

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

September 12, 2008

The Honorable Michael D. Griffin
Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Dr. Griffin:

The Aerospace Safety Advisory Panel held its 2008 Third Quarterly Meeting at Marshall Space Flight Center (MSFC), Huntsville, AL, on July 16-17, 2008. We greatly appreciate the support received from MSFC subject matter experts and their willingness to discuss our concerns open and candidly.

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

Sincerely,

A handwritten signature in black ink, appearing to read "J. W. Dyer". The signature is fluid and cursive, with a large initial "J" and "W".

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

Enclosure

**Aerospace Safety Advisory Panel
2008 Third Quarterly Report
Minutes and Recommendations**

Aerospace Safety Advisory Panel (ASAP)
Public Meeting
July 17, 2008
Marshall Space Flight Center
Huntsville, Alabama

ASAP Members Present

- Vice Admiral Joseph W. Dyer, USN (Retired), Chairman
- Dr. James P. Bagian
- Major General Charles F. Bolden, Jr., USMC (Retired)
- Mr. John C. Frost
- Mr. John C. Marshall
- Ms. Joyce A. McDevitt, P.E.

ASAP Staff and Support Personnel Present

- Ms. Katherine Dakon, ASAP Executive Director
- Ms. Sallie Birket Chafer, Reports Editor

Attendees, Public Session

- Roy W. Malone Jr., Director, MSFC Safety and Mission Assurance Directorate
- Pat Fuller, MSFC
- Vickie Rorex, MSFC
- Sandra Turner, MSFC

OPENING REMARKS

The Aerospace Safety Advisory Panel (ASAP) held the public session of the 2008 third quarterly meeting at the Marshall Space Flight Center (MSFC), located on the Redstone Arsenal in Huntsville, Alabama. Admiral Dyer opened the session by summarizing broad-brush ASAP observations.

First, the Panel is beginning to see the fruits of the decision to transfer knowledge from one generation of NASA scientists and engineers to the next as NASA assumes some of the prime contractor responsibilities for the Constellation Program. Program and technical leadership is complex and challenging, but also under way.

Second, it is especially evident to the ASAP that a number of MSFC safety programs are genuinely first-class efforts that deserve to be replicated at other NASA centers and improved upon as a basis for standardization. The MSFC safety tracking system and the staff's ability to identify trends and compare and document performance across years are perhaps best practices as well.

Third, the Base Realignment and Closure (BRAC) personnel moves will bring a tsunami of positions to Huntsville from Northern Virginia. Because the number of positions

exceeds the number of people making the move, the Panel is convinced that MSFC will face personnel management and workforce challenges that will negatively impact safety.

REUSABLE SOLID ROCKET MOTOR THRUST OSCILLATION ISSUES

Thrust oscillation, also known as resonant burning, has several important effects, including the generation and transmission of the oscillation as well as the effects on humans at the top of the rocket. The topic has received a lot of press recently, so the Panel was interested in the ground truth. Mr. Frost observed that, to its credit, MSFC understands the issue and has identified it early in the development of the full Ares vehicle, giving MSFC a lot of trade space for its team of engineers, safety personnel, rocket motor experts, and human factors engineers to resolve the problem.

Garry Lyle, Associate Director for Technical Management at the MSFC Engineering Directorate, reported that thrust oscillation is a well-known characteristic of every solid rocket motor (SRM), so engineers anticipate and understand it and must design around it. The Ares problem is that the four-segment SRMs for the Shuttle resonate at about 15 Hz (or cycles per second); because this does not match any resonant frequency in the Shuttle, effects are minimal. However, when the motors are lengthened to five segments, resonance drops a bit to 12 Hz, which could match a resonant frequency in the overall Ares vehicle. As a phenomenon, resonance in any aerospace vehicle creates the potential for structural concerns and normally is designed out of the structure, either by changing the impulse or by redesigning the structure to change its response.

