

**NASA ADVISORY COUNCIL (NAC)
Exploration Committee**

FINAL MINUTES: Public FACA Session

Meeting Date: September 21, 2010

AGENDA:

- Human Research Program and the Risk Process
- Exploration of Near Earth Objects (NEO) Objectives Workshop (Explore NOW)
- Global Point of Departure – Exploration Architecture & Other Agency Partnerships
- Status of Commercial Crew/Cargo Activity

ATTENDING:

Exploration Committee: Richard Kohrs (Chair), Nancy Ann Budden, Bo Bejmuk, Les Lyles, John Logsdon, David Longnecker, Bette Siegel (acting Executive Secretary), Jane Parham, Shawanda Robinson (Administrative Officer), Carolyn Griner, Richard Malow

Members Absent: Joe Cuzzupoli

NASA: Linda Andruske, Francesco Bordi, Steve Davison, Dennis Grounds, John Guidi, Jitendra Joshi, Margaret Keiffer, Ruthan Lewis, David Liskowsky, Phil McAlister, Anna McFadden, Kathy Nado, Benjamin Neumann, John Olson, Victor Schneider, Marcietta Washington

Public: Bill Beckman, Devin Bryant, Andreas Diekmann, Alain Dupas, Walt Faulconer, Amy Klamper, Jean Kranz, David B. Smith, David Young

(See detailed list, p. 7)

OUTCOMES

Recommended Action for ESMD – No. 1:

The NAC Exploration Committee requests from NASA EMSD information in the form of three charts: Our intention is to map, illustrate and contrast the high level critical research and technologies that are required for missions to LEO, the Moon, Mars, and NEOs. Intuitively it seems that the critical technologies will increase in number and difficulty as the destinations increase in distance and mission duration.

- (1) The first chart is already assembled, and was distributed to the Committee September 21, entitled: "Consistent set of Exploration Capability Investments" (Doug Cooke).
- (2) The second chart maps required critical research and technologies (left axis) against destinations (right hand axis) LEO, Moon, Mars, NEOs.
- (3) The third chart overlays innovative technologies that may be required or valuable over the same destinations.

Once we have examined and made any changes, we will share these charts with the NAC Technology and Innovation Committee.

Recommended Action for ESMD – No. 2:

RATIONALE:

Dr. Dennis Grounds briefed the NAC Exploration Committee on the risk assessment process that is used by the Human Research Program (HRP) to categorize risks related to human space flight and thus guide future areas of focus for HRP initiatives.

The Committee was pleased with the focus and effort devoted to crew health and safety, and with the depth of engagement of outside experts to assist NASA HRP staff in assessing the risks related to human space flight. The Committee noted that the risks are currently stratified into one of three categories, reflected as Red-Yellow-Green, and they are further stratified relative to design reference missions for Moon and Mars. The Committee finds that further work will be required to guide both the HRP strategic agenda and its timelines. More detail will be required to fully understand the extent of the “gaps” for those risks in the yellow and red categories, and the risks will need to be reevaluated and assessed for new design reference missions (e.g., flights to NEO objects), if such missions receive final approval and budget support

Action to ESMD:

The Committee recommends that the human health risks be further classified by defining the current CRL (countermeasure readiness level) and/or TRL (technology readiness level) associated with each risk, and associating these readiness levels with each risk classification. Such classification will better inform strategic research planning decisions, including both timelines for action and funding priorities. Further, the committee recommends that HRP perform similar risk analyses related to newly identified exploration missions (e.g., NEO), after there is clear definition of NASA’s mission strategies and funding priorities.

Recommendation No. 1:

RATIONALE:

The NAC Exploration Committee is pleased with NASA’s active engagement in seeking Interagency Partnerships. These efforts are critical in leveraging the innovations, capabilities, and resources necessary to develop the technologies for future space exploration missions.

While excellent communications are taking place at the technical levels amongst government agencies, the Committee feels that these cooperative efforts can be enhanced, and strengthened by gaining support from the top leadership of the appropriate agencies, such as DoD.

RECOMMENDATION:

NASA should seek opportunities to collaborate on technology development with the Space leaders at DoD, the Air Force, and other agencies. In particular, the Administrator should brief the DoD “Partnership Council” [Secretary of the Air Force; Commander of Air Force Space Command; Commander of Strategic Command; and Director of the National Reconnaissance Office] on NASA’s technology needs for space exploration and discuss opportunities to co-invest in complementary technology developments that can satisfy the common goals of reliable, affordable access to and through space.

Recommendation No. 2:

RATIONALE:

The June 28, 2010, National Space Policy calls for promoting “appropriate cost- and risk-sharing among participating nations in international partnerships” and augmenting U.S. capabilities “by leveraging existing and planned space capabilities of allies and space partners.” The first round of NASA planning for a NEO mission carried out by the Human Exploration Framework Team (HEFT) did not account for potential international participation, but NASA in the second round of HEFT activity that is just beginning intends to factor in potential international contributions. Reversing a NASA policy in place since late 2005, international partners will be able to contribute to the “critical path” in the transportation system required for a NEO mission, in addition to contributions to exploration activities at the

NEO. Having significant international contributions may be essential to making NEO and other deep-space missions affordable, given projected NASA budgets over the next 10-15 years. The Exploration Committee is encouraged by the approach set out in the National Space Policy and commends NASA for actively seeking international engagement in exploration planning.

