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

August 11, 2010

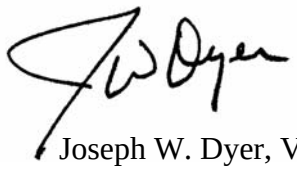
Mr. Charles F. Bolden, Jr.
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Mr. Bolden:

The Aerospace Safety Advisory Panel held its Third 2010 Quarterly Meeting at Langley Research Center, Hampton, Virginia, on July 15-16, 2010. We greatly appreciate the participation and support received from the subject matter experts and support staff.

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

Sincerely,



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

Enclosure

ASAP RECOMMENDATIONS, THIRD QUARTER 2010

2010-03-01: NASA's Safety Risk Tolerance for Human Spaceflight

2010-03-01a: Loss of Crew (LOC) Acceptable Risk Criteria

Finding: The ASAP applauds the overall review undertaken by NASA to establish a set of safety risk tolerances for human spaceflight. The acceptable mission risk for LOC is now to be expressed in terms of three levels: (1) the Agency acquisition threshold, which is the highest risk level to be tolerated by the Agency; breaching this level would normally result in program cancelation; (2) the Program Design/Mission Requirement risk level, which is the "build to" level and is somewhat more conservative than the Agency threshold to allow a margin of buffer; and (3) the Agency long-term maturity goal, which includes continuous-improvement upgrades and represents the long-term mission goal. The levels recently chosen by NASA and the Exploration Program for these criteria were significantly less conservative than those that have been used since the inception of the Constellation Program. For example, the Exploration Program requirement for probability of LOC on an International Space Station (ISS) mission has changed from 1/1000 to 1/270. This reduction in required safety came about, in large part, because of recent analyses that indicated that Ares 1/Orion could not meet previous goals using their current design. The new Agency criteria for future human spaceflight missions are less than one-third as safe as the old criteria and are not even significantly better than current Shuttle risk estimates. This is especially worrisome considering the fact that the criteria only consider the risks that are already known, not the always present hazards that have not yet been discovered. The Panel is concerned that allowing current Ares 1/Orion design weaknesses to drive the future Agency risk tolerance has resulted in criteria that may not result in the maximum safety that is reasonably attainable in future space vehicles.

Recommendation: The Panel notes that the LOC objectives are an improvement relative to Shuttle, but less than expected given history and technology advancement. NASA should undertake an effort to reevaluate the LOC risk criteria to determine if they represent the best levels of safety that can reasonably be provided by future safety-optimized manned spacecraft. The process should involve stakeholders and the technical community, and consider technical feasibility as well as mission tradeoffs that might be required. NASA should determine what the current threshold, design requirement, and goal numbers should be for the next refinement of safety risk requirements. The next refinement should also address how to select these levels such that they (1) encourage and incentivize continuous improvement and (2) have a formalized and documented rationale for the levels selected and a process by which they can determine which improvements in the future should be undertaken. Also, these rationale need to be clearly and explicitly communicated to all stakeholder groups in terms that are not only accurate, but in a manner that can be contextually understood in relation to other risks that have been accepted in the past or that provide relevant understandable comparisons.

Rationale: Required safety levels are one of the most important drivers for selecting future vehicle design architectures, safety factors, and required design features. If Agency risk tolerance levels are established at too high of a level, they will not drive future designs to the levels of safety that are reasonably achievable with modern technology. These key metrics should be based on what good future designs are capable of, not what a given current design may offer. Transparent communication of anticipated risks is paramount for the program to retain the confidence of stakeholders.

2010-03-01b: **Risk Requirements—Clarity and Communication**

Finding: The ASAP recognizes that communication of risk is difficult. In the beginning of the Constellation Program, there was a lack of clarity on what was a threshold, what was a requirement, and what was a goal—not only to the ASAP, but among NASA people. There are still some issues with clarity, e.g., program requirements appear in different places in different context, making them somewhat difficult to understand.

Recommendations:

(1) NASA should consider putting all the program requirements in one place so they are easy to find and simpler for configuration control.
(2) NASA should be more structured and faster in communicating changes to requirements, refinements to requirements, or additional insight from analysis of requirements.

Rationale: Some of the confusion associated with tracing requirements over time would be mitigated by a more structured and formal process. Communication of risk would be helped if there were more clarity on the risk requirements.