MSFC is attacking the issue on both engineering fronts. First, MSFC is trying to reduce the levels of thrust oscillation generated within the SRMs. Second, MSFC is considering adding attenuation or antiresonance features to the vehicle. Mr. Frost expressed great confidence that the problem is solvable and that MSFC is on the path to identifying the most effective solution while minimizing increased weight. The main limitation on vehicle vibration levels is the very stringent design limits allocated to vibration of the crew itself. The Panel notes the possibility that such limits could be raised, especially if the crew has few critical tasks at the time that the vibrations are most likely. On questioning, it was disclosed that a risk-based analysis had not been performed to assess the need to mitigate the oscillations based on the impact on crew performance. The presenters and the Panel members all agreed that such an analysis is needed to appropriately manage the associated risks.

Mr. Frost encouraged MSFC to expand human factors engineering involvement and to look for new ideas about human performance at those vibration levels, in particular by seeking input from experts who confront similar vibration limit issues (for instance, personnel who work on rotary wing vehicles such as those at the Army Aeromedical Research Laboratory at Fort Rucker).

UPDATE ON CAIB IMPLEMENTATION

As mandated by Congress and the NASA Authorization Act of 2005, the ASAP is responsible for evaluating and reporting annually on NASA compliance with the return-to-flight (RTF) and continue-to-fly recommendations of the Columbia Accident Investigation Board (CAIB). John Casper, Associate Manager of the Space Shuttle Program, provided specifically requested updates on the three CAIB recommendations—

external tank thermal protection system (TPS) modifications, orbiter hardening and TPS impact tolerance, and TPS on-orbit inspection and repair—that the RTF Task Group’s July 2005 final report categorized as needing more work. He also presented NASA’s recommendation that the ASAP close out these three recommendations.

Ms. McDevitt commented that this request is timely given the upcoming release of the *ASAP Annual Report for 2007*, which discusses this subject at some length, concluding:

While the ASAP is satisfied with...[NASA responses] to the three outstanding recommendations, the Panel continues to feel that it cannot make a final determination that would serve as the basis for closing those recommendations. As the Panel indicated in its *Annual Report for 2006*, the extensive review and analysis...necessary...are beyond the resources of the ASAP.

The ASAP noted that it was very pleased with NASA’s overall response and continuing substantive progress. NASA has taken the CAIB recommendations very seriously, investing tremendous effort in closing them out by creating meaningful solutions. No member of the Panel doubts that the Shuttle is safer today than it has been at any time in the past and at any time since the CAIB issued its recommendations, but Admiral Dyer noted that risk absolutely still remains. Mr. Frost observed that, as a matter of vehicle physics, NASA cannot totally eliminate the hazard associated with the three CAIB recommendations, but should continue relevant work as long as a reasonable opportunity for further improvement exists. Mr. Marshall agreed that NASA has (and should use) opportunities other than closeout to manage these risks. This said, the Panel’s consensus was that after all options are exhausted, it is NASA’s responsibility, not the Panel’s, ultimately to accept or reject the risks, as it does for each flight, by applying its very clear formal risk acceptance process, producing the accepted risk hazard report, and obtaining a final decision at the program level or from the NASA Administrator, depending on the level of risk.

The ASAP did confirm that it intends to continue monitoring the three remaining CAIB recommendations, using this status report (perhaps with an end-of-year update) as input for the 2008 annual report to the NASA Administrator and Congress. However, the Panel reaffirmed that it does not intend to take a position on closing out the three remaining CAIB recommendations.

MSFC–SPECIFIC SAFETY ISSUES, IDENTIFIED OPPORTUNITIES, AND NEAR MISSES

Ed Kiessling of the Safety, Quality, and Management Systems Department, which is part of the Safety and Mission Assurance (S&MA) Directorate, described the MSFC Industrial Safety Program. The ASAP was extremely impressed, not only by the in-place processes that MSFC personnel are pursuing—a hard-core program backed by attention to detail and exceptionally good internal and external communications—but also by the results and their potential for Agency-wide application.

During FY 2008 (through June), MSFC had no fatalities or disabling injuries, only 3 lost-time mishaps, and 23 OSHA recordable mishaps (all world-class figures). The lost workdays equate to a .06 rate, compared to .1 percent for generally world-class organizations (for example, DuPont, Alcoa, and other companies that have focused for years on preventing, reducing, and eliminating workplace injuries).

