NASA Advisory Council Space Operations Committee

September 13 & 14, 2010

Johnson Space Center

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CONTENTS

September 13, 2010

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September 14, 2010

Meeting Report Prepared by:

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September 13, 2010

Participants

NAC SOC Members Present

Col. Eileen Collins, *Chair*
Mr. Jacob Keaton, *Executive Secretary*
Dr. Pat Condon
Dr. Leroy Chiao
Mr. Tommy Holloway
Mr. Glynn Lunney
Ms. Joanne Morgan [*via telephone*]

Others Present

Laura Atkinson
Mark Carreau, *Aviation Week & Space Technology*
Dennis Grounds
Sam Henderson
Sue Leibert
Mike Shaw
Kevin Templin
Winfield Swanson, *rapporteur*

JSC Site Visit/Fact Finding (non-FACA)

Committee members visited the Atmospheric Re-entry Demonstrator (ARD) Simulations and System Entry Structure (SES) Dome facilities, the Robonaut-2 lab, and the Advanced Suit Lab. And the Astronaut Rehabilitation Facility

Presentations

Mr. Keaton opened the meeting at 1:11 and read the Federal Advisory Council Act (FACA) notice; specifically, each committee member was appointed by Administrator Bolden for his or her expertise, and all comments are on the record.

Col. Collins welcomed everyone and reminded them of this committee's mission, namely to advise the NASA Administrator formally and informally on how NASA can best fulfill its mission with the allotted resources, this committee's emphasis being space operations.

International Space Station Updates (FACA)—Mike Suffredini

Mr. Suffredini began with an explanation of his tactical chart of crew rotation, port utilization, and launch schedule from August 2010 until May 2012. They use 4 Soyuz for 2 increments, and each crew covers 2 increments. Expedition 24 began in the summer of 2010. The advantage of overlapping schedules is that the commander will have experience with the crew before a new crew takes over. Commander Yurchikhin will continue until October 24 when Commander Wheelock takes over. A 6th crew will serve Expedition 25. (delete this last sentence: "A 6th crew…")

To make room for the ULF4, they brought a new docking model that extended the Nadir port and moved Soyuz off the docking module. The big task was to install and activate the mini-research module (MRM). Subsequently, Russian extra-vehicular activities (EVAs) were completed. Of the 16 Expedition 24 objectives, all major tasks were completed, but some tasks were deferred, i.e., 6 were completed, 5 were deferred (awaiting contingency EVAs, lower priorities, or launch delay), 2 (including the Soyuz 22 return) are scheduled, and 1 (MRM outfitting and hardware

configuration) is continuing. Plans for Expedition 24 include operation of 127 integrated experiments in biology and biotechnology, Earth and space science, education activities, human research, and physical and materials sciences and technology. Experiments will support the work of more than 400 scientists. The ISS has 23 research facilities and now 4 new facilities have been delivered. NASA also needs to communicate what the scientists have done with the facilities on orbit. Since December 1, 2009, NASA had 29 experiments and international partners (IPs) had 49. Expedition 23/24 plans 133 experiments (72 NASA and 61 IP); NASA is now at number 42.

- *Col. Collins* noted that the Space Operations Committee had recommended last summer that NASA look at non-traditional means ways of reaching the business community to inform them of the ISS opportunities. *Mr. Suffredini* said there had been a huge push on that, but NASA has a long way to go, both to engage public interest and to get the National Lab going.

- In response to *Dr. Condon*, *Mr. Suffredini* said use of the ISS is important to Headquarters, but the bigger push is to get beyond the aerospace industry. The National Lab will reach more and more communities. NASA outreach activities—ham radio, Facebook, etc.—reach thousands of kids. *Dr. Condon* observed that, although NASA employees cannot lobby Congress members, they have education people who talk to their congressional representatives. *Mr. Suffredini* thought NASA needs to make ISS an asset everyone thinks about every day, so people will use it more.

Of the 272 investigations that have occurred on orbit, more than half have been completed. The European Space Agency (ESA) appears to have a higher percentage of research completed, but the accounting does not accurately represent this.

- *Mr. Suffredini* responded to *Dr. Chiao's* question about resupply stowage platform (RSP) utilization: Russia does not do as much research as we do; they have more external and commercial use than internal research. Their design to date has been geared to survival, but they are making good use of their segment, research module (RM) 1 and 2. The Multi-Purpose Laboratory Module (MLM) will be Russia's primary research module, which they hope to fly during 2012.

The 24 Soyuz/Expedition 25 research will continue until November 30. During this time, 3 Russian EVAs, primarily for research, will be done. EVA 27 will take things out, e.g., of the 11 panels around the exterior, 2 will be returned on ULF6. From September 2010 to September 2011, 6 Progresses and some commercial vehicles are scheduled.

- In response to *Dr. Condon*'s question, *Mr. Suffredini* said he thought legislation will mandate extending the life of the ISS to 2028. Therefore they reviewed the structure to see if they could get 30 more years out of it, although it was designed for 15 more years. Many parts can be replaced on orbit, but some cannot. They examined actual life in addition to planned life. The main limiting factor is fatigue life. They manage ISS to have no overload, but seals can fail just because of age. High fatigue areas occur where the truss attaches to the lab and where the power boxes are located for the ISS to fly. They do everything at 4 times life, and they will have to do a special analysis on that component.

The big driver is ascent load. Structurally they will have no problem because our Russian colleagues over-design everything. *Dr. Condon* wondered why they selected 2028. *Mr. Suffredini* said it signifies an exercise to extend life. Structurally, they think they can get twice the life, so they analyzed all other components to see whether they can get twice the life from them. That is how they arrived at the year 2028. (However, the mandate is not yet in place.)

All ULF5 astronauts were increment crew members on ISS. They will bring up and install the Permanent Multipurpose Module (PMM), the Express Logistics Carrier 4, and critical spare components. Space X demonstration #1 is scheduled for October, #2 for April, and #3 for May or June, but the last 2 flights may be combined to maintain the schedule. Space X started flights in August. The Federal Aviation Administration (FAA) has responsibility for safety of the surrounding community. NASA is responsible for the success of the mission.

- *Mr. Holloway*: How will NASA monitor a commercial vehicle and what is the strategy for commercial vehicles? *Mr. Suffredini:* Once they get the hardware, commercial vehicles are subject to the same safety requirements as NASA vehicles. They tried to separate issues that concern NASA in terms of mission requirements, e.g., safety requirements. These used to sit with NASA, but now NASA participates only in the verification process, i.e., decides what steps they have to take to verify, but NASA is not overseeing them while they do it. Industry has to specify how they will do it and NASA has to approve that (or not), similar to the process with the automated transfer vehicle (ATV). NASA also had a flight director working with ATV for years. Ensuring that they comply with verifications differs from NASA actually doing it. NASA allows mission success to be industry's responsibility. They don't get fully paid unless they succeed, but if they fail, NASA loses its logistic position.

- *Dr. Chiao* asked whether more live H-II transfer vehicles (HTVs) or ATVs were expected. *Mr. Suffredini* said the Japan Aerospace Exploration Agency (JAXA) played the role of verifying many requirements, and NASA has the same kind of involvement. A piece of the process is the initial design review, and NASA does not get involved with that. Nevertheless, safety requirements remain the same.

- *Dr. Condon:* Is it acceptable to lose a portion of mission success? How realistic is it to assume that the schedule will remain intact? *Mr. Suffredini* thought that Space X, Orbital, ATV, and HTV would give enough redundancy to ensure total success. The challenge of the 2012 period is that, if we lose a mission, it is in the transition phase and implies other delays. Flying regularly would prevent this. Space X will allow regular return of materials to researchers. *Col. Collins* asked about the possible June shuttle flight. *Mr. Suffredini* said, if everything flies on time, it will not be needed, but he wants it because he thinks everything will not fly on time.