2010-03-02: NASA Safety Center Agency-Wide Tracking of Safety Metrics

Finding: The NASA Safety Center has developed a more complete picture of NASA injury and mishap data. The ASAP is pleased to see the Safety Center taking on this role, and the ASAP would like to hear from the Safety Center at every quarterly meeting. It is encouraging to hear that the Administrator is asking for mishap reviews by Center Directors at his staff meetings.

Recommendation: The NASA Safety Center should begin to report and track the following: Center by Center comparisons of all metrics; categorization of the A, B, C, and D mishaps by type, location, cause; compilation of all incidents and injuries by cause; all fires on all NASA Centers; all electrical near misses like shocks, flashes, malfunctions on electrical equipment, etc.; all transportation incidents—both NASA vehicles and non-NASA vehicles on NASA business, trucking incidents, marine incidents, and aviation incidents; off-the-job incidents that result in loss time injuries or restricted work activities; confined space entry incidents; lifting and rigging incidents; rotating machinery incidents; and chemical and radiological exposure. This will take time, but NASA should start moving in this direction.

Rationale: Knowing where all Centers are on industrial safety incidents and mishaps is an important part of the safety oversight function. The safety findings and trends can be very helpful to NASA leadership in benchmarking and assessing the organization's overall safety culture and safety improvement efforts.

2010-03-03: NASA Standards Update as a Result of the NASA Engineering and Safety Center (NESC) Engineering Assessments

Finding: The NESC has completed 300 engineering assessments, and has well-documented reports that have been well received across the Agency. While these investigations are normally conducted to solve problems on systems and designs that already exist, the lessons that they uncover have the potential to provide a roadmap to future designers of similar systems. The Panel was pleased to see that many of the NESC investigators are also closely involved in NASA standards development and hopefully are codifying their findings for future use. However, the Panel believes that a stronger link between the investigations and appropriate standards would provide a more positive process to document and disseminate these lessons to future designers.

Recommendation: The standardized format for NESC engineering reports should be modified to include a section at the end of each report that indicates whether any standards need to be modified or developed as a result of the assessment. There should be a follow-on process to track that finding to completion.

Rationale: Establishing a positive link between the hard-fought lessons-learned analyzing current problems and the legacy that we leave to guide future designers will minimize the likelihood that those lessons will have to be relearned at great expense and risk.

AEROSPACE SAFETY ADVISORY PANEL
2010 Third Quarterly Report
Minutes and Recommendations

Aerospace Safety Advisory Panel (ASAP)
Public Meeting
July 16, 2010
Langley Research Center (LaRC)
Hampton, VA

ASAP Members Present
Vice Admiral Joseph W. Dyer, USN (Retired), Chair
Dr. James Bagian
Mr. John C. Frost
Ms. Deborah Grubbe, P.E.
Dr. George Nield

ASAP Staff and Support Personnel Present
Ms. Katherine Dakon, ASAP Executive Director
Ms. Susan Burch, ASAP Administrative Officer
Ms. Paula Burnett Frankel, Reports Editor

Attendees, Public Session

William Bihner, NASA HQ SOMD
Grant Watson, LaRC SMAO
Kelly Kabiri, NASA HQ SMA

WELCOME/OPENING REMARKS

Adm. Joseph Dyer, ASAP Chair, called the ASAP third quarterly Public Meeting to order at 2:00 pm. He thanked Mr. Stephen Jurczyk, Deputy Director of the Langley Research Center (LaRC), for hosting the ASAP visit. LaRC has been a place of historical and local contribution since the early days of aeronautics, going back to 1917. It has an annual budget of about $812 million, of which fifteen percent is externally funded, and a workforce of about 3700 civil service and contractors. LaRC primarily supports Aeronautics (52%), but also provides substantial support to Exploration (22%) and Science (26%). Particular areas of expertise include aerosciences, characterization of atmospheres, aerospace systems analysis, and aerospace structural and material concepts. LaRC has been a worthy contributor to many Department of Defense (DoD) challenges. Much important work has been done in the wind tunnels, from subsonic to hypersonic. There was an interesting discussion regarding the changing employment of wind tunnels. Over the last 50 to 100 years, most of the wind tunnel work has been experimentation and empirical. Today, much of the characterization and trades analysis can be done via computational fluid dynamics, but tunnels are still critical to verify the outcomes of models before proceeding to build. They are also very important in the area of turbulence analysis. Challenges noted for LaRC include NASA's omnipresent current challenge with respect to clarity across the planning horizon and transition between programs of last year and those going forward. In addition, LaRC has the challenge of older facilities and facility utilization.

