gerstenmaier, HEO Mission Directorate (HEOMD) Associate Administrator (AA), who provided the Committee with a report on the status of the Directorate. Mr. Gerstenmaier explained that the Nation' s goal in space exploration is to expand human presence deeper into the solar system and that NASA's role is to lead the effort. He presented a chart showing three phases for expanding human presence in the solar system in partnership with other nations. Phase 0 uses the International Space Station (ISS) to solve exploration challenges, evaluate the potential for lunar resources, and develop standards. Phase 1 marks the beginning of missions in cislunar space. Phase 2 calls for leaving the Earth-Moon system and reaching Mars orbit. NASA is leading future exploration by:

- maximizing utilization of the ISS,
- actively promoting low-Earth orbit (LEO) commercialization,
- resolving the human health and performance challenges,
- expanding partnerships with commercial industry,
- growing international partnerships,
- building the critical Deep Space Infrastructure, and
- enabling the capabilities to explore multiple destinations.

Mr. Gerstenmaier explained that NASA is putting heavy emphasis on developing standards for the next generation of hardware. The first set of standards developed was for a universal docking system. Standards are presently being developed for life support, avionics, power, and data. Comments on those standards have been received from NASA's international partners. In response to a question from Mr. Michael Lopez-Alegria, Mr. Gerstenmaier explained that the effort is being led in-house.

Mr. Gerstenmaier presented a chart showing eight strategic principles for sustainable exploration:

- fiscal realism,
- scientific exploration,
- technology pull and push,
- gradual build-up of capability,
- economic opportunity,
- architecture openness and resilience,
- global collaboration and leadership, and
- continuity of human space flight.

These principles are very important, he explained, and he requested the Committee's comments on them. Mr. Bowersox noted that the Committee had seen the principles evolve, and he asked whether they had changed very much from the last time they were presented. Mr. Gerstenmaier responded that there had not been any significant changes.

Mr. Gerald Smith asked whether NASA was getting any new international partners. Mr. Bill Hill responded that 26 countries, including India and China, were working on developing a global exploration roadmap. That partnership would be much broader than the ISS partnerships. Mr. Gerstenmaier explained that NASA does not have to do everything by itself anymore. It is leading the movement by doing, influencing, connecting, and orchestrating. Dr. Patricia Sanders advised that it is important to have leadership to make sure all the pieces work well together. Ms. Bartell asked whether industry was assuming leadership in LEO. Mr. Gerstenmaier responded that he is seeing a beginning for that kind of involvement, particularly with respect to pharmaceuticals. NASA must be careful to remain nurturing and not take some action to stop the process. He stated, "It is too early to say we have success, but there is enough to say there could be success."

Mr. Gerstenmaier described the four RS-25 engines that are ready to be used for the first SLS flight. He presented slides demonstrating collaboration between HEOMD, the Science Mission Directorate (SMD), and the Space Technology Mission Directorate (STMD). Every flight to the ISS is now "carrying a science mission payload in the trunk."

Mr. Gerstenmaier discussed the National Space Council (NSC) and stated that it had recently conducted a very effective first meeting. He presented a chart illustrating the benefits of public-private partnerships in space exploration. NASA helps its commercial partners through financial investments, sharing knowledge, providing infrastructure, and fulfilling early demand as an anchor customer. In return, the Nation receives an emerging space industry sparked by the initiative of private entrepreneurs that are creating new markets, lowering costs, and developing cutting-edge research. In response to a question from Mr. Joe Cuzzupoli, Mr. Gerstenmaier explained that public-private partnerships also have disadvantages; private enterprise is motivated by profits, which calls for protecting intellectual property and controlling markets. He added that "it doesn't help if somebody develops a secret sauce that is kept internal."

Mr. Gerstenmaier reviewed a slide showing the current fleet in the LSP. He discussed the Commercial Crew and Commercial Cargo programs. He gave an overview on Next Space Technologies for Exploration Partnerships (NextSTEP) Habitation. He described Lunar Cargo Transportation and Landing by Soft Touchdown (CATALYST). In 2014, NASA selected private-

sector partners for fielding a commercially-viable lunar surface cargo transportation capability. Those agreements were renewed in 2017. A slide was presented showing the Deep Space Gateway (DSG) and Orion. Mr. Gerstenmaier discussed a chart on the power and propulsion element (PPE) for the cislunar DSG and presented a slide illustrating how NASA's Deep Space Systems for human exploration are being built in all 50 states. He discussed international collaboration on the Space Communications and Navigation (SCaN) network.

Mr. Gerstenmaier explained that the ISS is a platform for deep space exploration, scientific research, economic growth, and global diplomacy. It brings the world together to discover, develop, and advance solutions for a better life on Earth and in space. He reviewed ISS partnerships with five space agencies representing 15 nations. It is the largest peace-time effort by the most countries in human history. Ninety nations are involved in research on the ISS. Mr. Gerstenmaier reviewed a slide showing the elements for the Orion spacecraft. It is a global program because the European Service Module (ESM), which is on the critical path, is being provided by the European Space Agency (ESA). Mr. Cuzzupoli observed that where there is a program with a schedule constraint, it has been important to keep other countries out of the critical path. Mr. Gerstenmaier responded by saying "if you want to go fast, go alone, if you want to go far, go together." He presented a slide showing the nations participating in producing the International Space Exploration Coordination Group Global Exploration Roadmap.

Mr. Bowersox thanked Mr. Gerstenmaier for his presentation.

ISS Update, Accomplishments, and Future

Mr. Bowersox introduced Mr. Sam Scimemi, Director, ISS, HEOMD, who briefed the Committee on the status of the ISS and on plans for the ISS transition.

Mr. Scimemi reviewed a chart showing flight plans for the ISS through February 2018. He described the crew for Increment 53 and showed the consumables available for increments 53 and 54. NASA prefers to maintain a 6-month supply for consumables, and existing consumables are sufficient through June 2018. Mr. Scimemi reviewed a chart on Increment 53-54 crew time utilization by sponsor. He discussed recently completed U.S. extravehicular activities (EVA's) and noted that two maintenance EVAs are scheduled in January. He reviewed a chart on ISS research statistics. The crews for Increments 53-54 worked on 297 investigations. Approximately 2447 investigations have been performed over the ISS lifetime. Mr. Scimemi presented a graphic illustrating global involvement in utilizing the ISS and noted that new participating countries are Iraq, Morocco, and the Republic of Malta.