The Panel expressed its sincere regret over the truly unfortunate onsite fatality. Although it was more the result of criminal action than an accident, the entire ASAP joins MSFC employees in grieving for the family. However, the Panel was impressed that MSFC already has taken action to prevent such an incident in the future, using an approach similar to the one for eliminating accidents.

Mr. Marshall noted that he was struck not only by the meaningful metrics generated by MSFC's world-class reporting procedures, but also by the associated leading-edge indicators (such as close calls, team metrics, and comparisons with other NASA centers or other organizations of like nature). MSFC is the first NASA organization that collectively gathers and analyzes data across all leading indicators at the same time, applying clear-cut visions and goals, key event timelines with milestones, and periodic assessments of Center failures and possible corrective actions. Mr. Marshall cited a few key recent successes, including ISO 14001 certification of a chemical management system institutionalized throughout MSFC; monthly Safety, Health, and Environmental (SHE) Program reports (submitted to the Integrated Management Systems Board) and SHE training assessment tools; the pressure systems improvement initiative; improved safety assessment processes; and, most important, a customer feedback assessment tool that solicits opinions on the effectiveness of safety programs from people working in the trenches.

Mr. Frost noted that although these tools currently are showing positive results, MSFC is continuing to observe and track its metrics and follow up on negative indicators. This continuous process improvement ensures that positive results are not a matter of luck, but rather intentional enhancements. He observed that MSFC safety procedures are world-class in no small part because of the level and quality of personnel. MSFC runs a modern management program with feedback channels and constant corrections to address the causes of problems, and the Panel concludes that other NASA centers should adopt similar or identical programs.

OVERVIEW OF CONSTELLATION PROGRAM ACTIVITIES

Jeff Hanley, the Constellation Program Manager, summarized the Constellation Program, which clearly is a huge, very complex undertaking and a serious focus of MSFC time and work, with expenditures totaling \$250 million a month even at this early stage. The Constellation Program implementation differs considerably from previous programs such as the Shuttle. Notably, MSFC is integrating all of the Constellation Program systems, and NASA is conducting Level 2 integration, previously a prime contractor task.

The ASAP unanimously agreed that NASA's prime integration role is a positive development that cultivates internal technical capabilities and thus the ability to own the program. MSFC is transferring knowledge, thereby building a new generation of rocket scientists and supporting the expanded management role of MSFC civil servants. Still, this approach entails risk that is exacerbated by factors such as the large number of moving parts, numerous vehicles, multiple producers, high burn rate, and program complexity. Mr. Marshall also cited the geographic dispersal of many of the involved organizations, the need for diverse programs to mature at the same time, exceptionally long Constellation Program lead times, and some new and unique problems (especially as the focus shifts beyond lunar exploration).

Dr. Bagian observed that a number of systems and structures are now in place to manage and integrate the Constellation Program, including communication channels at both Level 2 and MSFC. Ms. McDevitt added that people still have to understand and work effectively with the new systems to achieve the stated objectives. Furthermore, this approach requires a high level of vigilance and consistent monitoring of progress. Although ASAP conclusions are necessarily tentative at this early time, MSFC is making a good effort in the right direction, but must continue to learn as it proceeds.

The Panel also noted that the classic Department of Defense (DoD) or NASA management model paired a government program management office (responsible for cost, performance, and engineering oversight) with a total system integration contractor acting as prime. These two elements exerted a positive tension, but the Constellation Program does not include the same level of checks and balances. The Panel suggests the need to find positive tension some other way, for example, through groups such as the ASAP or through the technical expertise of NASA retirees or independent organizations.

