NASA AEROSPACE SAFETY ADVISORY PANEL
National Aeronautics and Space Administration
Washington, DC 20546
VADM Joseph W. Dyer USN, (Ret.), Chair

June 9, 2009

Mr. Christopher Scolese
Acting Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Scolese:

The Aerospace Safety Advisory Panel held its 2009 Second Quarterly Meeting at NASA Johnson Space Center (JSC) on April 29-30, 2009. We greatly appreciate the support received from JSC subject matter experts.

The Panel submits the enclosed Minutes with Recommendations resulting from this meeting for your consideration.

Sincerely,

Joseph W. Dyer, VADM, USN (Ret.)
Chair

Enclosure

Aerospace Safety Advisory Panel
2009 Second Quarterly Report
Minutes and Recommendations

Aerospace Safety Advisory Panel (ASAP)
Public Meeting
April 30, 2009
Johnson Space Center
Houston, TX

ASAP Members Present

- Vice Admiral Joseph W. Dyer, USN (Retired), Chair
- Dr. James Bagian
- Ms. Joyce McDevitt, P.E.
- Ms. Deborah Grubbe, P.E.
- Dr. Donald P. McErlean

ASAP Staff and Support Personnel Present

- Ms. Katherine Dakon, ASAP Executive Director
- Ms. Susan Burch, ASAP Administrative Officer
- Ms. Yasmin Naficy, Reports Editor

Attendees, Public Session

- Ms. Loretta Atkinson
- Mr. Perry Bennett
- Col. Eileen Collins
- Mr. J. Milt Heflin
- Mr. Larry Neu
- Mr. Ray Tolomeo

OPENING REMARKS

The Aerospace Safety Advisory Panel (ASAP) held the public session of its 2009 second quarterly meeting at the NASA Johnson Space Center (JSC) in Houston, TX. The Panel delivered the results of its findings in this public meeting based on briefings by and discussions with JSC officials, program managers, and chief engineers.

The Director of NASA/Johnson Space Center (JSC), Mike Coats, opened the Panel’s visit with an overview of the Center’s activities and issues. Director Coats communicated a number of concerns at JSC, including budget reductions, capped full-time equivalents (resulting in work being moved out to other NASA Centers), and uncertainty about when the next Administrator would be selected and announced. Director Coats noted recent EVA accomplishments and significant progress in the integration of major elements of the International Space Station (ISS), and the readiness of the Hubble Mission, which was up next and ready to launch at the time of the meeting. Director Coats noted NASA’s professional response to Hurricane Ike, which included publishing and communicating lessons learned with other NASA centers and private industry in the aftermath of the event, and preparation for the upcoming hurricane season.

Director Coats noted that each of the partner nations of the ISS will fly on station in the not too distant future. Another important note is that this period represents the beginning of the end of the Shuttle program, and therefore unique challenges will arise.

Director Coats also noted that every one of the astronauts will have been assigned to a Shuttle mission flight by the end of the Shuttle program. NASA is also actively engaged in selecting a new astronaut class within a month, making this an epic transition from Shuttle flights in Low Earth Orbit (LEO) to long-duration flights.

Constellation Program Manager Jeff Hanley briefed ASAP on the program's budget and project status (i.e., its accomplishments and challenges). The ASAP observed that the Constellation team has done a commendable job within the given constraints, especially in making budgetary decisions, which is beyond the team's control, and in some respects beyond the agency's control. ASAP agrees that Constellation is challenged and needs to be funded adequately to accomplish their mission.

CONSTELLATION PROGRAM – SYSTEMS ENGINEERING AND INTEGRATION

During this Pre-PDR phase, the Constellation program has only spent 10 – 12 percent of the current program budget. This is a reasonable indicator of how early it is in the development of the final design. Therefore it is understandable that some aspects of the program are still being worked out.

The Systems Engineering and Integration Office requirements flow down process, which starts from the President's Vision for Space Exploration (VSE), is communicated down through an Exploration Architecture Requirements Document (EARD). The EARD flows these requirements down to the program level, thus supporting the president's objectives. The requirements (both primary and supporting) are tracked (a best practice) through a program called Cradle. ASAP expressed that this mechanism is an effective way of making sure that all system, sub-system, and component requirements ultimately reflected in the design, are traceable back to the primary objectives. The Panel noted that there is commonality among projects at JSC in that many are using Cradle software.