LARC SAFETY OVERVIEW

Ms. Deborah Grubbe summarized the safety overview that was presented by Mr. Grant Watson, Director of the LaRC Safety and Mission Assurance Office (SMAO). She noted that he led an excellent discussion on his organization, which is quite strong. The site has a Voluntary Protection Program (VPP) star level certification, which puts it among the safest work places in the country, and the staff should be credited

with excellent results in maintaining that certification. There is good work going on around high voltage and electrical infrastructure reviews, and for a Center this age, that is very important. The Panel looks forward to hearing some good results from the reviews. There is a good focus on safety culture and improvements are ongoing. Because the safety organization is strong, there is an opportunity for the line management to more fully embrace their roles in safety leadership. The line organization is accountable for safety. It starts with the Center Director. For the management to discharge their roles more fully, Ms. Grubbe stated that she would like to see them take a more prominent role in safety reviews and spend more time walking around the laboratories and offices. The senior management may want to consider how the middle managers and engineers are directed, recognized, and rewarded for their participation in safety activities and safety results. There is some work to be done with respect to the managers and how they view their duties versus the SMAO team. Some of the data presented showed that there was great customer satisfaction at very high levels, consistently year after year. Mr. Watson and his team may want to consider looking for other measures of customer satisfaction to provide some variety and learn some different things.

Mr. Frost agreed that the program looks strong. The Panel looked at accident metrics charts, and it appears that LaRC is addressing the right subject. Mr. Frost suggested renaming the "goal" line on one of the charts—it is actually the average for the industry. A ten percent reduction over the last three years is a good goal that could be used.

PROPOSAL TO FLY THE STS-335 LAUNCH-ON-NEED (LON) MISSION AS A LOGISTICS MISSION: STS 135

Dr. James Bagian reported on the presentation by Mr. William Hill, Assistant Associate Administrator for Space Shuttle and Mr. John Casper, Space Shuttle Program Associate Manager, and the discussion concerning the proposal to use the LON mission as the last Shuttle mission (STS-135) in the early summer 2011 timeframe. The purpose would be for logistical support to provide additional upmass for the International Space Station (ISS), which otherwise would have to be handled by expendables that might not have sufficient capability. From a risk standpoint, the risk really involves what to do after the crew is there. There is no inherent additional risk associated with ascent of the Shuttle without LON vehicle being available. The risk involves a potential situation where the Shuttle, after berthing at ISS, would be found no longer viable for return. In this case, there should be two Soyuz available, which would take six crew, leaving four crew without an immediate means of return. The plan would generally be to rotate out the ISS crew first, then the Shuttle crew. The one downside is that in the eventuality that people would need to return solely on Soyuz, the time-on-orbit for some crew would be extended beyond the current nominal mission requirements. However, this is not thought to be a significant risk to crew health, as the time-on-orbit would not be outside the experience base of humans in space. The ASAP believes that the Program has looked at the various risks and has prudently considered them. It appears reasonable that this plan could be pursued. The estimated chances of two failures (Shuttle and ISS) are said to be 1 in 560, and is less than other risk levels that are already accepted by NASA, such as the overall risk for the Shuttle, which is approximately 1 in 90. The Program has analyzed the risks and is still considering whether it will go forward with the proposal. At this time, it appears that there are no "show stoppers."

Mr. Frost added that although there are some risks involved, both in length of stay and multiple launches, there are some safety benefits. The use of Soyuz eliminates the risk of common mode failure associated with the launch vehicle. Further, the mission could provide for additional ISS risk-reduction hardware (e.g., the oxygen dome for the hydrogen generator) that might be needed on orbit for a longer term. Adm. Dyer agreed that the plan would reduce the stress of ISS logistics. Flying out the manifest, including the LON reserve as a logistics mission, is something that Panel is comfortable with, at least as comfortable as it has been for the ongoing operations. However, this does not change the Panel's concern and advice against serial extension of the Shuttle over a longer period of time.