Mr. Scimemi presented slides on a featured investigation and a featured exploration technology. The Effect of Space Flight on Antibiotic Resistance of a Pathogenic Bacterium and its Genetic Basis (EcAMSat) will investigate the space microgravity effect on antibiotic resistance. The Phase Change Material Heat Exchanger (PCM HX) demonstration gathered important data to improve the effectiveness of a heat exchanger that will be used on Orion's deep space exploration missions. Mr. Scimemi described the recent SpaceX-12 mission and the status for the SpaceX-13 Mission, which will include the second reuse of a Dragon capsule and the first reuse of Falcon 9 first stage on a NASA mission. In response to a question from Mr. Joe Cuzzupoli, Mr. Scimemi explained that

SpaceX establishes the requirements related to re-using elements on SpaceX missions. NASA reviews those requirements to determine whether SpaceX meets the intended risk level. Mr. Scimemi described the status for the upcoming Orbital ATK-8 Mission and for the Commercial Resupply Services-2 (CRS-2) missions, which are planned for launch beginning in 2019.

Mr. Scimemi discussed the ISS transition. The 2017 NASA Authorization Act requires that NASA, in coordination with the Center for the Advancement of Science in Space (CASIS), ISS partners, the scientific user community, and the commercial space sector, "develop a plan to transition in a step-wise approach from the current regime that relies heavily on NASA sponsorship to a regime where NASA could be one of many customers of a LEO, non-governmental human space flight (HSF) enterprise." The ISS Transition Report was due to Congress on December 1, 2017. Mr. Scimemi described an ISS Stakeholder Workshop held over the summer to discuss policy and programmatic issues related to the ISS and LEO. A continuous U.S. human presence has been sustained on the ISS over the past 17 years. Private industry and other governmental agencies are not in a position to fully pay for ISS transportation, crew time, and power without ongoing NASA support. The primary cost driver for the ISS is transportation. Other drivers include infrastructure and the logistics for six crew members on-board year-round, the complexity of the on-orbit platform, and the cost to carry international obligations.

Mr. Scimemi presented a slide showing that China would be operating a space station by 2024 with participation from other countries, including ISS partners. By that time, U.S. Commercial Crew is expected to increase from 3 to 4, and NASA will be conducting HSF missions in cislunar space. Dr. Pat Condon asked will NASA have learned everything it needs from ISS for exploration by 2024. Mr. Cuzzupoli stated that by 2024 NASA would have either mitigated or resolved all the outstanding issues for moving on to the next phase in exploring cislunar space. In response to a question from Ms. Bartell, Mr. Scimemi explained that by 2024 NASA would like to be in a position where it can simply purchase time in LEO. Mr. Cuzzupoli asked whether Russia has mentioned anything about the ISS post-2024. Mr. Scimemi responded that the ISS partners have all said they are "sticking with us." He added, "the partnership lives in an intergovernmental agreement, not in the platform."

Mr. Scimemi presented factors to consider for the ISS transition:

- completion of exploration-related research and technology development requiring ISS;
- demand from government and private industry including research and for-profit motivated activities, and whether that demand will support private LEO platforms and associated transportation costs;
- establishment of cislunar Gateway capabilities and execution of missions beyond LEO;
- affordability in the larger HSF Exploration context;
- foreign policy;
- future of the National Laboratory;
- re-use of on-orbit ISS elements;
- long-term NASA requirements for LEO research and utilization; and
- scope of public-private partnership models.

Mr. Cuzzupoli stated, "with all that has been spent for ISS, all of a sudden come 2024 we are going to bring it down. Hard to believe." In response to a question from Mr. Gerald Smith, Mr. Scimemi responded that NASA does not have a long-term plan to get to where it becomes a customer in LEO. Mr. Tommy Holloway advised that for users to pay transportation costs, the cost would need to be reduced by a factor of 5 to 10, which he believed was not going to happen. Mr. Scimemi concurred with the assessment that transportation costs could not be reduced sufficiently. Mr. Gerstenmaier added that private companies today are paying for the research expenses on the ISS; however, NASA is still subsidizing costs for crew, transportation, and data. A path for transition is needed by 2020.

Mr. Bowersox thanked Mr. Scimemi for his presentation.

Exploration Systems Division

Mr. Bowersox introduced Mr. Bill Hill, Deputy AA, Exploration Systems Division (Exploration or ESD), HEOMD. Mr. Hill briefed the Committee on recent developments in deep space exploration systems.

Mr. Hill reviewed ESD's top concerns and progress. The Orion and SLS flight software build phase is progressing with some content deferral. Test facility capacity and software content prioritization remain watch items due to Integrated Test Lab (ITL) overlap between Exploration Mission (EM)-1 and EM-2. Spacecraft Command and Control System (SCCS) schedules have been modified due to software development challenges. The cross-program integrated software critical path schedule is being monitored. Integrated avionics and software verification and validation (V&V) testing for the Structural Test Article (STA) is being conducted at multiple locations in parallel with component level tests at suppliers and functional tests at element production sites. SLS Engine Section (ES) STA testing at NASA Marshall Space Flight Center (MSFC) successfully completed all test cases for Block 1. The Launch Equipment Test Facility (LETF) continues to make measured progress. ESD continues to operate under a Continuing Resolution (CR), and there may be program funding disconnects if that is extended to a full-year CR. Funding uncertainty still impacts EM-1 and EM-2 mission definition and content, interdependencies management, ground infrastructure, and efficiency of program planning and implementation. Mr. Cuzzupoli expressed concern over last minute changes that normally hit big programs and asked how complete they are on loads. Mr. Hill responded "50 to 60 percent." Mr. Cuzzupoli requested an update on loads at every meeting and suggested that it should be in the top chart. Mr. Marshall Smith, ESD Systems Engineer and Integration Lead, explained that the load information can be found in the overall integrated schedule.

Mr. Hill noted that the LETF is experiencing delays due to first-time test issues and technician availability. The MLP is experiencing delays for the same reasons. The MLP V&V schedule is being re-planned and continues to have a margin for additional delays. The SCCS is being reviewed against internal software efficiencies. The availability of experienced software developers is a watch item.

The Orion EM-1 Crew Module (CM) and Crew Module Adapter (CMA) production at Operations and Checkout (O&C) is making good progress. The EM-1 heat shield thermal proof test is complete

and results are being evaluated. The ESM production continues to be a significant schedule concern with potential impacts to the start date for ESM, CM, and CMA integration. To mitigate the delay risk, Lockheed offered to help Airbus, which agreed to accept Lockheed's assistance.