Further, system engineers have developed detailed Interface Requirements Documents (IRDs) to characterize system interfaces at all levels within the Constellation Program. Once these interfaces become finalized, they are moved to Interface Control Documents (ICDs), which are then placed under formal configuration control. The Constellation program anticipates that all these interfaces will be converted to ICDs by the time the Preliminary Design Review (PDR) is completed.

ASAP found that the requirements flow down is systemized, described in documentation, traceable, and based on good processes. A process of reducing down to only those requested changes that are necessary to insure requirement compliance (using requirements traceability) is essential to cap the ideas coming into a system, and produce a stable design to support a PDR. The management and traceability processes utilize reliable tools and processes, which indicate that the program's engineers are following best practices.

ASAP positively noted the amount and frequency of work process in place to maintain the Constellation Program's technical baseline, as well as the team's capability to not allow things to 'go stale'. However, ASAP indicated that the program needs to develop, use, and report back quantitative measurements to show how well work is progressing.

METRICS – QUANTIFYING PROGRESS

ASAP expressed confidence regarding the team's use of integrated design analysis cycles (their low-level milestones), as this practice allows quick design re-set without a lot of costly investment if issues arise. The Integration Review Board (IRB) can make a decision to discontinue a Design Analysis Cycle (DAC) early on, if a serious deficiency arises. It is clear that the Systems Engineering and Integration Office has assumed the responsibility for conducting integrated analysis, but ASAP still believes that while observation, articulation and integration are in place, identifying the basis for measuring progress (metrics) on a quantitative level is essential. While a process of observing and trending is in place, the Panel posed a question about what indicators this process provides to the team, especially in early stages of design.

As more major contractors come into play, the aforementioned type of communication and data will be important. This underscores the importance of having a set of quantified process metrics to accompany a well-documented process.

During discussions with the Orion team (responsible for Level 3 projects and Level 4 integration), the presenters indicated they would be using TBRs and TBDs to measure progress in addition to the Requirements Compliance Matrix. Those are just two metrics, and there may be others available.

ORION – SYSTEM INTEGRATION PANEL

Lockheed Martin, as prime contractor, leads some of the major engineering forums and boards, with NASA being members. In turn, NASA leads other major engineering forums and boards, including review boards, with Lockheed Martin as a member. Lockheed and NASA have very similar organizational charts, keep close contact, and know each other's counterparts. Authority for the vehicle integration and design control board is delegated accordingly, so that team members have a clear idea of what is required of them, such as tailoring requirements, change directives, and other elements to Orion system documents.

However, some of the current requirements—due to the dynamic nature of this phase of the program—are inconsistent with what is specifically called out in the Lockheed contract. These items are documented and are being addressed through contract changes. This process has been substantially improved and is smoother now than it was in the past.

INDUSTRIAL SAFETY TRENDS

At JSC, injury trends over time have decreased but have reached a plateau. The Industrial Safety team conveyed that JSC can do better, and that there is room to grow, as the "Best in Class" are an order of magnitude lower. The team is growing in this direction, and ASAP agrees a concerted effort will be required to achieve greater improvement. . Skip-Level Assessments provide an opportunity to reach further into the supervisory level to handle Industrial Safety more firmly. However, there also appears to be a gap in that Skip-Level Assessments are required, but there is no subsequent requirement for management to take action on those assessments.

JSC Industrial Safety rates are similar to other NASA centers, but JSC is striving toward improvement. At the same time the data suggests that JSC has performed well with Occupational Safety and Health Administration (OSHA) requirements.

CULTURE SURVEYS

NASA needs a strong quantitative and qualitative measurement/survey of culture, done with vigor and regularity, not only at JSC, but agency-wide. Doing so would identify negative trends, thereby enabling centers to take appropriate action. A previous NASA Administrator organized an excellent approach to integrate culture surveys; however, that process was put aside by the last Administrator. These surveys may be difficult for technical personnel to become familiar with, however ASAP made a recommendation in a prior public meeting to move ahead with this activity.