Dr. Bagian noted that the Hubble mission was a higher risk mission (with no safe haven capability), and the STS-135 mission would present less risk than that mission. The Program would not be operating outside of previous risk parameters. With respect to Adm. Dyer's comment regarding serial risk, Mr. Frost noted the

there have been some discussions about two additional missions using the remaining external tanks. He emphasized that the ASAP comments regarding risk are specific to the LON-335 tank, not the other two.

Dr. Nield noted a couple of other factors. With respect to future missions, he advised keeping a close eye on the workforce and the timing of the decisions. Right now, there is some uncertainty regarding when the flight would occur. There is a danger that some of the key people might no longer be in place.

AVIATION SAFETY PROGRAM ACTIVITIES AT LARC

Dr. Nield reviewed the ASAP's discussion with Mr. David Hinton, Deputy Director of the Aeronautics Research Directorate at LaRC. The ASAP assessed several programs in which LaRC is involved and focused its attention on Aviation Safety and Airspace Systems. One interesting point was the impact of NASA research on planning for the Next Generation Air Transportation System (NextGen), which is very important to the country. A number of aspects of the Aviation Safety Program were highlighted, including an intelligent integrated flight deck, integrated resilient aircraft control, and integrated vehicle health management. Discussions also included a review of LaRC's collaboration efforts with Unmanned Aircraft Systems (UAS) in the National Air Space (NAS). There is an increasing urgency to take advantage of UAS's capabilities to perform missions of vital importance to national security and defense, emergency management, and science. There are safety concerns about how the UAS could be integrated into the NAS with other traffic. Currently, there is no way to "see and avoid" without crew on board, and the challenge will be how to implement those systems with the technology that is available today. NASA has the technical expertise and is working closely with the Federal Aviation Administration (FAA) and other stakeholders to assist them in the development of requirements for how this could be accomplished in the near future.

Mr. Randall Bailey, the Team Lead for Flight Deck Interface Technology, presented some excellent information regarding particular systems and safety issues related to requirements for NextGen. He discussed data communications, equivalent visual operations, wake vortex modeling, and merging and spacing. In the data communications discussion, it was interesting to learn that the Europeans have already established requirements for the percentage of aircraft communications that will be via data-link by 2015 and 2030. To be compatible with developments in the future, the US must be consistent with some of these requirements, and that may drive the research and implementation schedules. There have been recent occurrences of aircraft being involved with wake vortices. As we move toward the NextGen closer spacing, we will need to understand the impacts of wakes based on real data. There was recognition that the National Transportation Safety Board (NTSB) continues to be concerned about runway incursions as possible causes of future accidents, and LaRC is looking at technologies that could minimize those. There are some issues and difficulties, e.g., there is some subjectivity in exercising judgment regarding how close vehicles should get to one another. Overall, the presentations and discussions were very informative, and the Panel gained a good understanding of the issues. Adm. Dyer added that LaRC's prowess in performing aerospace systems analysis could be seen in the presentations that were given.

Adm. Dyer noted that over lunch, the ASAP had its annual ethics briefing by Mr. Michael Monahan, Ethics Attorney at NASA Headquarters. The Panel commended Mr. Monahan on his excellent job in presenting the key points.

Adm. Dyer observed that the next three topics—Constellation safety risk tolerance, Constellation Loss of Crew (LOC)/Loss of Mission (LOM) update, and the Commercial Human Rating Plan—are closely interleaved.

CONSTELLATION SAFETY RISK TOLERANCE

Adm. Dyer asked Mr. Frost to join him in covering this topic. The research question has been posed: What is NASA's safety risk tolerance for human spaceflight? Retrospectively, the current calculation for Shuttle risk tolerance for ascent and entry is 1:155. Adm. Dyer commended NASA for improving transparency

and articulation, but observed that these areas of improvement represent the "low-hanging fruit." In the Constellation Program, the Panel has often heard the LOC statistics for design level requirements to be 1:1000. Mr. Bryan O'Connor, Chief of the Safety and Mission Assurance Office at NASA Headquarters, did an excellent job of sorting through the history of the LOC statistics. It originated with the Astronaut Office in May 2004, one of the first to put forward the 1:1000 requirement. The question has been: What was the Constellation requirement? Was it 1:1000 or 1:200+? Why the difference?

