July 22, 2014

Vice Admiral Joseph W. Dyer, USN (Ret.)
Chair
Aerospace Safety Advisory Panel
National Aeronautics and Space Administration
Washington, DC 20546

Dear Admiral Dyer:

Enclosed are NASA’s responses to recommendations from the 2014 Second Quarterly Meeting of the Aerospace Safety Advisory Panel (ASAP). Please do not hesitate to contact me if the ASAP would like further background on the information provided in the enclosure.

I look forward to receiving continued advice from the ASAP that results from your important fact-finding and quarterly meetings.

Sincerely,

Charles F. Bolden, Jr.
Administrator

7 Enclosures:
2014-AR-01 - Definition of Missions, Objectives, and Requirements for Performance and Certification
2014-AR-02 - Identification and Communication of Safety Risk
2014-AR-03 - Competition in the Commercial Crew Program
2014-AR-04 - Realism in Cost and Schedule
2014-AR-05 - Process for Managing Risk with Clear Accountability
2014-AR-06 - Commercial Cargo Risk Policy
2014-AR-07 - Robust Safety Culture
Aerospace Safety Advisory Panel Recommendation
Tracking Number 2014-AR-01
Definition of Missions, Objectives, and Requirements for Performance and Certification

Finding:
Unless a program’s mission and objectives are clearly defined and articulated, it is impossible to determine what level of safety risk is acceptable.

Recommendation:
NASA should clearly define missions, objectives, and requirements – for both performance and certification – in a timely manner. Once they are defined, NASA should resist continually changing these elements because of the deleterious impact on cost, schedule, performance, and safety.

To specifically apply this recommendation to NASA’s programs, the ASAP offers the following:

1) The ESD mission(s), objectives, and requirements, including Loss of Crew (LOC) and Loss of Mission (LOM) requirements, should be clearly and explicitly identified.
2) The rationale for maintaining the International Space Station (ISS) should be clearly stated.
3) The Commercial Crew Program (CCP) objectives should be further clarified and prioritized.

Rationale:
Requirements for both performance and certification need to be defined and communicated early enough in a program to be incorporated into the design from the beginning. Safety risks that could have been avoided or mitigated if addressed at the outset could become prohibitive to alleviate if identified too late in a development program.

NASA Response:
NASA concurs. Clearly defined and understood mission objectives are needed to determine the acceptable safety risk. The nature of the NASA Mission is to explore, which inherently means taking risks. NASA has demonstrated its ability in assessing risks throughout the Shuttle and ISS Programs. An example is the Agency decision to perform the last Hubble Space Telescope (HST) repair mission where NASA found ways to mitigate the crew rescue risk by having a second Shuttle ready to launch when the HST repair mission launched.

NASA’s human exploration endeavors have established acceptable safety requirements (LOC/LOM) for well-understood mission phases and uses LOC/LOM as key criteria in designing individual missions in part on relative risk levels and the relative acceptability of the resulting LOC/LOM. This will be an ongoing effort as NASA progresses with humans further into space demonstrating and learning in all phases needed for humans to go to Mars.

Maintaining the ISS to at least 2024 is necessary to perform the research and to develop the operations and test hardware systems in the environments that will be encountered in long-term
human exploration. These strategic objectives are executed within the safety and risk environment that the Agency has accepted for operations and transportation in low-Earth orbit. Commercial Crew objectives and risk levels are clearly defined in the following Agency documentation: ISS Crew Transportation and Services Requirements Document, Revision: C, dated November 2013.

In all of NASA's human exploration efforts, the mitigation of safety risks drives the analysis, subsystems design and test, integrated testing, and final flight certification. This is incumbent in all that NASA does for human exploration. NASA also recognizes the need to develop and maintain stable requirements to minimize cost and schedule growth that can influence key safety risk analyses.
Aerospace Safety Advisory Panel Recommendation
Tracking Number 2014-AR-02
Identification and Communication of Safety Risk

Finding:
For Exploration Systems Development (ESD) and its elements, the determination of acceptable risk threshold is dependent on the benefit to be gained by incurring the risk. For the International Space Station (ISS), the acceptance of risk (and cost) of extending the Space Station’s life is dependent on the benefit anticipated from maintaining the ISS’s capability for a longer period. For the Commercial Crew Program (CCP), accepting the risks inherent in embracing a new commercial partnership business model is dependent on the value of the approach’s objectives.

Recommendation:
NASA should rigorously identify the risks that it is accepting and the rationale for accepting them—i.e., the value expected that justifies accepting a safety risk—and transparently communicate this information to NASA’s stakeholders and the public.