Mr. Bowersox asked about the three schedule paths: the ESM, the Core Stage, and ground systems software. He noted that the Core stage production schedule had been slightly affected by weather. In response to a question from Mr. Bowersox, Mr. Hill reported that first-time production issues had revealed problems with staffing. Mr. Bowersox asked about the ESM parts supply issueMr. Hill explained that Airbus would work on the ESM through the holidays. Mr. Bowersox asked whether anything could have been done a few years ago to alleviate the problem. Mr. Gernmaier explained that, in hindsight, NASA could have seen some issues sooner. The focus had been on welding issues in the Vertical Assembly Center, which distracted attention away from the heavy manufacturing segments. The lesson learned is that it is important to seek out issues that are not the "hot issue of the day." Mr. Cuzzupoli suggested that the ESM could be shipped incomplete, and Mr. Hill responded that that was under consideration. Mr. Gerstenmaier added that NASA has learned that its prime contractors need to have physical inspectors in the subcontractors' plants to verify that equipment will be produced on time. In response to a question from Ms. Bartell, Mr. Hill stated that there are four to six months of risk in the critical path. Mr. Gerstenmaier commented that there is no margin through December 2019. Mr. Hill added that the schedule "would show negative margin."

Mr. Hill noted that the SLS liquid hydrogen (LH2) qualification tank proof test is complete. Progress has been made in addressing first-time build manufacturing efficiencies for Core Stage integrated assembly at the NASA Michoud Assembly Facility (MAF); however, ES component availability and overall Assembly Integration and Test (AI&T) status continue to be monitored. Core Stage is the enterprise secondary critical path and has minimal margin. Mr. Hill described efforts being made to support delivery date commitments to NASA Stennis Space Center (SSC). All four EM-1 flight engines, with controllers and certified software, have been delivered to SSC for Core Stage integration. A significant amount of EM-2 flight hardware is now in flow, including the Orion CM. ESM delivery for EM-2 is a watch item. Cross-Program Systems Integration (CSI) is supporting DSG mission planning, and the initial mission planning guidelines for DSG Phase 1 activities are being refined.

Mr. Hill presented a summary chart showing EM-1 integrated mission milestones. He reviewed a chart showing ESD's recent accomplishments. He discussed improvements to increase confidence in schedule performance. The Director of CSI is now solely focused on Systems Engineering and Integration (SE&I). A weekly ESD schedule review has been established. There is increased strategic evaluation of schedule risk and robustness measures. Senior executive reviews are being led by the Acting Administrator.

Mr. Hill presented status slides for the EM-1 Launch Abort System (LAS), the Orion structural qualification, the EM-1 CM, the EM-1 CMA, the EM-1 SM, SLS STA testing at MSFC, ES structural qualification, EM-1 Boosters and Engines, and the Software Test Lab. He discussed umbilical production and LETF testing. He described the status of work on the MLP, the VAB, and Pad 39 at KSC and presented slides on the Multi-Payload Processing Facility (MPPF), the SCCS, and Ground Flight Applications Software (GFAS). Mr. Hill indicated that a presentation would be given at the

next Committee meeting on whether the MLP should be modified for EM-2 or whether a new MLP for that mission should be constructed for an additional $300M. Mr. Smith noted that a new MLP would provide improved performance. Mr. Gerstenmaier, in response to a question from Mr. Bowersox, explained that NASA has considered a request for funding a second MLP in the current budget. He added that the 33-month window for modifying the MLP could not be reduced if the schedule for EM-1 slipped. Dr. Sanders advised that the NASA Aeronautics Safety Advisory Panel (ASAP) believes that it is important to build the second MLP because "it is important to fly often enough that you 'don't forget.'"

Mr. Marshall Smith reviewed CSI technical performance, recent major accomplishments, and near-term forward work. Mr. Smith stated that NASA is reviewing the integrated test schedule to see what improvements could be made without adversely impacting the risk posture. Mr. Cuzzupoli noted that NASA did not do "full up" testing on the Space Shuttle. Mr. Gerstenmaier stated that he would like to take some models beyond failure level. He added that he would fight requirements if there was something that could be done to save time in the schedule, and that there is an "art aspect" to testing. He requested that the Committee advise him when it sees unnecessary testing being performed that could adversely impact the schedule. Mr. Mark Geyer stated that time spent testing on EM-1 would save time on EM-2. Mr. Bowersox commented that the best thermal vacuum test would be flying EM-1.

Mr. Smith presented a chart showing the Cross-Program Integration Team's (CPIT) top technical issues: interim cryo- propulsion stage umbilical loads, differing pad stay times due to wind exposure for SLS and Orion, limited launch opportunities, potential damage to the RS-25 engine nozzles from solid rocket booster nozzle throat plug material, EM-2 loads, Orion primary structural design loads, and integration issues from potential uses of the Orion Simulator.

Mr. Bowersox thanked Mr. Hill and Mr. Smith for their presentations.

Commercial Crew and Launch Readiness Process

Mr. Bowersox introduced Ms. Lisa Colloredo, Deputy Manager, Commercial Crew Program (CCP). Ms. Colloredo briefed the Committee on the latest status and technical progress for the CCP Commercial Crew Transportation Capabilities (CCtCap) and Commercial Crew Integrated Capability (CCiCap) Space Act Agreements (SAA). The CCP Annual Performance Review conducted with Agency stakeholders is complete. Post Certification Missions (PCMs) 3 through 6 have been awarded to both Boeing and SpaceX. Multiple spacecraft and qualification test articles are in production and being tested simultaneously. Mission planning and preparations for eight CCP missions are in progress, four for each provider. Progress continues to be made in the burn down of key certification products. She presented slides showing the Boeing C3PF and the SpaceX Horizontal Integration Facility.

Ms. Colloredo reviewed a chart showing the CCtCap Combined Milestone Summary for Fiscal Year (FY) 2017 Quarter 3 (Q3). In response to a question from Mr. Bowersox, she explained that several SpaceX milestones had been separated into a new cluster of milestones to gain greater insight on integrated progress toward certification and provide incremental financing payments. She discussed the CCP Top Programmatic Risks matrix. The three highest Programmatic risks are

inability to meet the loss of crew (LOC) requirement, the cost of government provided services, and the Department of Defense (DoD) search and rescue training schedule. She explained that these risks do not reflect the providers' internal program risk matrices, which remain proprietary information. She reviewed a chart showing the CCP Top Program Safety Risks. Those risks are inability to meet LOC, aborting into sea states with unsafe rescue available, and crew entry accelerations and space flight-associated, neuro-ocular syndrome (SANS) exacerbations. In response to a question from Mr. Voss, Ms. Colloredo clarified to the Committee that the likelihood score means that it is possible that that neither provider is going to meet the LOC requirement and if not met, a variance with justification would need to be elevated for a decision.