Adm. Dyer voiced what he thought should be a requirements statement from the Panel: There is an imperative for NASA to be more formal, structured, and faster in communicating changes to requirements, refinements to requirements, or additional insight from analysis of requirements.

In summer 2005, the Exploration Systems Architecture Study (ESAS) asserted that LOC should be ten times better than that of Shuttle. It is the Panel's understanding that the ESAS spoke from the perspective of ascent, docking, and entry. At that point in time, they did not take into consideration the on-orbit risk of a lengthy ISS stay, and the numbers did not reflect it. In October 2005, the Constellation Program embraced 1:1000; then, things started to evolve and to reflect deeper thinking and more sophistication with regard to on-orbit risk. It was noted that the added risk of on-orbit stay to an end-to-end flight is dominated by Micro-Meteoroid and Orbital Debris (MMOD) impact.

Mr. Frost reviewed the history. He noted that the Exploration Architecture Requirements Document (EARD) specifically said 1:1000 for the ISS mission, which includes the on-orbit phase. As development progressed and the Probabilistic Risk Assessments (PRAs) were done, the Program realized that the risks for on-orbit stay had not been considered and were greater than expected. Although the Program was aware of the issue, it continued to carry the tighter requirement (1:1000) to drive the design. By March 2009, at the Preliminary Design Review (PDR), everyone recognized that the design could not make 1:1000. After some assessments, it was concluded that 1:270 would be the LOC requirement for the entire mission. This number was briefed at the Agency level (the Program Management Council) and has now been approved Agency-wide. The current assessment for Constellation is 1:231, but the Program expects to improve it to 1:270 and hopes to go beyond that if the program were to go forward.

Mr. Frost stated that his personal concern, as an outside observer, is that the vast majority of risk that is pushing Constellation over the 1:1000 requirement is in only two specific areas: MMOD (35% of the total risk) and parachute deployment (27% of the total risk). However, he has not seen the analysis that says those problems are not fixable or at least improvable. The MMOD risk is said to involve potential damage to the vehicle while on Station. If for some reason it couldn't be detected, the vehicle could re-enter with unknown damage, risking the crew. It would appear that there are a number of opportunities to improve this scenario, e.g., some type of shielding that remains on-orbit for reuse by visiting capsules, MMOD detection techniques, better inspection techniques, etc. When so much of the risk is in one place, it is hoped that that the design efforts would be exhausted to improve it. Also, there seem to be things that could be done with parachutes, e.g., more extensive testing to provide more confidence in the parachute, parachute redundancy, etc. Mr. Frost stated that the Panel would like to have seen a more rigorous examination in the risk acceptance process such that available design alternatives were clearly articulated to decision authorities before dramatic changes were made to the acceptable risk criteria. Whenever such risk decisions are made, the ASAP advises that the Program take a careful look at all available alternatives to make sure that no reasonable stone is unturned.

The Constellation risk change prompted an overall review by the Agency on what the risk tolerance level should be. The ASAP applauded this effort. Formally establishing what level of risk to human life is tolerable is not an easy thing for an organization to do. NASA went through a process and picked a number that is twice as good as the Shuttle. Mr. Frost indicated that his initial personal reaction was that this is not a very high bar for the Agency. Admittedly, this criterion is not a goal—it is the Agency's maximum risk tolerance. None the less, it seems that to use as a basis for the future risk tolerance only being as good as a system designed 30 years ago--that had no escape capability and all the hazards inherent in a reusable, side mount, multi-purpose vehicle--may not challenge future designers enough and may not provide all the safety possible to future astronauts. It would seem that the next generation of spaceflight should be perhaps five or ten times better than the last, especially when one realizes that the analyses that feed this metric do

not, and cannot, factor in the hidden hazards that always predominate in real-world safety performance. Mr. Frost recommended that NASA undertake a comprehensive effort to relook at the number to see if it can be improved. The process should involve stakeholders and the technical community, and consider what is possible and the cost/benefits.