RECOMMENDATION:

The NAC recommends that NASA pursue a policy that, considering the U.S. space industrial base and broad national security interests, invites potential partners to contribute to all aspects of the exploration architecture. In the exceptional case, where appropriate, partnerships on the critical path elements of the deep space transportation system should be considered.

Recommendation No. 3:

RATIONALE:

The future success of a commercial crew Low Earth Orbit (LEO) access vehicle in attracting customers other than NASA will depend in large measure on the recurring cost of operations. NASA is planning to co-fund the development cost and later buy seats on the commercial provider's transportation system. It is in NASA's and commercial provider's interest to drive the cost of operations as low as possible in order to attract other customers and to avoid a scenario where NASA is the only customer able to afford the service. It is therefore of paramount importance to incentivize the commercial developers to design the transportation system with cost of operations sufficiently low to attract other customers in addition to NASA.

RECOMMENDATION:

NASA should develop operability incentives for the acquisition of commercial crew capabilities. These incentives should drive commercial partner design to include features resulting in recurring cost of operations low enough to attract other customers in addition to NASA.

ACTIONS

NAC_10-0921_001: John Olson. Provide Committee a chart on the number of NEO's discovered.

DISCUSSION

Human Research Program and the Risk Process

Dennis Grounds, Program Manager of the ESMD Human Research Program, reviewed space exploration human risks background and the overall human risk management process, explaining the nature and diversity of human system risks in exploration missions, how the risks are base-lined and changed, the "scoreboard" showing status of research and management of these risks, and the relationship to other exploration risks.

Discussion Points

- The Human Research Program (HRP) helped the Constellation Program understand the risk of combination of vibration and acceleration, specifically what will happen to the human system at launch in a vibration environment.
- HRP produced the standard that went into the safety requirement regarding toxicity of lunar dust, which requirement will be ready for Constellation this year. Mars dust risk is not well characterized yet, as no samples have been returned for analysis.
- A requirement that is complete indicates the risk is controlled and there is a medical procedure established. A risk that is not fully understood includes a medical operations

procedure to monitor the crew for that. A pre-recognized treatment is identified but is not considered to be fully effective.

- Newly discovered visual issue is under research. It does not happen to all astronauts, or in both eyes.
- Even risks that are at the threshold of being declared controlled have work that can still be done to fully understand the risk and how to treat it. We have a long way to go to get the risks addressed for longer-term missions, with some a few years away and some twenty years away.
- Dr. Longnecker added that in terrestrial care, you don't necessarily fully understand a disorder before you treat it or develop countermeasures.
- The NASA standards document for reference concerning human risks is the SPACEFLIGHT HUMAN STANDARDS, VOL 1 and 2, kept in the NASA Standards Library. These standards were not used for Orion originally. Volume 2 was tailored for Orion.

Exploration of Near Earth Objects (NEO) Objectives Workshop (Explore NOW)

Dr. John Olson, Director, HQ ESMD Directorate Integration Office, presented a summary of this workshop, held August 10-11, 2010, in Washington DC. 175 participants registered onsite and another 1700 viewers participated via webcast worldwide. Workshop goals were to increase the collective knowledge and understanding of NEOs; to communicate to the world NASA's plans for a human mission to a NEO; and to capture external input on human mission objectives.

Discussion Points

- The workshop touched on planetary defense and had participants from the U.S. Department of Defense (DOD).
- The Committee wanted data on the number of NEO's discovered. Dr. Olson will provide a chart on this subject. **(Action 001)**
- Teams are currently looking at relevance of human NEO missions.
- NASA Jet Propulsion Lab is building the official catalog of NEOs discovered. The latest discovery report is 374 NEOs 100 meters or larger with a possible trajectory toward Earth.
- Cost is prohibitive for mining valuable metals on NEOs. Mining interests have actively participated in looking at moon as source of valuable metals.
- At the workshop, there were two roundtables, one with internationals and one with agencies. Some said NEOs were not interesting; others thought there is interesting science there.
- Japan is interested in a Hayabusa 2 mission. Russians expressed interest in Apophis predicted Earth encounters in 2029 and 2036 and wanted to send a mission to Apophis. Vigorous dialog on international side. This was a start, and it will continue in broader, multi-destination meetings.
- Definition of "keyhole" – a point in the trajectory of a NEO when you discover whether it will head to Earth.
- Dr. Logsdon pointed out that there have been three international conferences on planetary defense, and that there is a group trying to get the U.N. to pass a treaty on what to do if a threat is deemed to be immanent.
- Ms. Budden observed that in considering different destinations, whether LEO, Moon, Mars, asteroids, the common denominator is knowledge and technology. Dr. Olson added that the capabilities invested in NEO are extensible to the Moon and Mars.
- Dr. Longnecker noted an aspect that may be missing downstream in terms of human exploration. By focusing on NEOs, we are focusing on zero gravity environments. Lunar habitation was attractive to many members of the exploration and scientific communities because of the opportunity to study effects of partial gravity on the human system.