Ms. Colloredo described Boeing's accomplishments. Nine land-landing qualification tests have been conducted. The STA initial shock testing is complete. A crew emergency egress demonstration was performed. The first LAE hot fire test with the Pathfinder engine has been completed. She discussed Boeing's production and operations on Boeing Spacecraft SC1, SC2, and SC3. She described the status of the Atlas AV-080 launch vehicle and operations training preparations.

Ms. Colloredo reviewed SpaceX accomplishments. The Dragon Demo-1 capsule integration mating is complete. Qualification model structural testing is complete. Eight parachute-drop tests have been conducted. Lightning tower upgrades have been completed. Two Hardware-in-the-Loop (HITL) tables have been assembled to support software testing. Three Dragon Crew Modules are in production. She described the status of SpaceX operations training.

Ms. Colloredo reviewed Blue Origin's Accomplishments under its Commercial Space Capabilities Collaboration (CSCC) SAA and described technical and data exchanges under that agreement. She reviewed Sierra Nevada Corporation's accomplishments under its extended CCiCap SAA. Sierra Nevada performed a successful full-scale Dream Chaser engineering test article (ETA) unpowered approach and landing test at the NASA Armstrong Flight Research Center (AFRC). The test included detailed flight maneuvers.

Ms. Colloredo explained that the CCP continues to facilitate the development and certification of U.S. industry-based crew transportation systems. Boeing and SpaceX are meeting their contractual milestones and maturing their designs. Risks are being identified and NASA is engaged in meaningful insight. In response to a question from Mr. Cuzzupoli, Ms. Colloredo explained that NASA is usually present to observe test failures and when it isn't present, both providers are prompt about reporting failures to NASA after conducting a self-evaluation. She noted that both providers are making tangible progress toward flight tests and crewed missions to the ISS. The CCP has robust and efficient processes for granting certification, including addressing waivers and deviations.

Ms. Bartell requested additional information at the next Committee meeting on progress in defining the launch readiness process and how NASA would interact with the providers. Mr. Cuzzupoli requested that information be provided to the Committee about mistakes and errors that occurred in each provider's flight tests. Mr. Gerstenmaier explained that contractual intellectual property provisions would have to be taken into consideration in responding to that request. Mr. Bowersox added that NASA has assigned responsibility for CCP safety oversight to the

ASAP to minimize CCP's workload in responding to repetitive information requests from oversight organizations.

Mr. Bowersox thanked Ms. Colloredo for her presentation.

Discussion and Recommendations

Mr. Bowersox reviewed the Committee concerns that he presented at the last NAC meeting. Mr. Gerstenmaier stated the number of reviews of HEO programs remains the same or has increased and budget uncertainty remains the same. Mr. Gerald Smith suggested that the new incoming Administrator may be willing to help with those concerns. Mr. Bowersox noted that the Chief Engineer's Office had reviewed the 7120 process in an attempt to make it easier for the NASA programs. Ms. Bartell stated, "it didn't make it better, it made it worse." Dr. Sanders reported that ASAP feels there are "too many safety requirements" and added, "There are thousands and it makes you wonder how many are complied with. They get audited on how well they are meeting the requirements, not on how safe they are."

Mr. Gerstenmaier stated that he would provide to the Committee several Inspector General (IG) and General Accounting Office (GAO) reports on and recommendations to HEOMD. He asked that the Committee express an opinion on whether those reports are helpful. Mr. Bowersox offered to hold a special session on that matter at the next Committee meeting and added that discussion on the subject in a public forum would be helpful. Mr. Voss requested that the reports be provided to Committee members prior to the meeting. Mr. Gerstenmaier clarified that the intent is to evaluate the reports' benefits; not to stop or reduce the oversight. In response to a question from Mr. Lopez-Alegria, Mr. Gerstenmaier explained that the reports overlap each other and could be presented in a more beneficial manner; currently the reports seem more like "an enforcement activity." In response to Mr. Condon's assertion that a Committee opinion would not reduce the number of reviews, Mr. Gerstenmaier indicated that "it would shine a light on them" and give the broader community an opportunity to get involved.

Mr. Condon suggested developing a recommendation to establish a formal linkage between the NAC and the new NSC. He stated that it would be a mechanism for the NSC to take advantage of the expertise that exists in the NAC. Ms. Bartell stated that she was not comfortable with the proposed recommendation because the purpose of the NAC is to advise the Agency, not to advise outside the Agency.

Mr. Lopez-Alegria expressed concern about a shift to ending ISS in 2024. He stated, "if we don't make a good effort to establish a follow-on LEO capability, then the U.S. will have abandoned LEO." Mr. Bowersox suggested adding that concern to the Committee's list. Ms. Bartell expressed concern over whether the commercial world would be ready when NASA pulls away from LEO orbit. Mr. Holloway stated that scheduling is still a big problem and that NASA "may be working on symptoms instead of the disease." He added, "Orion has been around for 10 years and we are still working on it; we went to the moon in nine. We say it is money, but perhaps it is something else." Mr. Gerstenmaier responded that Orion is ahead of schedule; what had never been done before is

to rely on the Europeans for something like the ESM. He added that there could be a root cause behind the delay in the ESM or the core.

Mr. Bowersox thanked everyone for their comments.

Adjourn

Dr. Siegel adjourned the committee meeting for the day at 5:00 p.m.

Friday, November 30, 2017

Opening Remarks

Dr. Siegel reconvened the Committee meeting and welcomed everyone. She apologized for the delay in starting the meeting and explained that it was due to technical problems. She noted that the public would have an opportunity later in the meeting to make comments and that minutes would be taken and published. She introduced Mr. Bowersox.

Mr. Bowersox described the history of the NAC's committee structure. He explained that the NAC is charted under the FACA and is thereby authorized to provide advice to NASA. The HEO Committee is not a FACA committee and, therefore, must provide advice through the NAC. In accordance with the NAC's protocol, Committee advice intended for the Administration is given through findings and recommendations that are approved by the NAC. A formal response from NASA is only given when there is a recommendation. Findings are used when a response is not desired. Mr. Bowersox noted that the Committee also maintains concerns and observations for its own purposes. Those concerns and observations are noteworthy and receive almost as wide a dissemination as findings and recommendations; however, they need not be approved by the NAC and NASA does not have to respond to them. Mr. Gerstenmaier stated that, at a minimum, he would respond verbally to the Committee's concerns and observations. Mr. Bowersox noted that his presentations to the NAC always include the Committee's concerns and observations, and the Administrator is often present to hear them.