Rationale:
Determination of what constitutes an acceptable safety risk is based on a value decision that balances the potential untoward outcomes against the potential gains as defined by the mission and objectives. Only through such a balancing process can the determination of “How safe is safe enough?” be made.

NASA Response:
NASA partially concurs with this recommendation. At the national policy level, decisions to pursue the three programs identified in the finding have already been taken, and NASA is implementing them in keeping with NASA’s safety policies and requirements.

NASA’s Exploration Systems Programs (SLS, Orion, and Ground Systems) are being implemented as directed in the 2010 NASA Authorization Act. NASA has established Agency-level safety thresholds for future human missions to cis-lunar space, starting with EM-2. At a minimum the ascent and entry phases of the cis-lunar human missions shall be at least as safe as the Space Shuttle ascent and entry phases at the end of its operational life, and the in-space phase of the mission shall be at least as safe as a six-month ISS mission.

The ISS implements major portions of the U.S. space policy for human spaceflight, mainly: conducting research and technology demonstration activities to enable long-duration human spaceflight beyond low-Earth orbit (LEO); enabling the development of a LEO commercial market; conducting research and other activities that return benefits to humanity; and providing the basis for international cooperation in human spaceflight. Extending the life of ISS to at least 2024 enables and enhances each of these policy objectives. For instance, Human Research Program research activities for crew health, performance and countermeasures will not be completed until the mid-2020’s; and the commercial research and applications industries have at least 10 years to develop the knowledge and resources necessary to sustain a commercial demand for LEO. The ISS Program has conducted analyses that certify the safe operation of ISS until 2028.
The CCP's objectives are also in-line with the objectives of the ISS. CCP enables domestic crew access to the ISS and enables each of the ISS objectives in research, commercial market development, international partnerships, and returning benefits to humanity. Commercial crew capability will enable substantial additional crew hours for research.
Aerospace Safety Advisory Panel Recommendation
Tracking Number 2014-AR-03
Competition in the Commercial Crew Program

Finding:
NASA has elected to award a fixed-price contract for the certification and initial provision of commercial crew transportation. The contract award is likely to occur before certification requirements clarity has been achieved and confidence has been gained that the potential commercial partners can provide certifiably safe transport.

Recommendation:
In a fixed-price environment, NASA should maintain competition in the Commercial Crew Program (CCP) until there is confidence that the acceptable level of safety will be achieved.

While maintaining competition, the ASAP believes that it is imperative that NASA use its oversight and insight capability to ensure that competing providers do not shortchange safety in order to gain a competitive advantage in other dimensions, such as cost and schedule.

Rationale:
If competition is maintained, NASA may have alternatives other than accepting a less-safe design, unnecessary higher costs, or late delivery.

NASA Response:
NASA concurs that competition in CCP is critical to ensuring the crew transportation systems are safe, reliable, and cost effective. Promoting competition, as opposed to sole-source contracts where the Government negotiates with only one source, can save money, improve contractor performance, and promote accountability for results. As such, NASA has maintained competition in CCP even in the face of extreme budgetary pressure, and NASA will make every effort to continue competition as long as possible. However, regardless of the level of competition in CCP, NASA has no intention of compromising safety. Our safety and mission assurance requirements have been established, documented, and reviewed several times; and our industry partners must meet those requirements before NASA certification will be granted.
Aerospace Safety Advisory Panel Recommendations
Tracking Number 2014-AR-04
Realism in Cost and Schedule

**Finding:**
NASA may not have control over the budget amount that is appropriated for a program. Cogent and fair cost analysis will be necessary.

**Recommendation:**
NASA should strive for realism in cost and schedule.

**Rationale:**
Unrealistic cost or schedule expectations, or the combination of both, put undue pressure on performance and safety.

**NASA Response:**
NASA concurs. NASA responsibly establishes credible Life Cycle Cost Estimates (LCCE) for each project to inform management decisions and support the budget process. Realism is incorporated into the process by accounting for uncertainties as well as for the likelihood and consequence of discrete risks the project is facing, and by subjecting project estimates to rigorous independent reviews. Project estimates and inputs from independent reviews inform decision makers prior to making cost and schedule commitments, which have confidence levels associated with them. Once made, those commitments can be updated, if needed, to reflect significant project changes, including changes in appropriations. In addition, establishing confidence levels for project plans with associated budget profiles allows NASA to assess the impact of potential changes (e.g., proposed reductions during appropriations process) and communicate how those changes may affect the Agency’s confidence level of meeting cost and schedule targets.

The Agency, Mission Directorates, and implementing Centers utilize proven best practices to predict and evaluate project performance throughout the life cycle. NASA has been successful with recent initiatives specifically targeting these issues, including budgeting based on robust risk informed confidence level analysis of cost and schedule.