The Panel made several narrower Constellation Program observations. First, the Panel agrees that the virtual mission tool makes good sense. MSFC already has modified the structures and approaches based on lessons learned, and the ASAP has confidence that MSFC will continue this iterative process. Second, Mr. Frost noted that as little as a year ago, the Panel was concerned about human rating requirements for Constellation. Except for a few loose ends, NASA Headquarters in toto now concurs (after give and take on both sides), and the Agency recently released a new human rating requirements document. Third, other problems (such as SRM thrust oscillation and the impact of the BRAC, discussed elsewhere) affect the Constellation Program, so the Panel will continue monitoring them. Panel members did express their desire to obtain additional detail on the Agency's recently published NASA Human-Rating Requirements (NPR 8705.2) at a future session.

MSFC CONSTELLATION PROGRAM LAUNCH VEHICLE RESPONSIBILITIES

Drilling down into the Constellation Program, Jim Reuter, the Ares Project Office Vehicle Integration Manager, reported that MSFC now is focused primarily on Ares I, which will launch six crew members to the International Space Station and four to the Moon. The Panel noted that production of Ares I stages entails a mix of centers, contractors, and producers and poses a complex management challenge that is being met, but remains complicated.

Admiral Dyer observed that the Ares I initial operating capability (IOC) is scheduled for 2015, which is getting closer every day. The vehicle designs and program components are complex, but are simplified a bit by significant reuse of designs and materials (drawing heavily from the Saturn V and Shuttle) and by reliance on infrastructure investments (some new, but some old and still useful infrastructure). In addition, Ares I requirements are firming up and catching up with plans and builds. Mr. Frost commented that he had always been concerned that the Shuttle had a very limited (if any) capability to survive a bird strike during ascent, but was glad to hear that Ares I will comply with the now-standard NASA 5-pound vulture impact requirement.

The Panel has long been seeking two numbers to identify the design reliability (mission capability) requirements for the vehicle design, and Mr. Reuter reported that for the overall Ares I (combined ISS and lunar crew missions), MSFC is looking at a loss of crew risk on the order of 1 in 2,500 (assuming the ability to return from anywhere during the launch profile) and a loss of mission risk of 1 in 500.

Ares I leaders are targeting design completion in 2013 and IOC by 2015. The Panel was significantly relieved by MSFC progress on SRM-induced pulse vibrations and longitudinal control authority issues (noted previously). The upcoming BRAC move into Huntsville (discussed subsequently) is a risk element that Ares I program management must consider. The ASAP has identified a new issue to watch closely, the complex Ares separation design, specifically between the first stage and the interstage.

MSFC SCIENCE AND MISSION SYSTEMS RESPONSIBILITIES

John Horack, the Director of the MSFC Science and Mission Systems Office (S&MSO), made a primarily informational presentation on past and current projects. Mr. Frost noted that S&MSO is an interesting directorate with numerous responsibilities (for example, the science related to robotics and human missions), managing everything at MSFC but for the Shuttle and Ares programs. The ASAP had not previously heard much about S&MSO, which performs very impressive science, thinking about the future and what it will take to get there. The Panel notes a particularly interesting fact, that NASA has maintained a continuous human presence in space since November 2, 2000.

PERSONNEL RETENTION AND EFFECTS OF BRAC PLAN

Tereasa Washington, Director of the MSFC Office of Human Capital, reported that BRAC shifts are often viewed negatively, but the economic impact in this case is a significant gain in positions at the Redstone Arsenal (coming from the Naval Materiel Command, Missile Defense Agency, and others). The BRAC impact extends beyond NASA to the entire Huntsville region, which has to invest in infrastructure (for example, schools, roads, hospitals, emergency care) to serve the significant influx of new residents.

Admiral Dyer noted that there is always risk associated with large personnel shifts. As Commander of the Naval Air Systems Command (NAVAIR), he faced a challenge of comparable scope and complexity in moving 6,000 personnel from Northern Virginia to Patuxent River, Maryland. He expressed his belief that Huntsville is behind the curve because it takes 3 to 3.5 years to prepare for such a move and avoid adverse impacts.