ASTRONAUT CREW PROFICIENCY

The astronauts with whom ASAP met used as an exemplar what they do for familiarization, robotics, and EVA training. Evaluators put astronauts and candidates through EVA familiarization runs to determine whether they are qualified for further training. As an example, some astronauts are deemed qualified for EVA work, while others are not.

The crew members are further ranked by the EVA Evaluation Board as EVA A or B, which describes their ability level. ASAP witnessed an EVA evaluation during the Neutral Buoyancy Laboratory (NBL) tour.

The final decision whether the astronaut is ultimately deemed qualified and assigned to a flight depends on evaluations that possess both objective and subjective evaluation factors. ASAP noted this is a rational approach.

T-38 OPERATIONS

There will be a future decrease from 23 to 20 T-38s, as well as a simultaneous Block 3 upgrade, which will include a Traffic Collision Avoidance System (TCAS) and an Enhanced Ground Proximity Warning System (EGPWS). There is also consideration being given to building in a data link for weather radar. These upgrades should enhance safety.

The astronauts stated that the T-38 system simulator is being used more often now, and that they are also using the system for Crew Resource Management (CRM) training. The astronauts stated that CRM training is being incorporated into actual flights for both pilots and back-seaters.

Continuing the T-38 flying program during the gap between the Shuttle and Constellation was identified as being important during the public meeting. ASAP feels this program provides an excellent opportunity to observe, train, and evaluate crew office personnel in an environment that can elucidate suitability for future crew assignment. As the Shuttle program terminates these linkages to realism are significantly diminished if T-38 flying is curtailed. ASAP strongly endorses this position, as the realism of T-38 operation provides a valuable complement to ground-based simulations.

INTERNATIONAL ISSUES

A discussion regarding logistics flights between Moscow and Baikonur took place during the meeting with the astronaut office, revealing that crew and other NASA personnel travel this route on Russian aircraft that NASA has little insight into regarding safety-related information. In other environments this would not be allowed. This is worrisome since there are frequently a large number of NASA personnel on board a given flight. If an aircraft is lost, this could have a significant impact on program operation. An explicit evaluation as to the risk imposed by the use of such uncertain assets should be undertaken to decide if any change to the current use of Russian aircraft is warranted.

The relationship and the working level between NASA personnel and the international partners was described as good, with communication being open and functioning at a high level.

HUMAN RATING AND RISK-INFORMED DESIGN PROCESS

The current mechanism by which Constellation manages and assigns risk is somewhat different from the norm. This mechanism has one typical component that employs a burn-down of risks. On the identification and severity side, however, there is a process in place that the individuals involved understand clearly, but isn't as commonly used. The group has incorporated risk management and hazard identification in ways that are not completely congruent and need to be clarified further. ASAP further recommended to senior Constellation managers that they use either quantifiable metrics or specific examples to illustrate the meaning of certain terminology.

ASAP used emergency systems to describe the potential for miscommunication. In this example, there are those who would argue that because an emergency system is a back-up and is rarely used, it does not have to be as reliable as the primary system. Others, including ASAP, would support the view that when an emergency back-up system is needed, the primary system has already had a failure, thus the back-up system has to be even more reliable than the primary one.

ASAP commented on the Constellation Program's presentation regarding their process for what they call the 'design for minimum risk'. This process includes a mechanism whereby design margin (e.g., in the thickness of pressure vessels) is used to obtain minimum risk. This method requires a separate approval by the Constellation Safety Engineering Review Panel (CSERP) board for acceptability. The presenters informed ASAP about their process for determining when it is appropriate to use design margin instead of fault tolerance for achieving minimum risk. This process was well described and appeared robust.

CSERP (comprising CSERP1 [Ares] and CSERP2 [Orion]) was described as having a good and positive 'checks and balances' process in place. The team described the Integrated Hazard Analysis process (reviewed jointly by CSERP1 and CSERP2), which is reviewed by the Office of Hazard Integration and the CSERP board. This process incorporates an event-driven reduction in risk so that residual risk is both controlled and documented, with retirement taking place only after a specific event is successfully completed.