Adm. Dyer observed that NASA has made genuine progress in terms of the approach to communicating safety requirements, i.e., "how safe is safe enough." There is now a threshold, a design requirement, and a long term goal, with continuous process improvement. It is important to get these numbers on the table for commercial crew transport. They are articulated as 1:1000 for ascent, 1:1000 for entry, and 1:500 for ascent plus entry. These are the program's design mission requirements, and they differ from the Agency threshold, which is 1:300. Adm. Dyer noted that it appears that we are going from a current Shuttle system that is operating at 1:155 to a new system that has a threshold requirement of only 1:300, and this is disappointing. Historically programs tend to find their way down to threshold performance. Mr. Frost added that the trend toward the threshold results from all the tradeoffs that go with development. These numbers apply not only to the commercial space system, but to all manned spaceflight. As has been noted before, there will be a common set of standards for everyone.

Dr. Nield stated that he had a different philosophical view. NASA has made a lot of progress on how we discuss this issue. Part of the confusion in recent months has been due to the use of terms in different ways. The current process (which is being documented and approved formally) has several different numbers. There is a "threshold," which is a program "go/no go" or "cancellation point;" another number would be a program design or mission requirement; and another number would represent a "goal" to which the program would like to go long term. Separating those different numbers out is a healthy thing. Dr. Nield stated that he personally felt comfortable having a threshold that is close to what we have already demonstrated. As soon as we start hoping for an improvement and put that down as a threshold, we may be on a slippery slope. He would rather see a threshold that is close to what we have seen, and then have a good, ambitious goal that is beyond that. As we see what can be done, we can move the line forward. Having something that is too ambitious as a hard requirement may present problems. If we can figure out what is "safe enough" and call that the threshold, then we can work on bringing down the cost of getting to orbit. This would make a big difference in our overall space program—not that we would want to stop improving safety, but there are other factors in the trade space.

Adm. Dyer acknowledged that Dr. Nield has a different perspective. A number of Panel members feel that programs rarely if ever get better than design goals, but very often they move toward the threshold. If you embrace a 1:300 requirement for LOC, and you fly 300 flights, then you shouldn't be surprised if you lose one. Ms. Grubbe noted that we need to be very careful talking about numbers, because PRA is accurate but not precise. In PRA, 1:300, 2:300, 5:300 may all mean about the same thing, but not to the public. One of the real issues that NASA has going forward is not only the clear articulation of everything that the Agency is trying to do, but interpreting this for the public, the media, and Congress. That is extremely important.

Dr. Bagian commented that communication of risk is always a difficult thing. In the beginning, there was a lack of clarity on what was a threshold, what was a requirement, what was a goal—not only to ASAP, but among NASA people. Today, the model that was presented and discussed, while not perfect in clarity, is a great step in the right direction. The other issue that comes up is the utility issue—having a threshold is good, but having continuing improvement should be done. For small incremental investments, significant advances could be made. The next refinement should address the following: how to pick the goal above the threshold to (1) encourage and incentivize continuous improvement and (1) have some rationale as to which improvements make sense. Before the original Shuttle flew, the projected LOC number was around 1:10000. Adm. Dyer noted that this is the reason why he has discomfort with a low threshold number. If the design is discovered to be less robust than expected, there is not a lot of room for movement.

Dr. Bagian added that there are still some issues with clarity—program requirements appear in different places in different context, making them somewhat difficult to understand. NASA should consider putting them all in one place so they are easy to find and easier for configuration control.

Mr. Frost noted that one of the audiences that hasn't been included in the discussion about this change in risk is Congress. He observed that almost always the "real world" is not as good as the PRA. NASA has recognized that, and has chosen an improvement factor of 2:1, so that the resulting system will be at least as good as Shuttle. Mr. Frost said that he would argue that it should be a greater number; however, it is a complex subject. Now that there is a process in place, Mr. Frost recommended that NASA revisit this change with stakeholders, have this discussion at length, and see if they want to stick with the numbers. As a final note, Dr. Nield commented that PRA is helpful, but not necessarily representative of the hardware and flight history. Consistency in communicating with the public is important.