Large-scale projects face the challenge of executing development work on less than optimal life cycle funding profiles. The Agency is successfully adapting to this new operating environment. Balancing project content within the cost and schedule constraints of the authorization and appropriation language means much effort is focused on early communication with stakeholders to ensure everyone has the same expectations.

The Agency leadership is ensuring the best supporting processes and procedures are in place for risk-informed cost and schedule estimates in order to establish and meet Agency commitments. NASA’s mission success coupled with recent evidence of meeting project cost and schedule commitments reinforce the positive impact from the Agency’s initiatives.
The following areas of Agency policy and standard business practice illustrate ways where NASA has made several improvements to aid in improving the realism in its cost and schedule performance:

**Agency Policy:**
- Update Agency policies, requirements, and practices based on approved changes that result from lessons learned, verified studies, and ongoing performance analysis.
- Improve Program/project (P/p) management by adding, modifying or supplementing requirements to strengthen project success criteria for transitioning from one life cycle phase to the next.
- Have management processes which reflect inherent risks associated with NASA projects.
- Evaluate degree of scope, complexity, and risk of every mission, including the use of historical mission comparisons.
- Have adequate margins for mission scope, cost, and schedule so they have room to handle inevitable issues.

**Standard Business Practice:**
- Conduct periodic reporting that explicitly tracks, demonstrates, and updates the state of a project against its commitments.
- Ensure P/p follow NASA and Center requirements and best practices and that internal organization and programs have adequate staff to manage and oversee their projects.
- Ensure projects develop formulation plans to satisfy NASA’s and Center’s formulation criteria, and negotiate necessary funding and schedule to accomplish the work.
- Ensure P/p complete all work necessary to meet entrance and success criteria for each life cycle review.

Collect and disseminate lessons learned, including integration into Agency P/p management training.
Finding:
In 2013, NASA took a very positive step in documenting and clarifying the Technical Authority responsibilities. This formalization represents a practice that should be followed more generally—for example, in the informal process of validating the Safety and Mission Success budget to avoid an unfortunate budgeting structure at NASA Headquarters.

Recommendation:
NASA should consistently provide formal versus ad hoc processes for managing risk with clear accountability.

Rationale:
Reliance on the quality and integrity of personnel to “do the right thing” makes risk management personality-dependent rather than part of a formal process.

NASA Response:
NASA concurs. Risk acceptance decision-making is a key element of NASA’s ongoing activities to improve its risk management processes, and the Agency has made progress. Improvements to date include:

- Development of the Risk-Informed Decision-Making (RIDM) process so that:
  - The baseline performance requirements managed by Continuous Risk Management (CRM) now have a technical basis.
  - The known risks associated with each decision alternative under consideration are clearly identified and communicated to the decision maker.
  - The rationales for major decisions are documented.

- Placing significantly increased emphasis on managing aggregate risk (e.g., managing total probability of loss of crew, as well as managing individual contributors to that total) and on treatment of uncertainties so that the safety threshold/goal policy can be implemented.

- Placing significantly increased emphasis on managing to actual (aggregate) risk by advocating the use of safety performance margins to account for the expectation of unidentified risk sources when developing safety performance requirements (e.g., on Loss of Crew) that are verified by probabilistic risk assessment.

- Changing the risk management requirements (NPR 8000.4, Agency Risk Management Procedural Requirements). Implementation of the modified requirements will have the effect of fixing responsibility for key risk acceptance decisions and providing significantly improved technical bases for those decisions, based on documented protocols and supported by required analyses.
• Developing and promoting the construct of “risk-informed safety cases” to furnish the decision maker with an appropriate confidence and rationale for risk acceptance decisions.

The above are some of the building blocks that need to be in place in order to be able to institutionalize the application of formal methods for risk management (including risk acceptance) within the Agency.

The Office of Safety and Mission Assurance (OSMA) will work with the Mission Directorates and the Technical Authorities to review Agency-level and program-level risk management processes and documentation and identify gaps. Based on the findings, OSMA will work to identify and communicate Agency expectations for risk acceptance and accountability.

OSMA will keep ASAP apprised on findings and progress.
Aerospace Safety Advisory Panel Recommendation
Tracking Number 2014-AR-06
Commercial Cargo Risk Policy

Finding:
Early in the program, NASA limited the International Space Station (ISS) Program to non-critical or “Class-D equivalent” payloads on new vehicles. The assumption was that once NASA developed confidence in the reliability of that service, it would be able to fly more important cargo. As the ISS’s science and technology work expands, international vehicles are less available. As the Station’s components wear over time, the ISS Program has found it necessary to fly more and more important cargo on the new vehicles.