ASAP was informed that the CSERP board reviews any hazard, and that this board comprises both technical and safety authorities who must concur before a risk can be downgraded. This process is interactive, continually evolving, and incorporates key steps, so that the risk does not sit idle. Further, the information ASAP received on Human Rating and Risk Informed Design highlighted process and analysis cycles with flow diagrams, and described the iterative processes that pick up additional hazards and address them accordingly. This constitutes a good, solid practice at JSC, in ASAP's opinion.

With the Orion risk-informed design improvements there remained some confusion, specifically regarding statements about "zero base" activity and safety having to "buy its way" back in. However, during this visit it was made more clear by those presenting that there is no intention to fly a vehicle in the baseline category, and there is no intention to create a zero base vehicle. These terms were simply used to establish a minimum baseline.

The term “zero base” was then clearly defined as being a ‘floor’, to which design improvements were added to meet the human rating standards and to incorporate appropriate safety measures. This process and these changes were coordinated with Orion’s prime contractor (who is fully on board with the approach). Incorporating the prime contractors gives ASAP additional confidence that the team has a suitable broad based team with respect to safety analysis.

The Constellation team provided an extensive explanation of its mechanism for pushing down risks, noting that risks had to be differentiated between different missions. Based on this briefing, this team appears to be moving ahead and plotting out a reasonable path to PDR. ASAP continued to encourage the team to make hazard risk definitions and terminology more quantitative and precise in nature (referencing terms used, such as “Minor Damage” and “Major Damage”). ASAP fully encouraged the team to offer examples that define this type of terminology. The team agreed they will work on this suggestion to make the meanings more consistent and clear.

ASAP members noted that Mr. John Curry, Manager of the Orion Vehicle Integration and Design Office, delivered a presentation that built confidence. Mr. Curry presented tracking, traceability and other elements clearly, and understood well the LOC/LOM numbers allocated against the Orion vehicle, among other vital factors.

When considering a transition from a mandated redundancy of life critical systems to an approach that states “exercise good judgment,” the point was made that redundancy and a “cookbook” approach added weight. ASAP questioned whether the team was making this transition with specific guidance. The team explained that in the current processes, prior to documenting a risk characterization, all technical, medical, and other channels must concur that the risk has been properly classified. If concurrence cannot be reached, the matter is escalated to a high-level risk board, which constitutes good risk management practice.

ASAP’s view continues to be that documentation is definitely needed where an “exercise good judgment” approach is being implemented. This is an area of some concern, whether decisions would be appropriately documented for future referencing purposes, for example. In discussing risk matrices and decision matrices, the team had some difficulty explaining these items to the Panel. Though the team knew how the matrices worked based on inferred, innate reasoning, the workforce a generation from now may not understand the matrices’ logic and heritage. Capturing and articulating this logic for the future is important.

The Orion team understands that they need to communicate more clearly the integrated analysis being used, which is currently very complex. This includes giving examples if exact numbers are not available.

Rigorous discussion also arose regarding the probability of small risks building up and becoming a larger risk. Specifically, will current practices and approaches be able to detect this cumulative risk over time?

Another question, “How safe is safe enough?” was raised during presentations. This question is answered in the Constellation program as completion of a multi-tiered process of review, comment, update and approval.

The briefings conveyed enthusiasm about interactions between different disciplines in addressing designs and other factors. This indicates that the program teams feel the systems and processes are growing, improving, and working increasingly well, and that the products emerging are much better as a result.

Another item that emerged during the briefings was discussion about risk characterization in general. This is normally expressed as a combination of ‘Knowns’, ‘Known Unknowns’, and ‘Unknown Unknowns’. Knowns are handled with standards. Known Unknowns are handled with fault tolerance. Unknown Unknowns are handled with margin. The Panel noted that a robust approach, which includes all components (standards, fault tolerance, and margins), is necessary to operate in the hazardous environment of space.

Designing for minimum risk has not been fully completed yet, but is in progress and needs to be completed. Since there is no way of knowing all the risk factors of any mission, NASA has to count on the robustness of the design to allow for the mitigation of the Unknown Unknowns.