Power and Propulsion Element Status

Mr. Bowersox introduced Dr. Michele Gates, Director, PPE, HEOMD.

Dr. Gates described four advantages to using solar electric propulsion (SEP) in cislunar space: storable fuel, translation flexibility, mass savings, and technology advancement for deeper space applications. She explained that a PPE would provide key functions for the DSG concept, including transportation and controls for lunar orbital operations, power to DSG elements, and communications. The concept described is for a PPE launch co-manifested with Orion on EM-2.

Dr. Gates reviewed a slide showing PPE-related accomplishments against milestones. Most recent was the PPE Industry Study selection announcement. She explained that as part of NASA's NextSTEP BAA, contracts were awarded to five companies to examine differences between prior

SEP mission concepts, expected industry capabilities, and potential needs for supporting NASA's DSG concept. The contracts were awarded to Boeing, Lockheed Martin, Orbital ATK, Sierra Nevada Space Systems, and Space Systems Loral. The studies will help identify technical differences and implications between work developed under the Asteroid Redirect Robotic Mission (ARRM) and the proposed concept for the PPE. Dr. Gates presented charts showing 23 study topics and PPE near-term milestones.

In response to a question from Mr. Smith, Dr. Gates explained that the PPE would be completely autonomous; in response to a question from Mr. Voss, she stated that a flight unit could be built by 2022. In response to a question from Mr. Bowersox, she explained that the PPE would be fully assembled prior to launch. Mr. Bowersox asked whether any science activities or instruments would be included on PPE. Dr. Gates responded that there were no science reference requirements at this time, although they have been mentioned.

Mr. Bowersox thanked Dr. Gates for her presentation.

Future Human Exploration Planning/Deep Space Gateway and Transport Formulation Status

Dr. Siegel introduced Mr. Jason Crusan, Director, Advanced Exploration Systems (AES) Division, HEOMD.

Mr. Crusan presented a slide showing three phases for expanding human presence. Phase 0 refers to "now" and focuses on continuing research and testing on the ISS to solve exploration challenges. Phase 1 refers to the 2020s and operating in the lunar vicinity or "proving ground." Phase 2 begins after 2030, when humans leave the Earth-Moon system and reach Mars orbit. He reviewed a chart showing four potential utilization options for cislunar space: exploration technology validation, commercial capabilities, international capabilities, and science and research. Users and stakeholders should be represented in the concept development process. That process requires a balance to be developed between resources, schedules, technology, and objectives to ensure long-term sustainability of exploration systems. There are three near-term needs: establish an internal team for trade analysis, establish a way for the team to make decisions on trade analysis, and begin to document concept options and plans. Mr. Crusan reviewed a chart on the SE&I efforts showing three key analysis tasks for concept maturation: design integration, requirements development, and cross-program integration. He explained that SE&I conducts analysis for the overall systems engineering and integration for each concept. ESD uses a cross-program CSI structure and governance to integrate across the ESD. SE&I includes key personnel and functions of the ISS Future Capabilities Team, the NextSTEP Habitation activity team, and ESD CSI teams.

Mr. Crusan discussed international participation in deep space concept maturation activities. NASA wants to maximize ISS utilization for exploration and has led the ISS partner agencies in studying and developing the concept for a DSG in cislunar space. The ISS partners are also coordinating and contributing to draft interoperability standards for avionics data, communications systems, environmental control and life support systems (ECLSS), power systems, thermal systems, rendezvous, and external robotics. Mr. Crusan explained that the ISS

partners understand that international, commercial, and academic entities have significant capabilities to contribute to the larger effort.

Mr. Crusan explained that as integrated exploration planning and development progresses, it is important to plan what should be documented and controlled at the HEOMD level. HEOMD has implemented configuration management processes to manage and control documents that are applicable across programs. That will help NASA understand how a potential DSG and other options can support overall objectives. ESD documentation will be used as much as possible. Mr. Crusan presented a chart showing how the HEOMD Level 1 Exploration Objectives documents for exploration objectives are organized. HEOMD-001 translates and bridges the gap between NASA's human exploration strategy and discrete objectives for implementation. HEOMD-002 Configuration Management Process documents define the methodology and process for implementing configuration management for select integrated products controlled at the HEOMD level. HEOMD-003 Deep Space Certification Requirements document describe what is needed for deep space exploration systems certification. HEOMD-004 Exploration Requirements document describe what is being built. Those documents capture Level 1 requirements for the Orion, SLS, and Ground Systems Development and Operations (GSDO) ESD programs and future deep space capabilities. HEOMD-005 Exploration Design ConOps documents describe desired capabilities for systems and crews. HEOMD-006 Exploration Utilization Plan documents describe how the systems will be used and when the capabilities and resources are needed. At Mr. Bowersox's request, Mr. Crusan described how human rating requirements fit into the overall structure.

Mr. Bowersox thanked Mr. Crusan for his presentation.

Advanced Exploration Systems Update

Mr. Crusan briefed the Committee on the status of the AES Division. He explained that AES is responsible for rapid development and testing of prototype systems and validation of operational concepts to reduce risk and cost of future exploration missions. He described several systems. Habitation systems enable the crew to live and work safely in deep space, with reliable life-support systems, radiation protection, fire safety, and logistics reduction. Vehicle systems enable human and robotic exploration vehicles, including advanced in-space propulsion, extensible lander technology, and modular power systems. Foundational systems enable more efficient mission and ground operations and systems that allow for more independence. He presented a chart showing the activities that will be required at different phases in the exploration timeline. Phase 0 is for exploration systems testing on the ISS. Phase 1 is for operating in the lunar vicinity. Phase 2 is for leaving the Earth-Moon system. Phases 3 and 4 are for exploration in the Mars system.

Mr. Crusan presented slides showing deep space habitation systems that provide life support, environmental monitoring, crew health, EVA's, radiation protection, fire safety, logistics, and cross-cutting systems. He discussed the need for those systems to evolve from today's systems to future systems for deep space habitation. He reviewed NextSTEP ECLSS activities. Phase 2 contracts have been awarded and work is progressing. Mr. Crusan reviewed a chart on spacecraft fire safety. He described the Saffire IV-VI flight experiments, which are intended to demonstrate

fire monitoring and cleanup technologies in a realistic spacecraft environment. He described how NASA reduced the experiment's testing costs by taking advantage of the low air pressure found at the 14,000-foot elevation on Pike's Peak.