Focusing on MSFC, the ASAP confirmed a significant risk to effective workforce planning. Admiral Dyer's back-of-the-envelope analysis indicated that MSFC employs a round-number total of 5,000 civil servants and contractors (including 500 who directly support Ares), compared to 10,000 incoming BRAC positions. DoD experience is that 75 to 80 percent of personnel do not move when asked to relocate hundreds of miles away, so roughly 8,000 positions would need to be filled. If DoD stripped NASA to the bone, it still could not fill all of the necessary positions. Admiral Dyer declared that if he were a manager at MSFC and in the midst of a major program, he would view the imminent BRAC influx with serious safety concern, maybe even alarm.

Moreover, the peak BRAC year for Huntsville, 2010, is rapidly approaching. Mr. Frost noted that is also the transition year when the Shuttle ceases operations and Constellation ramps up, making this an emergency situation for MSFC. He worried that the Center is not sufficiently alert to, and prepared for, a possible sudden targeting of its most vulnerable and qualified personnel whose skill sets correlate closely to those needed by the Army. Although MSFC recognizes the issue, it also downplays the risk to some extent based on current trends, which do not yet reflect the BRAC impact.

The ASAP concluded that planning for BRAC moves is much more urgent and time sensitive at MSFC than at other centers. MSFC therefore should identify key and critical personnel (from the integrated civil service and contractor workforce) whose knowledge is absolutely crucial to the Center and the Constellation Program. Using an estimated ratio based on Admiral Dyer's NAVAIR work, MSFC probably will identify some 2 dozen to 3 dozen personnel whom it must do everything possible to retain. The Panel noted two related statistical issues. First, Mr. Marshall encouraged MSFC to further quantify real losses to the required level of specificity (such as other key career fields and Constellation Program schedule delays). The numbers will be raw, but will enable MSFC to determine the national impact and decide how to handle it. Second, Mr. Frost acknowledged the difficulty in gathering real numbers on the number of BRAC positions and skill sets. Only a few organizations have reported, accounting for 1,700 of the 10,000 Huntsville positions, a misleadingly small picture of the problem. MSFC should use currently available figures to build the best possible model, estimate the most probable BRAC numbers, create a position summary and skill set chart, and adjust the model over time.

To protect the Constellation Program, if it is not too late, MSFC should request relief (similar to the exceptions granted to DoD) from term appointment constraints and from retirement salary reduction offsets for reemployed annuitants. The Federal Government requires NASA to hire 15 percent of its civil service workforce as term appointments (introducing some softness in employee retention), but DoD is not subject to this requirement. In addition, under Office of Personnel Management rules, DoD can reemploy retirees from other agencies without a salary offset, so an eligible MSFC engineer or other civil servant could retire, accept an Army job, and draw 100 percent of the Army salary in addition to full retirement pay. NASA cannot match that very attractive economic package. MSFC has 664 personnel who are already retirement eligible, and that number will grow considerably by 2010.

MSFC TECHNICAL AUTHORITY

The ASAP concluded resoundingly that "MSFC gets it" after hearing presentations on technical authority (TA) by Roy Malone, Director of the MSFC S&MA Directorate; Dan Dumbacher, Director of the MSFC Engineering Directorate; and Robert Lightfoot, MSFC Deputy Director. The Panel is very pleased with MSFC's level of understanding, development, and integration of TA within the Center.

Mr. Marshall explained the importance of TA to the ASAP, which has addressed the topic since the CAIB recommendations identified the loss of TA and failure to execute a process as direct contributing factors to the loss of Columbia. The ASAP and the NASA Administrator have discussed his clear vision of TA at NASA, which the Panel has

repeatedly endorsed. Unfortunately, the ebb and flow of emphasis on TA as well as inconsistencies and lack of execution at the center level have caused consternation to this Panel and affected the Agency's ability to address critical issues.

At every center, the Panel looks for a formal process that ensures that the correct level of technical competencies are used to resolve and revisit issues; enables all cognizant parties to express their views, concerns, and enthusiasms; and resolves internal Agency disputes. At MSFC, that process includes a number of components. First, the governance council includes the Strategic Planning Council, Integrated Management Systems Board, and Center Management Council. Second, TA execution by the MSFC Director incorporates vertical and horizontal interfaces, multiple opportunities for discussions, emphasis on routinely involving the most technically competent professionals in the process so that they can express concerns and dissents, and provisions to elevate disagreements to the proper level of expertise to obtain resolution. Third, a particularly impressive MSFC-developed tool, the Center Management System, enables the Center Management Council to monitor project status from the management perspective and to track financial status and schedule performance. Fourth, reviews encourage the project manager, engineers, and S&MA community to look at technical status updates. Fifth, when disagreements occur, a forum (the Safety and Mission Assurance Council) fosters give-and-take dialogs, creating a healthy tension between technical and safety issues to resolve problems or escalate them to the next level if necessary.