In July, the External Active Thermal Control System (EATCS) Loop A pump failed, and with its demise went about half the DC-to-DC converter units (DDCUs). They got some backup power for the ISS Robotic Arm for the repair EVA. But, they underestimated the amount of work required to repair the pump, so 2 more EVAs remain undone. In 3 EVAs, they got the pump out

losing only 17 lb or 3% of the ammonia. Its performance is comparable to the other pump and to its performance prior to the failure. They have done a fault tree and have no recommendations for changing operations other than to make sure that everyone is looking at all aspects of the their systems; that change was made across the board.

Water coming out of water processor assembly (WPA) and out of the dispenser shows that total organics were steadily climbing, so they are now about halfway to the limit. Changing the multi-filtration bed resulted in a leveling off of the organics. Meanwhile, they are using the water and trying to sort out the problem. Pressure in the oxygen generator assembly (OGA) was rising. Material is thought to come from the pump, but it was coming from the screen. It is good to have an accurate reading mechanism. They are using Advanced Controls Technology Experiment (ACTEX) and want to refilter the water periodically. They will be bringing the Dome Orbit Replaceable Unit (ORU) home. Long-range, Mr. Suffredini thinks they will overcome all these problems.

For carbon dioxide removal assembly (CDRA), atmosphere revitalization (AR) racks were relocated to their permanent position the week of September 6, and 2 replacement CDRA desiccant/absorbent beds will be brought in. Finally, ISS top program risks have been categorized; and the Gagarin Cosmonaut Training Center (GCTC) transition from military to civilian is underway.

Space Shuttle Program Status—John Casper

The flight manifest shows seven flights from May 2009 to May 2010. During this time NASA set records again and again—fewest problems, lowest amount of debris, fewest interim problem reports (IPRs). This results from good teamwork and no major hurricanes. The team members are passionate about what they want to do, and they work best when they're flying.

Atlantis completed its 32nd and final planned mission (STS-132) May 26, 2010. Almost 29,000 lb of hardware was transferred and 8,000 lb was returned aboard Atlantis. As of September 2, the planning manifest lists flight 133 (ULF5), which was moved from September to November 1; and 134 (ULF6), scheduled to fly February 26. A possible mission, 335, is configured to bring down the pump for failure analysis in June. But, the working assumption is that the final launch will be in February.

- *Dr. Condon* asked about the backup plan if 335 is flown. *Mr. Casper* said they would use Soyuz as usual. It would take about 3 missions to get 4 crew members down, but there are plenty of supplies. Essentially it is a Soyuz rescue rather than a Shuttle rescue. *Dr. Condon:* What if an anomaly occurs such that the spacecraft cannot get to the station? *Mr. Casper:* There are no plans for that because the Shuttle would not be able to get there in time either. But, *Mr. Suffredini* added, the Russians are working on a modification.

The transition Space Shuttle retirement is on schedule. All flight units have been shifted to Kennedy Space Center. The plan is to put ET122 on flight 134, although some modifications have not been completed. More than 800 suppliers will be shutting down to end the program. After 2006, the workforce had been increased to nearly 14,000. The decrease began in October

2008, and today there are about 8000 employees (exclusive of contractors), all but a few hundred of whose positions will be eliminated by January 2011. There is no approved funding plan, but this is the plan they would execute if the last flight were indeed in September. Contractors have already announced their October lay-offs.

- In response to *Col. Collins, Mr. Casper* said the apparent increase in numbers results from the anomaly of how people charge hours during holidays.

The plan is to end major activities by 2012. Before February, key assumptions for the last 4 or 5 years were to finish and send people and material to Constellation; when they get a new plan they will begin feeding people into it. By the end of 2012, orbiters and other equipment will be taken to museums. More than a million line items of hardware have been reviewed; about 42% would have been transferred to Constellation, so now its disposal is under discussion. As for real property, the KSC transfers support the 21st Century Launch Complex and future Agency programmatic use; the Michoud Assembly Facility (MAF) is to be maintained at a customer tenant-ready (CRT) level through FY2011.

From the beginning, there has been a close partnership among the program, Agency, and Centers; projects and contractors; and local and state agencies. All have focused on collaboration, retaining best practices and lessons learned, and updates from the Agency. Communication is critical. They have used Web sites as rumor-busters and gotten feedback from surveys and other methods. The top risk is maintaining critical skills so NASA retains enough people, both Agency and contractors, to fly the remaining flights. Employees remain loyal to the program and attrition is remarkably low.

At the same time training and assistance is being offered to supervisors and employees, focusing on career development and skills assessment. Stress management and transition/change management workshops are also being offered. Meanwhile, we are monitoring the situation, developing contingency plans, and keeping up morale. Monitoring is being done by meeting twice yearly with prime contractors to assess and discuss best practices, monitor critical skills, and assess bench strength. Written into their contract is the area of emphasis for which they must track critical skills.

Buildings, such as the Palmdale facility, are being torn down and the land returned to its previous use. Platforms to go around the orbiter were demolished and sold for scrap. The MAF processing building has been emptied and tooling is in temporary storage. The part of Lockheed Martin that rendered custom Reinforced Carbon-Carbon (RCC) components in Dallas has closed.

All managers have been working on this transition for several years. Overall, the #1 goal is to fly the remaining missions safely and successfully. Top program risks are being identified and worked as a high priority. Retention of critical skills is a major program emphasis, and program resources are allocated to mitigate, control, and reduce these risks. People will be transferred into a new organization headed by Dorothy Rasco, program manager for the transition.

Commercial Crew to ISS (FACA)—Mike Suffredini

There are 2 aspects to a commercial resupply services (CRS) vehicle: the service phase and the development phase. The service phase addresses what we require; development is another discussion. Commercial crews offer the capability to transport crew members to and from ISS with rescue capability, dissimilar redundancy for crew transportation, potential cost reductions, and the opportunity for NASA to reassess, streamline, and restate requirements. It is a way to streamline the definition of requirements; NASA is trying to step back from directing to defining requirements. The ISS Program is working with the Commercial Crew Planning Office to distill the crewed vehicle requirements from numerous policies and documents into a single document of clearly stated key requirements. All level-1 requirements are included.

- *Dr. Condon* noted that the decision has not been made whether to have a "taxi service" approach or a "car rental" approach, and that decision will affect these discussions. *Mr. Suffredini* observed that there is an advantage to having diverse crews.

High-level crew transportation requirements are: as many as 4 crew members safely transported to ISS and returned every 6 months with early access to medical care and rescue. For instance, if a spacecraft were built that only lands on water, rescue capability would be limited. The USOS portion of the ISS was designed for 4 crew members, but international partners must also be considered. More frequent flights would have a major impact. It is predicted that by 2017, ISS will not be fully utilized because of lack of crew availablity. Meanwhile a balance must be maintained between frequent and infrequent rotation from a logistics point of view. Every visiting vehicle comes with engineering, operations, and time costs and impacts. In a 1-year period, 18 vehicle—6 Progresses, Space X demos, Orbital demos, etc.—will be flying to ISS, but every time a flight arrives it engenders a huge amount of work that takes time away from research. Indirect handover can be done when they mix the crews. Over 6 months, 6 crew members will rotate. Flying 3 or 4 spacecraft per year appears to be more lucrative than flying 2 per year, but it complicates the logistics on board, which detracts from research time. Crews need about 6 weeks to become effective and efficient.

Orion stays docked during this 1-year period, so air must be kept flowing. The work comes with docking and undocking. A huge amount of logistical work is incurred by adding these flights to ISS. A big advantage to partnerships is the rotation. The budget discussion will be a big factor because the partners signed on assuming we would have 4 crew members on ISS. At that time, the Shuttle was flying regularly, so their crews did not get as many opportunities to fly to ISS.