Mr. Crusan discussed in-space manufacturing and described 3-D printed urine funnels, 3-D wireless humidity sensors, and 3-D proof-of-concept dishes that can be scaled up to larger reflectors needed for deep space optical communications. He discussed the status of NextSTEP Phase 2 habitation contracts. Broad Agency Announcement (BAA) contracts and discussions with international partners will inform development of a reference architecture for the DSG concept. Ground testing prototype habitats will assess human factors, subsystem integration, interoperability standards, and common interfaces. Mr. Crusan noted that the process had been slowed initially due to funding limitations under the CR. BAA contracts have been awarded to Boeing, Lockheed Martin, NanoRacks, Orbital ATK, and Sierra Nevada. A contract is anticipated to be awarded to Bigelow Aerospace following negotiations over intellectual property terms. In Phase 2, NASA's partners will refine concepts and develop ground prototypes. In Phase 3, deep space habitation capabilities will be developed, and flight units will be produced as deliverables. Mr. Cuzzupoli asked how many launches would be required to put all the required hardware on the DSG. Mr. Crusan answered that three launches would be needed, one year after another, with the third launch bringing crew and additional logistics. Mr. Cuzzupoli asked what years would the SLS launches occur in, assuming NASA received an adequate budget for the launches. Mr. Gerstenmaier responded that EM-2 would launch in 2022, and EM-3 would launch in 2023 with some habitation capability. It would be 2024, he added, "if you wanted to wait for logistics." Mr. Cuzzupoli inquired about the estimate of schedule activity for returning to the Moon. Mr. Crusan responded that there is no specific timeline and that it would be a function of budget and stakeholder direction.

Mr. Crusan reviewed a slide on crosscutting government furnished equipment (GFE) for prototype habitats. He described a NextSTEP test team's successful first demonstration of a DSG concept habitat mockup in the integrated Power, Avionics, and Software (iPAS) environment at the NASA Johnson Space Center (JSC). In response to a question from Mr. Cuzzupoli, Mr. Gerstenmaier explained that DSG could use an ISS-class ECLSS, which could be retrofitted for deep space transportation. Mr. Crusan discussed in-situ resource utilization developments. Designs have been tested for cryofreezers to acquire CO2 from the Mars atmosphere. A water mining trade study to determine the effects of Mars water resource types on excavation and processing system requirements has been completed. A breadboard Microwave Processer and Open-Air Dryer for extracting water from soil has been tested.

Mr. Crusan discussed NextSTEP advanced propulsion. Three contracts have been awarded to develop 100 kilowatt (kW) electric thrusters and demonstrate continuous operation for 100 hours. He described the Mars Oxygen In-Situ Resource Utilization (ISRU) Experiment (MOXIE) and discussed Mars 2020 payloads. The Mars Environmental Dynamics Analyzer (MEDA) is a surface weather station to be provided by Spain. The Mars Entry, Descent, and Landing Instrumentation (MEDLI-2) extends the MEDLI Mars Surface Lander (MSL) measurements with additional heatshield observation locations, inclusion of supersonic aerodynamics, and backshell aerothermal and pressure observations.

Mr. Crusan presented a slide on EM-1 secondary payloads. He discussed planning activities to change CubeSat delivery dates due to the EM-1 launch delay. He described the ShadowCam, which is a NASA contributed instrument to be flown on the Korea Pathfinder Lunar Orbiter (KPLO). The ShadowCam has more than 800 times the sensitivity of the Lunar Reconnaissance Orbiter (LRO) Narrow Angle Camera and will image the Moon's Permanently Shadowed Regions (PSR). He described the LunarCATALYST SAAs that were awarded to develop commercially-viable transportation capabilities for lunar surface cargo. Those agreements were renewed in 2017 for two additional years. The Resource Prospector will be the first mining mission on another world. It will be used to characterize the nature and distribution of water and volatiles in lunar polar subsurface material and demonstrate ISRU processing of lunar regolith. Mr. Crusan concluded his presentation with a slide on student engagement and outreach activities.

Mr. Bowersox thanked Mr. Crusan for his presentation.

Public Comments

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

Discussion and Recommendations

Mr. Bowersox invited Committee members to suggest findings and recommendations. He presented a proposed observation and a proposed recommendation on the opportunity presented by the NSC to resolve issues affecting the broader space community, such as the dwindling supplier base for some critical space components. He reviewed the Committee's concern over decreased ISS funding after 2024 if NASA's focus moves to the lunar surface, and the Committee's concern that NASA's exploration plans may be focused too narrowly if planning for cislunar space is limited to the lunar surface.

Mr. Voss suggested that NASA should pay no attention to the fact that "they don't like the word Mars" at the Office of Management and Budget (OMB). Dr. Sanders stated, "we know there is something beyond cislunar space that we need to build towards." Mr. Bowersox commented, "we all would like to see a lander sent to the lunar surface." He added that the overall program lays out a logical path to do both the lunar surface and cislunar space, and he suggested that Mr. Gerstenmaier "go back to using his old charts." Mr. Voss asserted that HEOMD has taken a step backwards that precludes making progress because the Exploration program is now more nebulous and less clearly defined. Mr. Lopez-Alegria stated that in the last Administration, "the goal was Mars and very inspirational." He added that the Evolvable Mars Campaign provided a structure that remains and is still defined. He asserted that a lunar landing does not preclude going to Mars; therefore, he does not see any logic in recommending that HEOMD go back to something that has not necessarily been left. Mr. Bowersox suggested that the Committee could adopt an observation stating that it is "worried" about the situation. Mr. Holloway stated, "it is fantasy that using industry and international partners will make it cheap. If you are going to Mars in the 2030s, you are not going to go to the Moon." He suggested that the choice was either keep flying on ISS to 2030-38 or land on the Moon. He stated, "You're living in a fantasy land if you think you can even do an orbital flight around Mars in the 2030s, keep ISS, and land on the Moon." Mr.

Bowersox explained that going straight to the lunar surface would make it take longer to get to Mars. It would be "a policy that is going to come from outside NASA."

Mr. Holloway cautioned that "programs that try to do too much for too little for too long end up getting canceled." Mr. Smith advised that NASA should forget Mars in 2030 and follow Mr. Gerstenmaier's approach to do the things that would eventually get to Mars. Mr. Holloway agreed that good things are being done to enable humans to eventually go to Mars. Mr. Cuzzupoli explained that Mr. Gerstenmaier would prefer the Gateway program because it includes the capability to go to the Moon, to cislunar space, and go to Mars. He stated, "I think the decision has already been made for us that we are going directly back to the Moon . . . The Space Council is looking at who else is going to go to the Moon . . . you get into a race in going back to the Moon." Mr. Cuzzupoli added, "if the U.S. does not go back to the Moon, then we are a second-rate space nation." Mr. Bowersox suggested that a refuelable Moon lander could be the most effective approach; he noted, however, that it could take longer to develop than the DSG. Mr. Cuzzupoli suggested an observation saying that NASA needs NSC direction.