Dr. Bagian observed that Mr. Lightfoot not only described the MSFC project status dashboard (which assigns red, yellow, and green indicator lights), but correctly emphasized that the dashboard is strictly an aid—one tool among many—in identifying issues that deserve more discussion and better understanding.

Ms. McDevitt noted some excellent MSFC safety initiatives related to TA. For example, MSFC created Chief Safety Officer (CSO) positions at the GS-15 level, on par with their engineering counterparts, and has assigned a number of top MSFC engineers to these CSO positions. The ASAP has not seen this approach at other NASA centers and commends S&MA leadership. Such numerous reassignments elevate the level of S&MA competence and prestige, change the image of safety from an afterthought to an integral process, and indicate that MSFC is a good place to work. Ms. McDevitt expressed the Panel's hope that such personnel rotations are not a short-term measure.

Mr. Marshall was struck by the S&MA reorganization to optimize its ability to address the transition under way from the Shuttle to Ares I and V programs. S&MA leaders have brought respect to the organization, which is hard to accomplish in the safety community. S&MA not only has taken steps to improve the organization, but also is producing tangible effects. For example, no meeting proceeds without a safety officer in attendance, and personnel from prestigious MSFC organizations are applying to join S&MA. Mr. Frost concluded that the MSFC solution is not just theoretical; it is working, and if it works at MSFC, it can work everywhere.

ASAP RECOMMENDATIONS, THIRD QUARTER, 2008

2008-03-01. The ASAP recommends that the staff of the NASA Chief of Safety and Mission Assurance should assess the Agency-wide applicability of the MSFC approaches for implementing a successful industrial safety program.

2008-03-02. To expedite future ASAP site visits, the Panel recommends that other centers present leading and lagging industrial safety performance metrics similar to those tracked by MSFC, establishing a basis for discussions with the ASAP. This approach would give the Panel opportunities for gaining a better, more consistent understanding of safety processes; improving the bases for comparing and contrasting programs; and perhaps also supporting NASA cross-pollination of good ideas.

2008-03-03. The ASAP agrees with the new Constellation Program approach to integration, which places NASA in the position of prime systems integrator, but the Panel notes that it is a high-risk proposition. Although NASA and MSFC deserve high marks for a good start, the ASAP recommends that this Panel and others should continue to closely monitor the progress of Constellation Program operations for years to come.

2008-03-04. The ASAP concluded that planning for BRAC moves to the Huntsville area is life-critical at MSFC, so (1) the Center should review Constellation and other core ongoing programs to identify key and critical personnel whom the Center absolutely must retain to deliver required Constellation Program services; and (2) to protect the integrity of the Constellation Program and level the employment playing field with DoD, MSFC should immediately request Government waivers from term appointment constraints and from retirement salary reduction offsets.

2008-03-05. In accordance with its mandate, the ASAP will continue to monitor new developments relevant to the three CAIB recommendations that have not been closed out, but the Panel does not have the resources necessary to conduct the extensive review and analysis necessary to recommend closeout. NASA must decide whether to accept the risks associated with the remaining three CAIB recommendations before the Panel can decide whether to concur.

2008-03-06. When the timing is appropriate, the ASAP requests a briefing from NASA on the new, recently published NASA Human-Rating Requirements (NPR 8705.2).

2008-03-07. The ASAP recommends that NASA perform an updated risk-based analysis in the near future to assess the crew-performance impacts of thrust oscillations generated within the Ares I SRMs. This timely analysis will enable NASA to quantify, manage, and if necessary mitigate operational risks associated with such oscillations.