- *Mr. Holloway* asked what the verification plan for commercial personnel is and requirements vs certification and verification. *Mr. Suffredini* reported that they have written requirements for human aspects. *Mr. Holloway's* concern is that it is easy to decide requirements, but what about certification and verification and who will participate. FAA has responsibility, insight and oversight, for communities on the ground. NASA's role will be different. Also, FAA is not using the philosophy NASA is changing to, and FAA is painfully specific about requirements for airplanes. Therefore FAA and NASA will both have to evolve into this process. *Mr. Suffredini* sees 2 fallacies: commercial can do it quickly, and NASA can provide requirements that are clear and concise overnight. Now the question is verification. Oversight vs insight needs

to be discussed and decided. There is a lot of work to be done before specifications can be set—it is a big, big challenge. Until we sit down and decide verification for each requirement, the job will not be done. For some requirements, you do oversight and for some, you do insight. But between insight and oversight is a huge chasm. The question is what strategy the Agency should take.

- *Mr. Suffredini* agreed with *Mr. Lunney* that it is not just up to NASA to figure this out. NASA is trying to get populations in place so they can have this discourse. *Mr. Lunney* recalled that both he and Mr. Holloway had a similar situation 15 years ago, which was very difficult even though they knew who the players were. *Mr. Suffredini* predicted that no commercial crew vehicle will fly to ISS in 2013.

The biggest challenge is the uncertain budget. Beyond that, increased demand on crew time has put them behind the curve in the first month of change, which could affect National Lab work. Research on ISS may become more than 50% U.S. Logistics are problematic, but crew availability is an even greater problem. The ISS program, with industry, will continue to define the ISS requirements for a crew transportation and rescue vehicle and develop a docking system with delivery on orbit by 2014. Meanwhile the program will continue to streamline ISS processes to increase utilization for National Lab and commercial customers. The schedule is fine for today's mandates, but if there is an advantage and money is available, how will an increased workload affect crews?

- In response to *Col. Collins*, *Mr. Suffredini* said, even if 2 commercial vendors are equally qualified, it will be possible to have work for only 1. Both would have to get all the way to ISS. NASA is discussing funding 2 vendors, but the cost for 1 could reach $3 billion or $4 billion.

- *Dr. Condon* noted that down-selecting to 1 would counter the government's abhorrence of sole-source vendors. Do we assume we will remain competitive with 1 vendor because the Russians are still working on it? *Mr. Suffredini:* The choice will be made after 2 commercial companies go to the demonstrations; then NASA will select 1 based on performance. *Dr. Condon:* If the life of ISS is extended to 2028 and we have 1 commercial provider, then it may not really be a sole-source provider. *Mr. Suffredini:* Selection involves a huge amount of work for the Agency and we cannot have this conversation until vendors have been selected. We would lose dissimilar redundancy, but the cost could force that.

- *Mr. Suffredini* assured *Ms. Morgan* that these issues are communicated to all stakeholders, including the Office of Management and Budget (OMB) and Congress, as we go along.

Commercial Vehicle Crew Design (FACA)—Peggy Whitson

To have a successful commercial market, it is imperative to use NASA's experience base, and the current astronaut corps could be used for that. The Astronaut Office has submitted a letter that describes commercial crew vehicle transition concepts for flight safety, and another that describes their position on crew suits for ascent and entry. With commercial providers, we are

talking about an unknown amount of insight and oversight and we may have to accept greater risk to fly on orbit. The goal should be 1 in 1000 predicted loss of crew (LOC) during ascent and entry. This requires a booster with high ascent reliability and an abort system for crew escape. There should be full envelope abort/escape capability with no black zones.

NASA NPR 8705.2b Section 1.2.2 states, "human-rating includes incorporation of design features and capabilities to enable safe recovery of the crew from hazardous situations." This would include fault tolerance to catastrophic events (level derived from integrated design and safety analysis) and protection against fire, depression, or toxic atmosphere. As for pressure suits, in 3 instances in the past, crew members were not wearing pressurize suits—in the 1st and 3rd, all crew members died, and in the 2nd all were hospitalized. After the Challenger explosion (the 3rd), NASA required pressure suits. Ascent and entry situations are too dynamic to consider donning a pressure suit during that time, so it must be done ahead of time. Other situations in which wearing a pressure suit, despite other measures, would be life-saving are loss of vehicle pressurization, and fire or toxic atmosphere. A black zone is defined as, during powered flight, a region of the ascent trajectory from which an abort is not survivable.

Requirements for crew transport are: ISS must have continuous US presence onboard at all times. The vehicle must be able to transport a crew of as many as 4 members and must have assured crew return capability. It must have a safe haven, isolated from possible toxic environments or space debris. Red conjunctions come up at the last minute, so there is no time to move the ISS; or fires could require waiting in the safe haven, which has so far been the Soyuz. In addition, each crew must have 2 people trained to pilot the vehicle, which is consistent with commercial pilot world. These concerns make a difference for handling handoffs.

The discussion of operations philosophy has centered on 2 options, the "taxi" model or the "rental car" model. With the taxi model, you get in and someone else drives you to and from your destination, i.e., a commercial operator ferries ISS crew members. With the rental car model, you rent a vehicle to go to and from your destination, i.e., the ISS crew would be vehicle operators. The rental car is optimized for direct handover with minimal extra consumables required, and it leverages NASA's operating experience to ISS. The taxi model uses valuable up- and down-mass to support the dedicated commercial operators to fly the vehicle to and from ISS, would require additional non-NASA crew costs, and flight of an additional vehicle if assured crew return uses the same vehicle. To start the cycle, you would have to have 2 vehicles to bring the first driver back.

- *Dr. Condon:* Flight rules can be developed incorporating International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR) restrictions. NASA has 50 years' experience in mission control through to recovery. If a commercial contractor has that responsibility, and at some point NASA wants to go beyond low Earth orbit (LEO), NASA will need its mission control capability. How can that experience level be maintained in NASA? *Ms. Whitson* agreed that this is a significant question and that we do want to maintain the experience base within NASA. *Dr. Condon* suggested deciding on commercial transport to and from the ISS to maintain internal capability—it would be a trade.

- In response to *Col. Collins, Ms. Whitson* said the letters she wrote did not refer to black zones because they just stated the position of the Astronaut Office.

Key design drivers for assured crew return (ACR), which implies a safe haven to be used for immediate crew departure, either as a "lifeboat" vehicle docked to the Station for the duration of the mission or 1 vehicle for transport and a separate one for rescue; a place to escape space debris and other emergency situations (e.g., fire, toxic fumes); and a place to be used for medical emergency. All would be needed for about 6 months. Currently the US has 2 docking ports and 2 berthing ports. If ACR is separate from crew transport vehicle, it will require 2 ports at the time of swap. The design should allow flexibility for relocating the vehicle to any docking port.

If all US crews are rotating on the same vehicle, it requires on-orbit overlap time of on-coming and off-going ISS crews of 7 to 10 days for the direct handover. Decreasing the time that takes reduces use of consumables. Indirect options are feasible, but must be designed to ensure continuous US presence on station. Fewer crew member changes at any one time, but twice as many launches of crew transport vehicles are needed. Ideally, no overlap would be required or gaps would be 24 hours or less. During handover, long duration crews need time to exchange real-life, on-orbit configurations and processes, typically face to face. Discussions would include joint scheduled activities, including robotics, EVA hardware processing, and integrated oxygen and water processing.

Space flight resource management depends on training. Spaceflight involves time-critical decision making with potentially life-threatening consequences. Integrated simulations with crew members are necessary, and the taxi scenario would require supplemental training with the non-ISS crew. The Soyuz model uses 6 to 12 months for technical training. If the ACR is a separate vehicle from the transport vehicle, more training time will be required. At least 1 vehicle simulator should be located at JSC—as it is, 50% of astronauts' time is spent traveling to various countries.