Mr. Cuzzupoli observed that the requirement for human rating is not only for commercial crew. Mr. Bowersox noted that it would depend on who controls the requirements and requested that a Committee briefing by experts on the subject be scheduled.

Mr. Lopez-Alegria expressed concern over giving up the venue of LEO as a resource. Mr. Bowersox requested that Mr. Lopez-Alegria develop language for that concern. Mr. Lopez-Alegria stated he was concerned about the U.S. pulling out from the ISS partnership in 2024. Mr. Bowersox explained that the ISS would not see a sharp cut-off in 2024 and would keep flying if the U.S. left, although the U.S. elements might be discarded. Mr. Holloway asserted that the ISS partners have the same budget issues as the U.S. Mr. Lopez-Alegria suggested that the Russians may be planning to split off on their own. A viable commercial presence may be the only way for the U.S. to be able to continue to reach LEO, unless it is willing to depend on the Chinese or the Russians. In response to Mr. Bowersox's suggestion that the ISS could be given to private industry. Mr. Lopez-Alegria responded that "nobody would take that on due to the liability issues." He added that the best way to stay in LEO is through commercial operations and that the best way to do that would be to establish "a longer runway than 2024." Mr. Bowersox asked Mr. Lopez-Alegria to prepare language for that to go on the Committee's observation list.

Mr. Bowersox expressed concern over focusing too much on the lunar surface if it means discarding the DSG. He noted that there was one finding and one recommendation for the NAC to consider. In response to a question from Mr. Lopez-Alegria, Mr. Bowersox explained that the Committee's concerns "carry more gravitas" than its observations. Mr. Cuzzupoli noted that the NSC as previously constituted did not have its own advisory council. Mr. Bowersox noted that the incoming NASA Administrator would not likely eliminate the NAC unless he is satisfied with the advice he was getting from the NSC. Mr. Bowersox added that there is an ongoing Congressionally-mandated study on whether the NAC should be continued.

HEO Committee Observations

The committee observed continued technical progress on HEO programs since our last meeting, and continues to be impressed by the amount of work being managed by the directorate team.
• NASA has a lot of work ahead to accomplish the goals being set out for deep space exploration, while at the same time developing commercial crew capabilities and managing the International Space Station. Increased emphasis on organizational efficiency, stable requirements and decision velocity will be critical to meet the current schedules.
• The implementation of the National Space Council provides an excellent opportunity for NASA to air and gain assistance in resolving issues which affect the broader space community such as the dwindling supplier base for some critical space components.

• NASA plans to take a different approach to human rating of a deep space gateway than that used for human rating of the Orion deep space transport, since a human rated spacecraft would be present whenever humans were present to tend the gateway. Documentation of the approach used to certify that this human tended spacecraft is safe for humans would be useful for future programs.

• The phased approach that NASA has developed for exploration that included work in LEO, a Cislunar proving ground, and other phases in deep space supports NASA strategic plan objectives and was comprehensive,yet flexible. It should continue to be used as the guiding framework for our Nation's space exploration program to expand human presence across our solar system, even if the focus in Cislunar space moves to the lunar surface.

Proposed NASA Advisory Council Finding

NASA Human Exploration Strategy

Name of Committee: Human Exploration and Operations Committee

Chair of Committee: Mr. Ken Bowersox

Date of Public Deliberation: November 27 and 28 (HEO Advisory Committee)

Short Title of Finding: NASA Human Exploration Plans

NASA's current phased approach to exploration which includes ISS for the Earth dependent phase, Cislunar space for the proving ground and goals beyond Cislunar for the Earth independent phases provide a useful framework for future exploration efforts. An important element in the phased approach is that human exploration efforts in the Cislunar proving ground contribute to future exploration efforts beyond Cislunar space, even if the focus of Cislunar activity shifts to the lunar surface

Recommendation

TITLE: Interactive Link Between NAC and National Space Council

Recommendation: The Council recommends that NASA work with the National Space Council staff to establish an interactive link between the NASA Advisory Council and the National Space Council.

MAJOR REASONS FOR PROPOSING THE RECOMMENDATION: The implementation of the National Space Council provides an excellent opportunity for NASA to bring up problems and gain assistance in resolving issues which affect the broader space community such as the dwindling supplier base for some critical space components. The NASA Advisory Council has tremendous insight NASA and could provide valuable input to the National Space Council staff on significant issues which have not reached the urgency level required for discussion at formal Space Council meetings.

CONSEQUENCES OF NO ACTION ON THE PROPOSED RECOMMENDATION: NASA will lose opportunities to gain the help of The National Space Council on issues that may not yet have reached the urgency level required to be brought up and discussed by Space Council members.

HEO committee Concerns

• Budget uncertainty and lack of flexibility in use of funds continues, and now has greater potential for program disruption as SLS and Orion get closer to launch.
• Bureaucratic processes that NASA imposes on itself do not always add value to balance their load on the organization and are a threat to accomplishment of NASA's exploration mission.
• The number and intensity of current reviews of the HEO programs are not helpful and use too many precious resources.
• Low SLS and Orion Launch rate pose future risks for proficiency of the operations team and reduce program resilience in the event of mission failure
• Shifting priorities may result in the reduction of government funding for the ISS before a viable U.S. commercial follow-on capability is established. This capability is critical to allow NASA continued access to low Earth orbit for research, deep space exploration system testing, and other applications that may arise.

Mr. Bowersox thanked the Committee members for their active participation. He thanked Ms. Renee Pullen, Ms. Eracenia Kennedy, Dr. Bette Siegel, and the NASA audio-visual team for their support. Dr. Siegel thanked everyone from the Kennedy Visitor Center for their help.

Adjourn Public Session

Dr. Siegel adjourned the meeting at 12:00 p.m.