In discussing the concept of design robustness, ASAP used the example of weight control in aircraft and the difference between conventional takeoff and landing airplanes, and Vertical Short Take-Off and Land (V/STOL) airplanes. Both take good design and weight mitigation, but the weight requirements for V/STOL cause tradeoffs that by necessity lower margins. The subsequent results are very different, and show that while weight control is important to both, fundamental requirements set the process for reaching the desired conclusion. Overall there was consensus that the Constellation Program is in its early stages, but at the same time has overcome important challenges evident earlier in the design development.

KNOWLEDGE MANAGEMENT

A Panel research question: Is NASA capturing, preserving and communicating knowledge generated over the last 50 years of spaceflight? The newly appointed JSC Chief Knowledge Officer, Jean E. Engle, is adapting her knowledge management system to the existing knowledge capture model and practices already in place, as opposed to pursuing a new system. This approach has produced a great deal of cooperation as opposed to organizational resistance. ASAP determined that this speaks well of the program, constituting a powerful approach, and believes that a best practice ought to be adopted along these lines across NASA.

At the same time, while the Knowledge Management program is the catalyst to standardizing knowledge capture practices across the agency, the resources and staffing required to complete the pertinent tasks may be insufficient across the Agency at large.

ARES

Thrust oscillation was discussed as it had been on many prior occasions. The Ares team indicated they would prefer to use passive as opposed to active counter-measures to address thrust oscillation. The sooner they can finalize this assessment and decision, the better, so they can continue with the design process. The Ares team seems to be moving well along this path and making good decisions, in addition to keeping ASAP informed.

ASAP RECOMMENDATIONS, SECOND QUARTER, 2009

2009-02-01: ASAP recommends that in maintaining the Constellation Program's technical baseline, NASA must develop, use and report in-process and outcome metrics to assure risk management processes are being followed and that progress is being measured.

Though design integration has progressed substantially, ASAP believes NASA's work process would be enhanced by adding quantitative measures that can be introduced, tracked and reviewed periodically, thus serving as indicators of a successful work process.

2009-02-02: ASAP recommends that NASA be more aggressive and transparent in communicating changes—and the rationale for changes—relating to some areas of the Constellation design and development process. This would prevent NASA's detractors from resorting to using incorrect or incomplete information that puts NASA in a weakened or defensive posture for no technical reason. For example, a significant media miscommunication occurred following NASA's release of information about a change in the number of crew seats on the Orion (a design decision). Media outlets subsequently took this information out of context, resulting in incorrect conclusions being relayed to the public.

2009-02-03: ASAP recommends that Hazard and Risk Matrix definitions be more quantitative in nature. Risk definitions must be improved and made more precise. Since approving the risk and accepting the risk are not the same, these terms must be made more clear and differentiated, particularly in any information that is released. The ASAP also recommends that NASA train all its new engineers and managers in its hazard and risk management processes, so that everyone can better appreciate and understand how this relates to their work.

2009-02-04: ASAP recommends that NASA exercise appropriate diligence with respect to insuring the acceptable safety for aircraft employed in all host countries. If the existing safety level is insufficient or documentation is incomplete, actions need to be taken that will result in improvements to the existing providers' operations, or instituting new resources to provide this transportation.

2009-02-05: ASAP recommends the Industrial Safety team more openly communicate the results of Skip-Level Assessments of supervisors to senior leadership. This will allow leadership to become increasingly involved in, and more knowledgeable of, the Industrial Safety Program.

2009-02-06: ASAP recommends NASA acquire a means to continually identify workforce and management issues before they grow into even larger problems. Using a workforce survey is an accepted practice and can be integrated within normal HR and program activities. Properly employed, this will serve as a proactive leading indicator of organizational effectiveness.

2009-02-07: NASA (in all locations) needs a strong quantitative and qualitative measurement of culture changes, done with rigor and frequency. ASAP subsequently recommends that NASA reinstitute a periodic culture assessment.

2009-02-08: ASAP recommends that NASA adopt a best practice to standardize knowledge capture and management practices across all centers.