The Astronaut Office encourages NASA representation at commercial developer's facilities and especially in the design process to ensure operability and habitability. In the new commercial model we have to devise a new balance between insight and oversight, and, regardless, we will have to accept greater risk. Either "fail operational"—the vehicle can incur a single failure and still perform its mission—or "fail safe"—the vehicle can incur a second failure and still return the crew safely—should be standard.

- Both *Dr. Condon* and *Col. Collins* thought "encourage NASA representation at commercial developer's facility" should be changed to "demand NASA representation…." But, *Ms. Whitson* said it is more complicated than that.

- *Col. Collins* noted that people are disciplined in not talking about what they do in their day-job, so intellectual property, etc. should not be a problem. *Ms. Whitson* thinks we can avoid such problems by giving the same information to everybody. *Col. Collins* agreed that those rules of engagement could be worked out to everyone's satisfaction. But, these are very big prices to pay for commercial spaceflight. She wants it to succeed, but the human factors issues may hinder or prevent that. There are many safety issues.

The current situation presents opportunities to reduce dependency on foreign assets, to gain new ideas from new partners, and to rethink how NASA applies requirements. At the same time, it presents concerns that the US will be totally dependent on commercial companies for crew transport to ISS. Risk is increased if we have a separate ACR in addition to a crew transport vehicle. In addition, there are unknown risk-management processes to assess the safety of commercial transportation systems and service. Because non-Russian international partner crew members make up the crew complement, ITAR and EAR regulations may interfere with flight rule development, launch commit criteria, training materials, etc. Lastly, training NASA and the commercial team for proximity operations will have be defined.

- *Ms. Whitson* agreed with *Dr. Condon:* He saw the need to rethink NASA requirements—requirements tend to get added but never deleted, so it would be good to be sure that all the requirements are needed. At the same time, we should not allow a legitimate requirement to be deleted if there is a good reason to have it.

- *Mr. Holloway* interjected that the other part is that NASA has 50 years' experience, which gives them a tremendous base with which to make those judgments. We should be a lot smarter than we were 50 years ago, and technology has certainly advanced a lot in 50 years, but NASA wants to continue doing things the same way and is less willing to incorporate new practices. *Ms. Whitson* agreed that NASA does need to take another look at how it does things—there is a balance.

In conclusion, there are many programmatic and safety-related uncertainties with relying solely on the commercial crew concept. The foremost concern is a potentially extended period during which the US does not have indigenous access to LEO. We should also remember that a strong NASA–commercial relationship is needed for the expeditious transition to a commercially developed, human-rated launch system.

Ms. Whitson invited committee members to send additional questions to her as they arise.

ISS as a Long-duration Space Exploration Testbed—Benjy Neumann & Jitendra Joshi [*via telephone*] & Dennis Grounds

- *Col. Collins* opened the discussion with the question, "Are we using ISS to help prepare us for future deep space exploration, and if so, how is it being done?"

Benjy Neumann
On ISS, they do microgravity, research, physical, and life sciences and technical demonstrations that are part of new programs. Now they have 10 projects with more technology demos, so ISS is an important part of preparing for human exploration. Most capabilities we need are technological. However, the budget projection keeps changing. The National Research Council (NRC) is producing a Decadal Survey in all l3 areas of ISS research. Much, but not all, of this research should be done in space. Still, we cannot give specifics without a budget, so, this is not planning, but guidance that the ISS is a central piece of our program. The extent will be financially driven.

- In response to *Col. Collins, Mr. Joshi* clarified that a Decadal Survey is being done at the behest of NASA for life and physical sciences. It was driven by the fact that we had purposefully reduced the portfolio of life and physical science research that was not directly flight-related. This Decadal Survey is chaired by Elizabeth Cantwell and Charles Woodward. An interim report defines how ISS is relevant; Mr. Joshi will send it to Col. Collins tomorrow.

ISS serves as a platform for complex engineering integration, as well as scientific research. It serves as a facility to gain operational experience and technological validation in crew operations, spacecraft systems operations, and crew–system interface operations. ISS enables exploration, as research in life and physical sciences will enable exploration. Life sciences include behavioral health, human factors, cardiovascular function, musculoskeletal fitness, immune function, and radiation effects. Physical sciences include partial gravity effects, mixing of cryogenic fluids, multiphase flow, heat transfer, and materials processing and recycling.

- *Col. Collins* asked if there is a program that manages technology for future exploration, as well as human adaptability to space. Is that managed under a single umbrella?
  Mr. Holloway asked if someone in the explorations program has a list of things to do on ISS along with what is needed to support those things, or is this just discussion?
  Mr. Neumann said it is difficult: the February presidential budget request focused on these capabilities. Therefore, they put together a clear program that has goals, highly focused on demos and with budget, schedule, and deliverables. It is not an ISS-driven plan, but a goal-driven plan with ISS as a large part. However, that exists only in planning because funding will not be available at least for the first year. *Mr. Joshi* added that a major driver for ISS utilization is the human research program.

Dennis Grounds
It has been 5 years since the Agency turned ISS toward human goals and since they have had a program in life sciences areas. In fact, he is preparing a talk on what ISS has done to further medical research. They also have a prospective program and a budget to support it. Operating at long distances is a future goal because you have to change ISS operation to include latency.

- *Mr. Holloway* thought they could build a system to let the crew do their thing.
  Mr. Grounds pointed out that they have to get buy-in from participants, but he agreed there is a way to do that. He can see how that affects medical treatment, part of which is not doing piecemeal technologies, but doing prototype medical systems. They will take the best of the Mars systems and adapt them to smaller and more efficient systems. They can compile fairly concisely what has been done and what can be done. Congress is asking for that throughout the Agency.

- *Mr. Holloway* concluded that funding is the question. *Mr. Grounds'* department has experienced 5 years of budget stability and has been able to accomplish a lot; other areas have not had that advantage. Specifically, they have done a lot in radiation on the environmental characterization and transport of radiation throughout the vehicle, but not on the biological experience. They will continue to use the Station where it is appropriate.

Muscle and bone loss constitute an added reason to have the advanced resistive exercise device (ARED) and a 2nd-generation treadmill. They want to translate that into the Mars systems. They have done work to bring back samples to look at nutrition, e.g., vitamin D dosage has not been adequate. Behavioral health has concentrated on areas of technology that substantiate anecdotal accounts, e.g., astronauts not being up to their usual performance, and sleep. Sleep monitoring is no longer anecdotal: now part of operations as a real measure rather than something done subjectively. They hope, with Japan, to put a human-powered centrifuge on ISS to address key questions on whether intermittent artificial gravity is a major replacement for some current technologies. They want to undertake a campaign to look at the interaction between behavioral and the sensorimotor system.

In conclusion, they have a plan, although part is yet to be completely formalized; they have a history of accomplishments; funding is stable; and ISS is a top priority. In FY2011 the program will have a small increase. ISS utilization will increase by 5% of the budget, but 50% of the experiments. It is a good Mars training vehicle for which they have everything but consistent logistics.

- *Col. Collins* does not want to miss opportunities. *Mr. Grounds:* Congress, i.e. the House Committee on Science and Technology, is also asking for a complete, discrete plan for utilization of the ISS.

- In response to *Mr. Holloway, Mr. Grounds* said the budget is in Exploration Systems Mission Directorate, as is the technology piece, e.g., closed life-support systems. *Mr. Joshi* added, that within new technology planning, there are 3 or 4 demos to be done, e.g., cryogenic food transfer and storage, habitat, eclipse system, and it is all pertinent to a Mars mission. *Mr. Neumann:* It is similar to the Constellation program with an objective of building it within a certain time: It had milestones and reasons for timetables. In the new world, this is not a factor. The Human Exploration and Framework Team (HEFT) was created as an organized way to evaluate ways NASA can do things. It is a design reference system. The team is working on various missions, including psychological conditions. In Exploration that group will set requirements, which program managers must answer to, with appropriate programs and budgets. Strategic guidance disappeared with Constellation, and this replaces that guidance. It is Agency-driven and Agency-blessed.