COMMERCIAL HUMAN RATING PLAN

Adm. Dyer discussed the Commercial Human Rating Plan. Mr. Philip McAlister, Special Assistant to the Administrator at NASA Headquarters, was the discussion lead. Adm. Dyer observed that a successful program resembles a three-legged stool: one leg is success criteria (what we want system designers to deliver); another leg is acquisition strategy, which includes contract type; and a third leg is cost estimation and resources. To have a successful program, one must have all three legs. While one may argue about the level of safety, everyone recognizes the progress that NASA is making in setting the current rate for success criteria, and that puts the Agency an important and difficult step ahead. An even more difficult step is how one verifies that a design can deliver, and how one balances insight, oversight, and test results. Experience would say that there must be a mix. It is unaffordable to demonstrate a sufficient number of flights to ensure that success criteria have been met. One cannot launch enough times to demonstrate via test alone. The "old way" of gaining confidence was some testing coupled with oversight. However, industry speaks with a clear voice: less oversight is essential to delivering a more affordable program. We seem to be moving toward a program of insight (where NASA can observe but not direct changes during design) combined with test results to have enough confidence downstream. Adm. Dyer noted that he was somewhat uncertain as to the pragmatic difference between insight (with the responsibility to tell the contractor when something is clearly insufficient to fly) and oversight. Still, NASA has taken a step in the right direction and the activities to date represent forward progress. The next step—how to validate and verify—will be even more difficult.

Mr. Frost commented that he was in complete agreement with Adm. Dyer, and he complemented Mr. McAlister on his work and his plan. The ASAP has identified this shortfall for almost two years, and finally sees that progress is happening. Ms. Grubbe stated that one of the things that impressed her was Mr. McAlister's openness to ideas that come from different places. Mr. Frost added that the proper way to give oversight and control the situation in a fixed-price environment is a complex subject. He advised NASA to get some advice from those who have done it before. DoD has tried this and has had mixed results.

Dr. Nield commented on the "portfolio strategy." Concern has been raised about how more government reliance on the commercial element is going to work. He noted that there is mix of large contractors that are accustomed to operating under a "cost plus" environment, and a mix of small, entrepreneurial companies that have some great ideas but may not have the experience or realize how hard it is. The question is: How can NASA issue Space Act agreements fairly and at the same time ensure a successful program? He invited the Panel to think about an analogy—retirement planning—and consider the portfolio approach, i.e., diversify and accept higher risk in one part of the portfolio to get a higher return, but not put all of the investment into high risk ventures. The government could do well by considering different potential providers, some that may be more "reliable" and likely to achieve the product but with a higher cost, and others that may have more risk but may produce lower cost with more payoff. In other words, have both low risk/higher cost providers and higher risk/potentially higher payoff providers in the portfolio. However, this would make the procurement very complex. NASA management has been very clear that it hopes to be able to structure this in a way that there will be multiple bidders, with competition, so that if one team is not successful, NASA is not left "high and dry."

Adm. Dyer noted that the approach is complicated by a couple of things. One decision that has been made is to pursue a firm fixed price arrangement as opposed to cost-plus research and development (R&D). It would be worthwhile to know what the world body of knowledge has to say about safety implications of

fixed price vis-à-vis cost-plus R&D. There may not be a good academic study on this topic. Adm. Dyer observed that in his experience, making investments in performance improvement of any kind (in safety or otherwise) is more stressful in the fixed price environment. Another challenge in the portfolio strategy is the governance responsibility of post-Enron corporate boards vis-à-vis risk-taking on behalf of the stockholders. A mix of candidate producers, made up of risk-averse public companies and entrepreneurial small companies, will be challenging but is doable. Mr. Frost noted that in his experience with fixed price providers, there are obvious pressures not to incorporate safety features that cost money; however, this could be mitigated if there are other motivations that would inspire safety consideration, e.g., public image and liability. Therefore, NASA should be very careful about the liability limitation on these contracts. If companies do not have liability exposure, there is less pressure for safety.

With respect to marketing, Ms. Grubbe commented that it would be interesting to take a product or service and examine its providers and their profitability over time. When considering the delivery of cargo, equipment, or people to an inhospitable environment, one should ask the question: What is the market for this type of delivery? There may be some models that have been put together to look at this type of question.

Adm. Dyer summarized that success criteria, acquisition strategy, and cost estimation/resourcing are all directly related to the overall safety of the program. The ASAP will continue to look at this topic.