Recommendation:
NASA should revisit its Agency-level commercial cargo risk policy.

This reassessment should be made with the intent to:

- Make clear to the programs, Agency leadership, and stakeholders what, if any, limits to ISS cargo are appropriate for the relatively unproven vehicles and the limited insight/oversight posture currently in place;
- Provide guidance on when and under what circumstances the ISS Program will be able to fly important cargo in the commercial cargo vehicles;
- Decide whether and how much to ramp up Government insight for recurring early flight activities, as well as future design and/or operational changes by the contractors; and
- To the extent that the Agency chooses to accept a higher risk posture than was indicated or assumed by past policies, update those policies in the interest of transparency.

Rationale:
When asked about the earlier “Class-D equivalent” guidance, NASA managers acknowledge that it has not been formally lifted. At the very least, this gives the appearance of an inconsistent risk philosophy for ISS cargo versus other Agency activities.

NASA Response:
NASA partially concurs on the recommendation. The cargo flown on Commercial Resupply Services (CRS) missions are either replaceable or do not represent a NASA strategic investment; hence the “Class-D equivalent” designation. The CRS program was created in the post-Shuttle era to provide cargo supply and return for the ISS. It was not meant to replace the Shuttle robotic, Extravehicular Activity, and other capabilities that were required to assemble the ISS. CRS provides cargo transportation redundancy in providers and frequency required by the post-assembly complete configuration of the ISS. The Agency is well aware of the advantages and risk associated with CRS and has chosen cargo appropriately. ISS cargo items such as Extravehicular Mobility Unit hardware, batteries, research equipment, and crew support supplies are all replaceable, and NASA distributes the cargo across multiple vehicles which include Dragon, Cygnus, Automated Transfer Vehicle, and H-II Transfer Vehicle.
Aerospace Safety Advisory Panel Recommendation
Tracking Number 2014-AR-07
Robust Safety Culture

Finding:
NASA's safety culture originates at the Agency's leadership level and flows down from there.

Recommendation:
NASA should continue to foster a robust safety culture.

Rationale:
Leadership must take special care to communicate consistently and clearly, especially regarding decisions that challenge long held values—such as the CCP fixed-price contract for recertification or the weighting of price over safety in the CCTCap Request for Proposal (RFP) – or involve violation of previously articulated policy decisions, such as CRS cargo only involving non-critical, Class D-equivalent hardware. NASA should "take the temperature" of its safety culture through the Agency with regular measurements, formulate and implement appropriate corrective actions where indicated, and assess the impact of the corrective actions.

NASA Response:

- The NASA Culture Survey is a 20-item questionnaire that is sent to all NASA employees, by Center, in order to evaluate the safety culture of each Center. The survey is distributed on a 3-year cycle, and the results are assessed and presented to the Center Director. Each question gives the participant an opportunity to provide a rating as well as comments on safety culture at their work areas, Directorate, and Center. NASA is now on its second cycle of the survey. NASA uses the results of this survey for benchmarking and trend analysis and shares the results to build awareness of safety culture and to promote improvement.

- The Organization Safety Assessment was implemented in 2014 to evaluate the safety culture for current human spaceflight programs. Organization Safety Assessments survey those programs through structured employee interviews and conclude with a direct conversation with the Program Manager and Deputy. As part of the process, after the Program Manager has been briefed on findings, observations, strengths, weaknesses, and recommendations, an executive-level discussion is held with the Associate Administrator, Associate Administrator for Human Exploration and Operations Mission Directorate, the Chief, Safety and Mission Assurance, the Chief Health and Medical Officer, and the Chief Engineer to review the findings and discuss lessons learned and next steps. To date, NASA has completed Organizational Safety Assessments for the Commercial Crew Program and the Space Launch System Program and is planning Organizational Safety Assessments for the Multi-Purpose Crew Vehicle Program, Ground Systems
Systems Development and Operations Program, and the International Space Station Program. It is notable that the Program Managers from the Commercial Crew Program and the Space Launch System Program have both, independently and voluntarily, requested a follow-up Organizational Safety Assessment in one year, at which time an assessment of the impact of the corrective actions related to the assessment will occur.

In addition, NASA offers two online training courses through SERTERN: Orientation to NASA Safety Culture and Safety Culture for Supervisors. NASA also has a very active Safety Culture Working Group that tracks safety culture activities throughout the Agency, disseminates information Agency-wide, fosters open exchange of safety-related information, and ensures that the Safety Culture Program is relevant to and benefits NASA’s programs and institutional activities and the NASA workforce.

By continually assessing, educating, and engaging with its workforce, NASA is making progress to strengthen and sustain a healthy safety culture for the future.