- *Col. Collins* agreed that this is a turbulent situation, but, she said, "The work you are doing is very important and we want to help however we can in the advisory role we have. We agree that it is important to use ISS to look beyond." *Mr. Neumann* said they now have the added feature of the Chief Technologist, so there will be coordination of our investment across missions. They are doing their best to keep their hands around everything and stay focused.

- *Mr. Lunney* hears about crises and life support systems, but not power for missions away from the Sun, and the US has taken prohibitive steps in the nuclear area. *Mr. Neumann*:

For the past few years, a fission 10-kW source power system, has been funded, and nuclear power is also on their list.

- *Ms. Morgan* noted that external organizations may criticize investigators severely in the future if we neglect opportunities for ISS; it is a due-diligence issue. *Mr. Lunney* thought electric propulsion was one of those things. *Mr. Joshi* and *Mr. Neumann* agreed that electric propulsion is key to enabling exploration.

Col. Collins, hoping for a more stable budget, thanked the presenters. She offered to write a recommendation that NASA continue this sort of work.

Mr. Keaton adjourned the day's session at 5:25 PM.

September 14, 2010

Participants

NAC SOC Members	*NAC Commercial Space Committee Members*	*Others Present*
Col. Eileen Collins, *Chair*	Bretton Alexander, Chair	Laura Atkinson
Mr. Jacob Keaton, *Executive Secretary*	John Emond, Executive Secretary	Mark Carreau, *Aviation Week & Space Technology*
Dr. Pat Condon	Lon Levin [*via telephone*]	Ken Gidlow, FAA
Dr. Leroy Chiao	Bernard Harris Jr, MD [*via telephone*]	Brian Duffy
Mr. Tommy Holloway	J. Michael Lounge	Phil Engelauf
Mr. Glynn Lunney	Patti Grace Smith	Melissa Preble, United Technologies
	Wilbur Trafton	Marc Timm
		Winfield Swanson, *rapporteur*

Mr. Keaton opened the meeting at 8:10 AM and reviewed FACA regulations. Col. Collins welcomed everyone. Committee members had toured the Astronaut Rehabilitation Center before today's meeting, and yesterday were informed by presentations. Members of the Commercial Committee arrived at 9:00; theirs is the only other presentation. The rest of the meeting will be devoted to discussing yesterday's presentations and whether to take any of this forward formally to Administrator Bolden. (When he receives a recommendation, action is required; informal observations require no action.)

Recommendation Preparation and Discussion (FACA)

Col. Collins summarized yesterday's activities:

Building 16 laboratories: They keep getting better: dome simulation (360° view) is an important part of training, but there is talk of removing it. Some companies have formidable capabilities, but it is an important asset—awesome training equipment—which should be used regardless of any new wave of promises.

Robonaut is impressive.

Building 7, the Space Suit Design Lab: Astronauts and the Astronaut Office must be integrally involved. The issue is broader than just suits. Many issues are associated with interfaces between the astronaut and the suit—mobility, comfort, fatigue, etc. Col. Collins will ask Ms. Whitson about that and will report back. The design lab needs to collaborate with someone who is currently on flight status. There is also the issue of wearing a suit on ascent and reentry.

Mr. Suffredini addressed 4 mishaps and how they were addressed, which was very helpful—are they being documented? The real problem is whether people read the lessons learned; furthermore, when people leave, all that information is lost.

- *Mr. Holloway* noted that the lessons learned database is not user-friendly. *Col. Collins* will look at this. Capturing lessons learned in an accessible manner is more important now that the budget is creating gaps in time. She added that Mr. Coats had a story-telling project. *Mr. Lunney* agreed that this subject will become increasingly important.

Col. Collins will take some charts on facilities shutdowns from Mr. Casper's ISS update forward to Administrator Bolden in October. Shut-down is going as planned and there are no concerns although what will happen to the Civil Service people is still a question.

- *Mr. Holloway* heard that the operations personnel could go to technology development, but his experience is that they have a different way of working and he predicted that they would leave before they would develop technology.

- *Dr. Condon* asked what the rescue plan would be if 335 flies. If it gets to the Station they will have Soyuz for rescue. Risk analysis shows the risks of getting into orbit, but not of being unable to get to the ISS. *Mr. Holloway* thinks that risk is minuscule. This situation is no different than previous flights since Columbia; Shuttle rescue could not have gotten to the orbiter in time to rescue the crew, so there is no change in terms of overall approach.
  Col. Collins added that there are no more external tanks (ETs) after the June mission (if they fly it). It would not make sense to keep another Shuttle for that mission because there is no way to launch it.

A chart will be added on lessons learned and on civil servants.

ISS as a testbed for future exploration: they have a plan for astronaut health,, but apparently no plan under one umbrella for exploration technologies (yet) . They are not sure what will happen regarding the budget. The risk is missed opportunities. This could all be brought under 1 person with a list of ESMD priorities for which they want to use ISS.

- In response to *Mr. Holloway, Col. Collins* said that with the commercial enterprise, insight and oversight mean having a NASA person involved in commercial design; this needs to be defined more specifically,

- *Dr. Condon* recalled that the Air Force went from oversight to insight, but that the 2 were defined oppositely to their use here. It is important to clarify definitions. *Mr. Holloway* thought the overarching question was how NASA will assure adequate certification and verification. *Mr. Lunney* never hears what industry people think about this. How do you control this path? Commercial suppliers may resist NASA involvement. *Dr. Condon:* The defense industry loved it when the Air Force only said what they wanted, but not how to achieve it. Now the pendulum is swinging back to more government involvement. *Col. Collins:* The user has to be there every day to answer questions and point the direction. We need a balance between insight and oversight. *Mr. Holloway* suggested having a small group of experts follow the process closely. We cannot get the same result by meeting once a year and reviewing plans.

Rental car vs taxi models—a Shuttle pilot concept?

- *Mr. Holloway:* If a spacecraft is built correctly, training would be minimized. Excess people should not be exposed to the risks of going to ISS. More straightforward is to send people to ISS on their own vehicle; it remains there, and they return on that vehicle. It is the most efficient and productive and exposes the fewest people to the risks inherent in spaceflight. If the vehicle is commercial, those people would have to be trained to operate the ISS. *Col. Collins:* Training takes 2.5 years and is half the time spent overseas (ESA's is a distributed system). *Mr. Lunney:* Is anyone having a dialogue with commercial providers?

The Astronaut Office position is that pressure suits be required for ascent/entry, and that there be no black zones.

A recommendation proposed in April was "Using ISS as a Testbed for Future Exploration." It recommended developing flight operations concepts to benefit both commercial operations and future human exploration beyond LEO. These concepts could be semi-autonomous and demonstrated on ISS; they should cover both time-delayed and noncontinuous communications. More work on this is needed. The whole thing changes so ground operations becomes a sustaining organization to provide long-term advice rather than a real-time monitoring system. "You don't have to know where you're going; just that communication will be delayed."

Greetings by Mike Coats, JSC Center Director

Mr. Coats thanked members of both committees for serving, noting that it is a difficult and unprecedented period when NASA especially needs good advice. While down-sizing at the Centers; they are trying to maintain their focus on the missions. They have 2 (maybe 3) more Shuttle missions. Yet, people want to stay on the job as long as possible, and are not transitioning to new jobs as soon as they could—the workforce is highly motivated and dedicated. Mr. Coats invited questions:

- To *Col. Collins'* question about Civil Service employees, *Mr. Coats* said everything is in limbo. For the Shuttle phase-down, they had planned to move people to Constellation, but that is no longer possible. About 3000 contractors are working on the Shuttle and ISS. In the worst case, 7000 are assigned to either the Shuttle or ISS. To find work for the civil servants, Mr. Coats will have to reduce the contractor workforce even more; a lot of expertise is in the contractor workforce and that will be lost. He hopes the House and Senate will reach a decision this month; a continuing resolution is uncharted territory.