METRICS UPDATE

Ms. Grubbe reported on the metrics update that was presented by Mr. Alan Philips, Director of the NASA Safety Center at Glenn Research Center (GRC). Based on prior ASAP recommendations (2008-02-07 and 2009-03-03), the NASA Safety Center has developed a more complete picture of NASA injury and mishap data. This was one of the most comprehensive overviews on occupational mishaps that the Panel has seen, and the ASAP is encouraged to see the Safety Center taking on this role. This was a great first step, and the ASAP would like to hear from the Safety Center at every quarterly meeting. It is encouraging to hear that the Administrator is asking for mishap reviews by Center Directors at his staff meetings. This was also one of the prior ASAP recommendations. More management involvement at senior levels will help drive the middle management interest and lift the safety level overall. Ms. Grubbe hopes that all the NASA managers are watching and modeling the Administrator's behavior.

Additionally, as the metrics are pulled together for and reported to the ASAP, Ms. Grubbe recommended that the Safety Center begin to report and track the following metrics: center by center comparisons of all metrics; categorize the A, B, C, and D mishaps by type, location, cause; compile all incidents and injuries and by cause; report and track all fires on all NASA Centers; report and track all electrical near misses like shocks, flashes, malfunctions on electrical equipment, etc.; report and track all transportation incidents, both NASA vehicles and non-NASA vehicles on NASA business, trucking incidents, marine incidents, and aviation incidents; report and track off-the-job incidents that result in loss time injuries or restricted work activities; confined space entry incidents; lifting and rigging incidents; rotating machinery incidents; and chemical and radiological exposure. This will take time, but NASA should start moving in this direction.

Adm. Dyer noted that the NASA Administrator, Mr. Charles Bolden, joined the Panel meeting late in the afternoon the previous day and also for part of the morning of the present day. The Panel commended Mr. Bolden as he carries out his responsibilities during this time of change and challenge. The ASAP has every faith and confidence in his leadership.

INFRASTRUCTURE FUNDING ISSUES UPDATE

Dr. Bagian reported on the infrastructure funding issues update provided by Dr. Woodrow Whitlow. He noted that the presentation was essentially what the Panel had seen in the past. The ongoing problem is inadequate funding to deal with infrastructure maintenance issues. NASA appears to be more in a reactive mode than a preventive mode. One of the key issues is how to maintain structures beyond their design

life—over 80 percent of the facilities Agency-wide are beyond their design life at this moment. The NASA strategy has been to identify facilities that are not needed now or in the future and demolish them, and the Agency is moving forward on this plan. Due to fiscal constraints, there is a limit to NASA's ability to pursue the overall facilities plan in a satisfactory manner.

It was not clear what safety risk criteria are used for disbursement of capital improvement funds. Mr. Frost noted that the Panel got into this subject at its last quarterly meeting in April. At that time, the Panel queried how much of the $125 million for maintenance and repair was related safety. The ASAP has still not received an answer, and continues to pose that question.

NASA'S INFRASTRUCTURE ISSUES—LANGLEY PERSPECTIVE

Dr. Nield reported on the LaRC's facilities overview that was presented to the ASAP by Mr. George Finelli, Director of the LaRC Operations Directorate. The Panel was pleased to see that the people at LaRC are looking at the data and trying to address the issues. They are now getting a better handle on where they are, and deferred maintenance is being tracked. There are some increases in the maintenance budget in near term. There has been an effort to identify recent breakdowns and degraded performance incidents, and these have been used in the budget rationale. The ASAP saw a lot of proactive assessment in terms of facility conditions and a strategy for the future. All this is being incorporated into the overall strategic plan for the Center, and a good job is being done.

NASA ENGINEERING AND SAFETY CENTER (NESC)

Mr. Frost noted that the NESC continues to be a "shining star" and a success story for NASA. Mr. Tim Wilson, NESC Deputy Director, briefed the ASAP on its current activities. The NESC has completed around 300 engineering assessments, and they have well-documented reports. There is an opportunity to link results of the engineering assessments to NASA standards. In response to an ASAP recommendation, the NESC agreed that it would be a good idea add a standardized paragraph at end of each report making an assessment on the need to modify any standards. Mr. Frost added that the NESC has done some good work on the Constellation abort system, and he was happy to see that the Center has taken that knowledge to the potential commercial providers, transferring what has been learned. This is the kind of interface that will be needed by the commercial world.

There were no further comments, and the meeting was adjourned at 2:35 pm.