NASA ADVISORY COUNCIL
Human Exploration and Operations Committee Meeting
Kennedy Space Flight Center
The Debus Conference Facility, Atlas/Redstone

AGENDA

Wednesday Nov 29, 2017

NAC HEO COMMITTEE PUBLIC MEETING

10:00– 10:05	Call to Order, Welcome & Opening Remarks	Mr. Ken Bowersox & Dr. Bette Siegel
10:05- 10:15	Welcome to KSC	Mr.Robert Cabana
10:15-11:10	Human Exploration and Operations Overview	Mr. Bill Gerstenmaier
11:10-12:10	ISS update, accomplishments and future	Mr. Sam Scimemi
12:10- 1:30	***Working Lunch – non FACA***	
1:30 – 2:30	Exploration Systems Division	Mr. Bill Hill
2:30- 3:30	Commercial Crew and Launch Readiness Process	Ms. Lisa Colloredo
3:30-3:45	***Break***	
3:45- 5:00	Discussion and Recommendations	
5:00	***Adjourn***	

NASA ADVISORY COUNCIL
Human Exploration and Operations Committee Meeting
Kennedy Space Flight Center
The Debus Conference Facility, Atlas/Redstone

Thursday Nov. 30, 2017

NAC HEO COMMITTEE PUBLIC MEETING

8:30 – 8:35	Opening Remarks	Dr. Bette Siegel / Mr. Ken Bowersox
8:35 – 9:00	Power Propulsion Element Status	Dr. Michele Gates
9:00- 9:45	Future Human Exploration Planning Deep Space Gateway and Transport Concept Status	Mr. Jason Crusan
9:45 – 10:30	Advanced Exploration Systems Update	Mr. Jason Crusan
10:30 – 10:35	Public comments	
10:35-10:45	Break	
10:45-12:00	Discussion and Recommendations	
12:00	Adjourn public session	

Dial-In and WebEx Information

PUBLIC SESSION

Telecon Number: 1-888-324-9238
Toll Access: 1-517-308-9132
Telecon & Toll Participant Passcode: 3403297
Webex
WebEX Number: 993 268 960
WebEx Passcode: Exploration@2017

****All times are Eastern Time****

Human Exploration and Operations Committee Membership
November 2017

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

Human Exploration and Operations Committee
Kennedy Space Center
Debus Conference Facility
Cape Canaveral, Florida

November 29-30, 2017

MEETING ATTENDEES

HEO Committee Members:

Bowersox, Kenneth, *Chair*	Aerospace Consultant
Siegel, Bette, *Executive Secretary*	NASA Headquarters
Bartell, Shannon	Aerospace Consultant
Chiao, Leroy	Aerospace Consultant
Condon, Stephen "Pat"	Aerospace Consultant
Cuzzupoli, Joseph	Aerospace Consultant
Gardner, Ruth	Kennedy Space Center
Holloway, Tommy	Aerospace Consultant
Lopez-Alegria, Michael	Commercial Spaceflight Federation
Sieck, Robert	Aerospace Consultant
Smith, Gerald	Aerospace Consultant
Voss, James	University of Colorado, Boulder

NASA Attendees:

Hill, Bill	NASA Headquarters
Scimemi, Sam	NASA Headquarters
Geyer, Mark	NASA Headquarters
Gerstenmaier, William	NASA Headquarters
Finch, Josh	NASA KSC
Griffin, Amanda	NASA KSC
Matthews, Derrick	NASA KSC
Colloredo, Lisa	NASA KSC
Chevalier, Mary Ann	NASA KSC
Pullen, Renee	NASA Headquarters
Cabana, Robert	NASA KSC
Gates, Michele	NASA Headquarters
Smith, Marshall	NASA Headquarters
Crusan, Jason	NASA Headquarters

Other Attendees:

Clark, Stephen	Spaceflight Now

Ketcham, Dale	Space Florida
Harwood, Bill	CBS News
Sanders, Patricia	ASAP (Chair)

TELECON ATTENDEES

Aaron Oesterle	Polispace
Al Conyers	NASA
Allen Li	House Science Space & Technology Committee
Andrea Riley	Nasa HQ
Bill Harwood	CBS News
Bob Dilee	Boeing
Branscome	NASA Consultant
Brian Card	NASA
Tyler McCullette	Health Science Committee
Chris Gilbit	VE Consult
Chris Moore	NASA
Cindy McMillan	NASA Commercial Crew Program
Dan Black	White House Office of Management and Budget
Dan Cooper	Dialogic Imaging Consults
Dan Shorey	OMB
Dan Thomas	NASA
Daniel Lentz	Unaffiliated
Dave Huntsman	NASA Glenn Research Center
Tony Reichhardt	Air and Space Magazine
Deann Reilly	Boeing Company
Debra Ludban	NASA JSC
Gail Allen	NASA HQ
Helen Grant	NASA HQ
Tabitha Thompson	NASA
Tim Finkel	NASA
Jennifer Read	NASA JSC
Jim Gray	Mars Inc.
John McManamen	NASA HQ
Kathryn Hamilton	NASA
Katie Boggs	NASA
Katie Spear	NASA
Steven Witkowski	Moog
Steven Seisloff	Boeing Houston
Kiersten White	NASA HQ
Linda Karanian	Karanian Aerospace Consulting
Lynn Loewy	NASA HQ
Marc Selinger	Defense Daily
Marcia Smith	Space Policy Online.com

Marguerite Brodwell	NASA HQ
Mark Mozina	ULA
Marshall Smith	NASA HQ
Mary Faller	NASA
Mary Lynne Dittmar	Coalition Ford D Space Exploration
Maryanne Chevalier	NASA Commercial Crew Program
Meredith McKay	NASA
Michael Ching	NASA
Mujoud Merancy	NASA
Nicholas Cummings	US Senate
Philip Floss	NASASpaceflight.COM
Rebecca Regan	Boeing
Susan Reddy	Unaffiliated
Renee Pullen	NASA
Richard McKinney	Independent Consultant
Richard Rogers	Steller Solutions Inc.
Rick Irving	NASA
Robyn Gatens	NASA HQ
Ryan Faith	House Space Subcommittee
Ryan Stott	US Government Accountability Office
Sam Gray	Mars Inc. correct
Stephanie Sherhultz	NASA
Sarah Brown	Boeing
Shaun Daly	NASA

Human Exploration and Operations Committee
Kennedy Space Center
Debus Conference Facility
Cape Canaveral, Florida

November 29-30, 2017

LIST OF PRESENTATION MATERIAL[1]

1) Human Exploration & Operations Mission Directorate Overview [Gerstenmaier]
2) International Space Station Status and Transition [Scimemi]
3) Commercial Crew and Launch Readiness Process [Colloredo]
4) Exploration Systems Development Status [Hill and Smith]
5) Power Propulsion Element Status [Gates]
6) Future Human Exploration Planning: Deep Space Gateway and Transport Concept Status [Crusan]
7) Advanced Exploration Systems Update [Crusan]
8) Multi-User Spaceport: From Vision to Reality [Cabana]

[1] Available at: https://www.nasa.gov/directorates/heo/nac-heoc