- *Dr. Condon* saw the focus on people involved with the Shuttle, but what about morale of non-Shuttle employees? *Mr. Coats* conceded that they do have morale issues and it is a challenge. And there is stress between contractors and civil servants. The Civil Service workforce is fixed at 17,000 for NASA; with more money, the contractor workforce increases, and with less it decreases. They are having regular all-hands meetings, but with so much unknown there is still a lot of uncertainty. If they have a continuing resolution, it could continue for a long time.

- *Mr. Holloway* lamented the fact that politicians in the Senate and House are determining the kind of vehicles NASA needs in the future. What is the strategy and approach for procuring certification and verification to commit NASA people to a commercial vehicle? *Mr. Coats:* We don't know yet, but we're working on it. Everyone says they will have enough insight and oversight to make sure astronauts fly safely. He fears that NASA will be required to fly our people on commercial vehicles regardless of quality. At the same time, NASA needs commercial vehicles to avoid having to pay the Russians to fly our people back and forth. We're having a lot of discussion, but as yet it is at a high level.

- *Commercial Committee member(Brett Alexander):* Fewer people at JSC are involved in commercial than at KSC, which has full-time people working on it. NASA needs to find a way to pull that team together, especially in the commercial vehicle environment. From a workforce perspective, there is no home yet for commercial at JSC; here everyone does it on the side in addition to their day job. *Mr. Coats* reassured the speaker that JSC and KSC talk weekly.

- *Col. Collins* brought up insight vs oversight and the need for a knowledge program to capture lessons learned. If we lose the workforce, we could lose that experience reflected in the corporate knowledge. Is this ongoing? When *Mr. Coats* started at JSC 5 years ago, he was dealing with an aging workforce, and he asked Jeanie Engle to set up mechanisms to capture lessons learned and tie together the 33 existing databases, which were unconnected. He wants to capture the knowledge and make it accessible. Col. Collins would like to access this database. Mr. Coats will invite Ms. Engle to talk to the committee.

- *Mr. Trafton:* As industry waits to see where this ends up, what would Mr. Coats recommend to industry to get ready for commercial space ventures? Where should they put their R&D dollars before NASA makes a decision? *Mr. Coats:* We have technically difficult challenges, e.g., radiation, methane propulsion. How humans survive for extended periods in isolation is another issue. NASA is helping with miners in Chile using information from ISS, e.g., the miners were on a starvation diet and NASA could pass on nutritional information (don't feed them a lot all at once), as well as psychological things. NASA needs to do a better job of informing the public so they will understand why space research benefits people on Earth. NASA needs to provide technology pulls, so investment is efficiently directed.

- *Dr. Harris* observed that the political system adds difficulty. In Mr. Coats' opinion, are there better ways to do this? *Mr. Coats* has been trying to make the point that it is difficult to maintain a long-term program with multiple administrations, particularly as the US has a history of throwing out incumbents. Therefore, no party has been in control for more than 8 years, but a successful space program relies on continuity. It would be helpful to have something like the Decadal Survey that would continue regardless of politics. It is also important to have international participation for stability and meeting commitments. *Col. Collins*: The National Space Council has been used, but we need an independent group that will not become politicized. The NAC only advises the

Administrator on use of the resources he has been given. *Dr. Harris:* The Decadal Survey is based on science with which there are clear decisions points: either something advances science or it does not. You say an independent group may stabilize our space policy, but space is science and also what the nation perceives is worthy of the US. *Mr. Coats* hoped we could form a group of experts in the field of human spaceflight, but it comes down to why we have human space flight. He thinks technologies devised for space will serve Earth, e.g., recycling water, and people need to be informed about this. Other reasons for human spaceflight are political. But, we can't even agree on that.

Joint Discussion with Commercial Space Committee (FACA)— Bret Alexander

Mr. Alexander wanted to coordinate overlap between the 2 committees—Space Operations, and Commercial Space. Commercial Space has not addressed the safety issue, including the Commercial Human-Rating Plan (CHRP), because they assumed Space Operations was doing that.

- *Mr. Holloway:* Requirements are important and determining them is a big job, but getting a safe vehicle is more important.

- *Dr. Condon:* What about mission control? Who has control of launch, mission control, and recovery? If the program takes us beyond LEO, how does NASA maintain expertise? *Mr. Alexander* met with Paul Hill to discuss this yesterday (September 13), namely what NASA's capabilities are, what they need to maintain ISS, what they need for exploration, what commercial needs to do, how do the 2 committees overlap, and who would have the responsibilities especially during this interim period. *Dr. Condon* thought the 2 need to collaborate at least in the interim period.

- *Col. Collins* wants to make those decisions as soon as possible. *Mr. Alexander:* We've couched it as a transition plan. Is there a sharing of responsibility? He wants to make clear how things will work before NASA puts out a solicitation. Long-term certainty is to make a business plan, and getting NASA to that point early so those decisions can be made has been their focus, rather than what that decision ought to be.

- *Col. Collins* thought workforce needs may fit here. *Mr. Alexander:* Both for NASA and the contractor community, lessons learned and expertise must be maintained and preserved to operate in a different environment. And, that can only be successful as a joint effort.

The work plan begins with defining "commercial space," and second, who maintains it and the progression and transition. The Commercial Space Committee has met about once a month, i.e., twice between NAC quarterly meetings because their advice is needed in the early stages. They have reached 1 observation, 1 finding, and 4 recommendations.

They observe that the NASA Commercial Orbital Transportation Services (COTS) program is progressing. The committee would like to be informed of developments on the program, and believes the program could be a viable model for the commercial crew program.

- *Mr. Holloway:* COTS may be a basic model, but the business of being able to commit humans to a vehicle is much more difficult and requires much more involvement than committing commercial cargo. *Mr. Alexander* agreed—this is just a conceptual approach of a new way of doing contracting.

- *Mr. Lounge* brought up the business point of view. *Mr. Alexander* said it is not prescriptive; it just indicates that the committee looked at it. They explained each observation, finding, and recommendations with their NASA collaborator to clarify whether each was necessary.

The Commercial Space Committee finds that the use of Space Act Agreements (SAAs) is appropriate for the proposed commercial crew transportation program. Subsequently, for crew transportation services, the use of Federal Acquisition Regulations (FAR) Part 12 commercial services contract is appropriate. Many legalistic and procurement and contracting issues are involved. They have met with the Office of Legal Counsel and with procurement people, who agreed that SAAs are an acceptable way to go, but the committee did not want to box NASA in. They used to call them private–public partnerships because they must benefit both. Later, when NASA is buying services, FAR Part 12 is the way to go. In a contract you can include all those nested requirements, like the Air Force does for ELV contracts and NASA does for its science missions. It is more than just a standard form; it could include all the safety requirements. His long dialogue with NASA on it indicates that consensus seems to favor it.

Their 4 recommendations are: Defining the NASA Market; Concept of Operations and Acquisition Approach; FAA Licensing; and Business Case.

<u>Defining the NASA Market.</u> People with whom Mr. Alexander spoke in various programs have no consensus as to NASA's needs in 5 years, e.g., NASA will need 3 or 4 or 5 seats. Commercial Space needs certainty before a solicitation is put out. Commercial capabilities may differ from those of Soyuz or NASA. We need to know whether durations will be 1 month or 3 months, how other passengers will be allowed to come onto ISS, and limitations of life support. Consensus is needed on all this and other issues before solicitations are published.