Global Point of Departure – Exploration Architecture & Other Agency Partnerships

Dr. John Olson, Director, HQ ESMD Directorate Integration Office, presented an overview of NASA partnerships – international, with other US Government agencies, with scientific and academic communities, and with commercial entities. He reviewed the international partnership strategies and architecture for human lunar exploration and the current activities and plans of the International Space Exploration Coordination Group (ISECG). He also provided a look at ESMD's international partnership status and partnerships with Other Government Agencies to leverage their capabilities and infrastructure.

Discussion Points

- Missing from recent ISECG meeting were China, Russia, India, and Australia. However, China, Russia, and India sent representatives from their embassies; and India pledged to join.
- Incorporation of international considerations into HEFT is under discussion currently. ESMD is attending Technical Interchange Meetings with international partners to get their input. We are also looking at surveys and several other mechanisms. It is a delicate balance. NASA has to maintain its stance yet involve international participation before they feel they are given only the leftovers.

Status of Commercial Crew Activity

Mr. Phil McAlister, ESMD Commercial Crew Planning Lead, provided an overview and status of NASA's Commercial Crew Initiative, touching on the future state of the vision of commercial human spaceflight to Low Earth Orbit (LEO), the objectives, approach, and framework of the Initiative, insight and oversight methodology, ISS Goals, the Concept of Operations, and the timeline. The commercial crew initiative is designed to meet the objectives of satisfying NASA's ISS crew transportation needs and enable the growth of a commercial human space flight industry for use by NASA and other customers.

Discussion Points

- Commercial Crew capabilities do not yet exist, so first phase is development, with demonstration and testing: 2011 - 2015.
- Final decision on acquisition strategy has not been made. Commercial business models as well as government contracts are in the trade space.
- Responsibility for safety is still on the government. Suppliers will have to meet NASA requirements for Human Space Flight Certification.
- Determination has not yet been made concerning certification vs. licensing. Even with FAA licensing, NASA certification will still be needed for the gap not covered by FAA.
- The NASA Human Rating Certification Document is expected to be baselined by the end of September.
- A business case analysis would be too specific. We can say there is a definite demand for human space flight in LEO, which has existed for the last 30 years. No one knows how big the market will be, because it is price point dependent. Studies suggest that demand might be 60 passengers per year by 2020.
- A key consideration that enabled the Commercial Crew Initiative to go forward is the decision to extend ISS until 2020.
- Insight/oversight approach is only for development phase. We have not yet outlined the services phase approach. The NASA Launch Services Program is our model.
- Mr. Bejmuk advised that saving money in development can make operations more complex and costly. Design should be constrained by how well it will operate, not just to make development and certification easy.

- The winning contractor will have to be responsible end to end and will have to meet schedule, costs, and safety requirements. NASA will provide continuous insight with discrete oversight, which is reverse of the old way.
- We are still assessing whether the Crew Rescue Vehicle will be done by commercial providers.
- We do not anticipate the flight director being a NASA employee. If we see a safety issue, for example something gets into the ISS keep-out zone, then there will be a handover to NASA as flight director.
- NASA will not be buying a mission, we are only buying seats. NASA is not dictating the launch site.
- NASA should not dictate a concept of pressure suits. That might eliminate a more innovative and cost-effective idea. This is a cultural change for NASA. We don't want NASA on the critical path, because it will be subject to appropriations.
- NASA will both pay for specific things and cost-share total cost with the provider. It is co-investing rather than purchasing. NASA will not take delivery of any items.
- During the next five years, we will rely on Soyuz.
- Commercial transportation of humans to space is within reach, and it is a great development for NASA and the nation. NASA's stakeholders want NASA to be in the exploration business, not LEO transportation business.
- The program planning office will be at Kennedy Space Center, with deputy at Johnson Space Center. This is a new way of doing business. Lead is Ed Mango at KSC, deputy is Brent Jett at JSC's astronaut office. We will draw on the Center strengths.
- There is a strident debate going on in the public domain concerning the Commercial Crew Initiative. NASA would appreciate the support of NAC; change management requires support across the board.
- Mr. McAlister stressed that nothing presented today should be interpreted as criticism of NASA previous operations. NASA has provided amazing safe and reliable systems.

FUTURE BRIEFING SUGGESTIONS:

- Precursors – robotics, analogs
- ESMD participation in science missions, with joint meeting with NAC Science Committee
- HEFT II
- Skunk works at NASA centers - JSC

See next page for Attendees other than Exploration Committee Members.

Presentation charts and materials will be posted on the NAC Exploration Committee web site:
<http://www.nasa.gov/exploration/about/explorationcommittee.html>

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