- *Col. Collins* referred to yesterday's briefing on a traffic model, which indicated that the more traffic you have, the more time is taken away from crew activity. We need a balance. *Mr. Alexander:* Providers need less detail, but more certainty. E.g., could NASA buy 8 seats at 1 time or 2 sets of 4? Or could NASA allow companies to propose how to do it? Most important is for NASA to say where they want to go.

- *Mr. Holloway:* What you think tomorrow's need will be is probably not what you will in fact want in 5 or 10 years, and we need to allow for that continuing evolution.
  Mr. Alexander: We have been in a Shuttle and Soyuz era and are moving to Soyuz-only era. The commercial era opens possibilities and it doesn't have to be like Soyuz.

- *Col. Collins:* How do commercial companies interface with NASA? *Mr. Alexander:* Interaction between companies and NASA will be defined by the Commercial Crew Planning Team. Availability of commercial services may change operations of ISS.

- *Mr. Lunney* asked about the definition of "commercial crew." *Mr. Alexander:* The NASA definition is: commercial entities (companies) providing overall service—launch vehicle, spacecraft, whether crewed by private astronauts ferrying NASA astronauts or piloted by NASA astronauts. Commercial capabilities imply that they will do launches for NASA and also for the private sector. *Mr. Lunney:* Ultimately, we need commercial spacecraft that are crew-able.

- *Mr. Lounge:* Whatever it turns out to be, NASA should not mandate it; offerers should be allowed to tell NASA what they propose to do. *Mr. Holloway:* But, the impact of involving multiple people increases risk. *Mr. Lounge:* These considerations would affect selection. *Col. Collins* wondered if terminology is the problem. *Mr. Alexander* said this is being discussed.

Concept of Operations and Acquisition Approach. NASA should structure the service approach to keep the aperture as wide open as possible. Solicitations should specify the minimum or maximum number of seats, not the number of flights, so vendors can use innovative approaches.

- *Mr. Lunney:* NASA has to weigh how much of a problem that presents to them. *Mr. Alexander:* NASA has to decide whether it is technically sound and workable and whether it puts too much strain on the operation. If NASA says, "give us exactly this," vendors may try to force-fit something. Commercial will also be dealing with other non-NASA customers, such as foreign countries and space tourists.

- *Dr. Condon:* There are operational considerations, such as how many people you want on ISS at the same time, and sequence of events. What will meet our needs? This does not absolve NASA from a lot of planning and thought up-front. *Mr. Alexander:* Therefore our first recommendation is, think about what you really want.

- *Mr. Holloway* asked about the interrelationship. *Mr. Alexander* personally thinks there is an existing model—8 people have already paid to go on the Soyuz, and more than 150 foreign astronauts have gone up on NASA craft. These are potential models for researchers and others. There is a market, but how big it is and how fast it develops is moot. Enabling that market is important. Without that eventual market, there is no reason for NASA to change the construct of doing it. We want to plan it with the right expectations, and the Commercial Space Committee is discussing how to talk about this. Doing just a cost-plus plan will not incentivize the system. The most important thing, from a commercial market perspective, is it is not just a space-tourist market. There are multiple market segments (tourists, researchers, industry, foreign governments), and how fast each one develops is more nuanced. Safety and reliability continue to be issues, but will be helped by more frequent flights.

FAA Licensing. US commercial launches are regulated by FAA, which includes human flight. We recommend that NASA engage the FAA as soon as possible, rather than adding it on later in the process.

- *Mr. Alexander* responded to *Mr. Holloway*: FAA's scope of licensing is all about the safety of people on the ground, but that does not conflict with other NASA requirements. Having 2 different operations concepts would add risk unnecessarily. It also impacts development. Doing things one way for NASA missions and another for private missions adds uncertainty and risk. The only difference is that the customer, not NASA, will have go/no go authority. We need certainty up-front as to what the risks will be.

- *Mr. Holloway* thought it important to define the scope. *Mr. Alexander:* Originally they wanted a single regulatory regime. In the interim they have said it is important to revise this before a solicitation goes out, and NASA and FAA should begin these discussions now and at the right level—real dialogue among people working on the issues.

- *Col. Collins:* FAA licensing appears to be another layer of bureaucracy, and FAA and NASA are both government agencies. Is it redundant? *Mr. Holloway* thought an operations concept was needed to prevent people from misinterpreting. *Mr. Alexander:* Commercial people know that a not-for-NASA launch must be FAA-approved. We need standardization, and he wants to define it up-front and have consistency.

- *Mr. Lunney* asked what the implications of that kind of licensing are and the price for that freedom. *Mr. Alexander* thinks there is no price, but NASA must decide this at the beginning. NASA should start this now and find out if there are undesirable implications. *Ms. Smith* agreed that clarity is important—we don't want multiple regimes because who can be held accountable will be questionable. FAA licensing is an intensive safety review (to protect the uninvolved public). But, there is a nexus between the 2, and a benefit to the person who is flying in the vehicle.

- In *Mr. Holloway*'s experience, there was a continual dialogue on protection of the public vs protection of the people in the spacecraft. *Ms. Smith:* NASA maintains control by putting requirements in the contract; FAA regulates safety inspections on the ground.

- *Mr. Lunney:* The discussion goes beyond range safety to independent safety review. *Mr. Alexander:* All NASA authorities will be embedded in the contract. FAA has a safety review process and has authority to extend a license or revoke it until the time of launch. FAA licensure amounts to having another independent safety review. Other financial aspects include government indemnification and insurance. It is not in NASA's interest to have a divergent process. To *Col. Collins'*, *Mr. Alexander* replied that the Air Force range people have not yet been brought in.

Business Case. Internal metrics must be developed on how to monitor the companies. To have insight, you need to know the company will not go out of business before or during launch. This requires a different expertise than NASA has yet needed.

- *Mr. Holloway* would say metrics and techniques; that NASA needs more than metrics. *Mr. Alexander* agreed. Different abilities are needed than monitoring technology. This relates to cash flows, etc. that ensure that the business continues.

Absent in these discussions are: CHRP, insight/oversight, flight certification, and safety review process.

- *Col. Collins:* We are concerned about certification and insight/oversight. Astronauts will want close involvement with commercial design and production, whether it is a taxi or a rental car model. NASA cannot delay too long on many of these issues, including the role of FAA and Air Force range people. Astronauts want to wear a pressure suit on ascent and entry, and to have no black zones. Other issues are purely operational.

- *Mr. Alexander* asked to be informed about deliberations on insight/oversight. The only overlap he sees is during the transitional period. *Col. Collins:* If NASA is the only or first user, NASA should have a lot of involvement and oversight. If a company is the only and first user, then they should have that role.

Discussion with Bill Gerstenmaier (FACA)

Mr. Gerstenmaier offered to answer questions.

- *Dr. Condon:* What lessons were learned from the pump that failed? *Mr. Gerstenmaier:* It gave evidence that the plan we had for Shuttle retirement was sound, and planning to have items pre-positioned and crew trained generically to do that were sound. ISS carries 14 big-ticket EVA items that would have to be replaced quickly if they failed. Crews and team did a phenomenal job although they were minimally prepared. We learned that ISS had more thermal capability than was previously thought. The failure had a 3-week impact for research. The process worked well, but we can make it better and we will. It will be the model for the future when the Shuttle is not around. We wanted to cross-strap the thermal loops, but did not because we couldn't figure out how to make it work. Also, we learned that the data in June indicated pump failure, which had not been noticed. We want to add redundant technology or a second pump. It was a great learning experience and will look at other technology throughout the Station. The pump may be brought back. We will have to learn how to make such repairs on orbit. SpaceX can take things, but not return the pump because it is too large. As we go to exploration, we need to figure out how to do such things in remote locations. *Mr. Holloway:* We have to figure out what spare parts will be needed ahead of time. *Mr. Gerstenmaier:* "Infant mortality" has to be eliminated from the technology before it is committed to a Mars journey.

- *Col. Collins* considered the logistics of down-mass. On Mir it was so crowded it almost became a safety issue. Will Space X have this capacity? *Mr. Gerstenmaier:* We have a jettison policy, enabled by a retrograde arm, e.g., jettisoning a 300-lb ammonia tank. ISS has a pretty loose envelope. The amount of time in which it has to decay must be factored-in, so space is not cluttered with debris. We can also use ATV or HTV to burn trash. But, he agreed, crowding is a consideration.

- *Mr. Lunney:* How does NASA certify readiness for flight? *Mr. Gerstenmaier:* This will be in his shop. Both *Mr. Lunney* and *Mr. Holloway* asked who knows the strategy and approach. *Mr. Gerstenmaier* said they do not have that defined yet. First the conflicts must be resolved. We talk about commercial crew, and we don't have a crisp definition of what it means or what the real objective is—is it to create competition or new markets? Why are we pursuing commercial? When we know that, then we can look at these issues. They all roll up into the certification-of-flight process and they all drive up cost. Commercial may be a little more efficient, but it won't be able to be that much more efficient when given the same requirements.

- *Mr. Alexander:* The White House has a definition and objective as has NASA. *Mr. Gerstenmaier:* Part of the reason I don't have an answer is I want to be responsive to the overall need of what we are trying to do. It is good to get what commercial wants and what they can provide, but NASA has to internalize that. Regardless, there is no way a vehicle arriving at ISS every 2 days will be acceptable. And we need to establish a minimum set of certifications.

- To *Mr. Holloway* it is a compromise between turning 2000 people loose from JSC or none; there has to be a more correct answer. *Mr. Gerstenmaier:* They are trying to use commercial cargo to understand the issues, to see what commercial companies can do on their own and where they need help. It may not be appropriate to turn over some things to a commercial company.

- *Mr. Holloway:* It is in the details; the words don't mean much. *Mr. Gerstenmaier:* We have overstepped in some areas. Setting the balance will be the real challenge. It's not that we are not trying—it's difficult.

- *Mr. Suffredini:* NASA should produce a white paper to tell us what to do with commercial cargo, and use the same philosophy for commercial crew. When the verification steps have been worked out, the insight/oversight will become evident. *Mr. Gerstenmaier:* The expendable launch guys have a series of requirements, and they are providing independent analysis. *Mr. Holloway:* For the Shuttle, we went through a process of deleting requirements that seemed unnecessary; then Columbia exploded, and all the requirements were uncritically reinstated. *Mr. Gerstenmaier:* There was no risk to hardware performance. The requirements deleted were those that would be inspected again at a later stage, so he was dismayed that they were all reinstated uncritically.

- *Mr. Lunney* asked what would be helpful. *Mr. Gerstenmaier:* There will be the 2 extremes. He needs cover from both extremes to enable development of the right technical plan. He also needs flexibility to evolve in the future. Without this freedom, much of his time will be controlled by politicians who are designing rockets for him. This committee can point out that it is a time-consuming process. *Mr. Holloway* suggested reducing inspections by having a team of experts for the process of verification and certification to say what is not necessary. *Mr. Gerstenmaier* suggested using cargo as a demonstration.

- *Mr. Alexander:* Is the schedule 3 months or 9 months? *Mr. Gerstenmaier:* They may be a year away from the first set, but they need involvement from industry, and recognition that this will change over time. We also have to be careful that, when a problem crops up with industry, we don't overreact and institute extreme requirements. He is not sure that a spacecraft can be built to the Gold Document. We need to watch this as we set requirements. *Mr. Holloway* thought overreaction could result in $5 million worth of unneeded things. *Mr. Gerstenmaier:* We need to plan for the inevitable accident to prevent overreaction, so we don't create such a restrictive environment.

- *Col. Collins* recalled that John Shannon, when asked a few years ago, wanted people to stop changing things; they need stability. We can document what we've learned and what our perspectives are.

- *Mr. Holloway:* The biggest problem is associated with lack of understanding of what you're really doing, what your approach really is, and how you're interacting with the "Beltway" politicians. This committee does not want unintended consequences from recommendations. *Mr. Gerstenmaier:* The Space Station is incredibly important; it drives the commercial market and human space flight. We don't talk about how hard it is to keep ISS flying and all the work and hours that go into it. ISS doesn't stay in space and operate without a lot of help. Therefore we cannot get so involved with new rockets that we neglect ISS. We have not been able to do unconstrained research on ISS; research is pretty structured by time, but we are starting to see the first results. e.g., The National Institutes of Health (NIH) has 3 investigations, e.g., bone loss and immunity loss: bone loss seen in the 1-G environment in the lab and then compared with 0-G environment. This is not a space person, but a person interested in bone loss in the elderly who sees space as a tool. The immune system doesn't work at 0 G, and an NIH immunologist wants to do the same sort of comparison with immune loss in the elderly. ISS can show that there is a market independent of the NASA world and can create new economic markets. We may have 5 years to prove ISS for this market and as an economic engine. And, we must be sure we don't mess this up. We don't want to inhibit what we do with NIH, et al.

- *Dr. Condon:* Using ISS for experiments, we are gaining experience in long duration flight outside LEO and how to operate where there are long communication lags.
  Mr. Gerstenmaier: We will do more autonomous simulations with the crew.
  Col. Collins: We have been asking that question since April, and just got the answer. Our committee's concern is missed opportunities. *Mr. Gerstenmaier:* How do we take the lessons from this pump repair to Earth and maximize that? NASA needs real applications on Earth, e.g., studying the elderly. The National Research Lab wants to study optics in a new research and test environment. A lot of development comes from systems missions, which doesn't have enough funding. They are finding other ways to fund, e.g., NIH is funding its own investigations.

- *Col. Collins:* Space Station utilization is #1 on the work plan. We want to find creative ways to get the message out to industry, health care, etc. *Mr. Gerstenmaier:* The National Lab will be a 501(c)3 corporation and they can work on this. Cells mutate more in space.

ISS has flown *Salmonella* vaccine and methicillin-resistant *Staphylococcus aureus* (MRSA) vaccine. Entropia, used to make biofuel, was flown on the past 3 shuttle flights. Another issue is Shuttle fly-out.

- It is not easy to shut down the program. The toughest issue is that staff cannot transition into Constellation positions. The last tank will ship out of New Orleans Monday. Discovery rolled out of the vehicle assembly building (VAB) recently. It is an emotional time and we need to be sensitive to that. We allow employees to bring their families for the last roll-out, have a picnic, and sign the wall on their last day. But we want to avoid a circus environment and let employees do what they want to do. How to do this in uncertainty is a problem—we don't know whether we will have the June flight. (There has been a study on Contingency of Crew Response.) *Col. Collins* asked whether NASA had issued an official statement on STS135. *Mr. Gerstenmaier:* It is not accommodated in the President's budget. NASA thinks it is the right technical thing to do. It is a contingency flight, which we make look like a real flight. At the end of the year Mr. Gerstenmaier will make a recommendation. In general, people will execute anything. They just want some certainty.

- In response to *Col. Collins, Mr. Gerstenmaier* said the Human Exploration Framework Team (first led by Steve Altemus, but now by Steve Olson) has taken over the job of architecture of an HLV as a whole infrastructure piece. There is no official position on where that sits yet.

Mr. Gerstenmaier invited members of both committees to send him questions via their committee executive secretaries.

Mr. Keaton will send Col. Collins proposals of each Mission Directorate for their proposed uses of the Space Station. Of 89 proposals received, 16 were selected. Col. Collins will share results with the Commercial Committee.

Adjournment

Mr. Keaton adjourned the meeting at 12:10 PM. The next meeting of the full NASA Advisory Council is October 4.