

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

December 20, 2015

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

Dear Mr. Bolden:

The Aerospace Safety Advisory Panel (ASAP) held a Public Telecon Meeting on December 14, 2015, to discuss two recommendations: Orion Risk Assessment and Human Space Flight Mishap Response Procedures.

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

Sincerely,

A handwritten signature in black ink, appearing to read "J W Dyer", enclosed in a thin black rectangular border.

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

Enclosure

**AEROSPACE SAFETY ADVISORY PANEL
Public Telecon Meeting
December 14, 2015**

Aerospace Safety Advisory Panel (ASAP) Attendees

Dr. Patricia Sanders
CAPT (Ret.) Brent Jett
Dr. James Bagian
Dr. Donald McErlean
CAPT (Ret.) Robert Conway
Mr. John Frost

ASAP Staff and Support Personnel Attendees

Ms. Carol Hamilton, NASA ASAP Interim Exec. Director
Ms. Marian Norris, NASA ASAP Administrative Officer
Ms. Paula Burnett Frankel, Writer/Editor

Other Attendees via Telecon

Kevin Dorn, Parsons Corporation
Bill Jordan, NASA/Johnson Space Center (JSC)
Theodore Kronmiller, Law Office
Frank Moring, Aviation Week
Diane Rausch, NASA Headquarters
Christian Rice, House Committee on Science, Space and Technology
Nigel Simmons (not affiliated/member of the public)

Opening Remarks

Ms. Carol Hamilton, ASAP Interim Executive Director, called the meeting to order at 3:30 p.m. She reviewed the Agenda, which included possible ASAP recommendations on two areas of interest.

Dr. Patricia Sanders led the meeting for the ASAP Chair, VADM Joseph Dyer (Ret.), who was unable to attend the telecon. Dr. Sanders introduced the topics and noted that there were two areas to be discussed—Orion risk assessment and human space flight mishap response procedures.

CAPT (Ret) Brent Jett discussed the first proposed recommendation on the Orion Test Plan. At the last quarterly meeting, the Panel had discussions with NASA regarding the original Orion test qualification plan from 2010 and the changes from that plan until today. The Panel learned that there were two categories of changes that were made. In 2010, NASA, in an effort to reduce Orion’s development cost, decided to switch from a dedicated qualification test article to a distributed qualification approach. This change resulted in 18 issues or “gaps” in the qualification plan for Orion. There were a series of changes since 2010, where NASA was attempting to close those gaps or issues. Those changes have been ongoing.

There second category of changes is those that have been made in response to cost and schedule pressures on the program. Two examples caught the attention of the Panel: the reduced fidelity of the Ascent Abort 2 (AA2) test; and the decision to go to module-level, direct field testing for vibro-acoustic qualification as opposed to integrated reverberant testing.

NASA informed the Panel that the change to AA2 was made to reduce cost. Also according to NASA, the change to vibro-acoustic qualification was made to reduce schedule risk for Exploration Mission (EM)-1 and enable

acceptance testing for subsequent missions to be performed at the Kennedy Space Center (KSC), saving time and money.

CAPT Jett noted a few things about the AA2 test. The decision go to a “boilerplate” or “non-flight-like” crew module instead of a high-fidelity crew module for AA2 was the subject of a lot of discussion at the last quarterly meeting and is most concerning to the Panel. AA2 is the only opportunity to flight test the Launch Abort System (LAS) and its interactions with many other Orion systems in the challenging transonic flight environment. Qualification of the abort system ultimately relies on analytical models that are very complicated and have some degree of uncertainty. The new test plan misses a valuable opportunity to obtain a high-fidelity test point for analytical model validation as part of a complete “end-to-end” system test.

Mr. John Frost noted that we have a history in Gemini and Apollo of extensive abort testing. CAPT Jett agreed. He stated that the LAS is a primary safety feature, and if something goes wrong during the early phase of ascent, it is the last hope for the crew. It is an extremely important system, and the Panel feels that an end-to-end test with a high-fidelity module for AA2 would be extremely valuable. The AA2 is only one example of a test that was modified as a result of cost pressures. The Panel is concerned that NASA has not fully assessed the aggregate increase in risk that is being accepted to hold schedule and content for EM-2. While each change to the test and qualification plan, considered individually, may appear to be a rational approach to dealing with cost and schedule issues, the cumulative effect is often not evaluated. While the desire to fly crew on Orion as soon as possible is understandable, NASA is building a long-term exploration program, and adjustments to the near-term schedule or mission content that result in far safer systems can be an advantageous trade.

CAPT Jett proposed the following recommendation.

The ASAP strongly recommends that NASA evaluate the combined effects and aggregate risk increase associated with the multiple changes to the Orion test and qualification plan. The Panel especially recommends NASA review decisions that were driven, in part, by a constraint to hold the EM-2 schedule and content for 2021. As part of the review, the Panel recommends that NASA fully assess the alternative of schedule relief and/or EM-2 content change as opposed to accepting the additional risk associated with the modified test/qualification.

In response to a question from Mr. Frost, Jett cited some of the gaps that were caused by the change from the dedicated to the distributed test plan. One of those was the deletion of pyro shock separation testing at the system level. That has been one of the more challenging gaps to close, and it is not clear that NASA has completely closed it. They are doing component and subassembly testing and can provide some limited pyro shock testing with the environmental test article at Plum Brook. However, it appears that there is additional risk being accepted by NASA. Even though they may ultimately close the issues, they may close them with some additional risk acceptance. Mr. Frost added that pyros in general are difficult to simulate, and that is a good one to do actual testing on.

CAPT Jett noted that the original test plan for AA2 would have provided a critical data point for the forward bay cover, which would have combined the actual acoustic and pyro shock environments of a transonic abort. This is an example of combination of decisions and aggregate effects.

There was no further discussion, and the Panel concurred in going forward with the recommendation.

Mr. Frost discussed the second topic, human space flight mishap response procedures. At ASAP’s last quarterly meeting at Johns Space Center, Mr. Rick Gaven discussed NASA’s planning for mishaps in the Commercial Crew

Program (CCP). As part of that planning, the Program had mapped out what type of investigation they would have under various types of mishaps. The Panel found that because of some existing Congressional language, they would have to plan on a Presidentially-appointed commission for investigation of some types of mishaps where such a commission may not be needed. This type of investigation for some types of spacecraft systems mishaps did not appear to be warranted. In looking at the NASA 2005 appropriation document, it does have language that appears to be aimed at what NASA was flying at the time—the Space Shuttle and International Space Station, which were fully reusable NASA assets. In today’s world, we have different types of systems: commercial crew, not owned by NASA, and even Orion, which is not a multi-use system. The ASAP concluded that the 2005 language should be updated to fit the kinds of systems that NASA is flying today.

Mr. Frost summarized the finding. The CCP is now developing a formal plan for how it will respond in the event of a major malfunction or mishap. In addition to optimizing what can be learned by proper investigation of malfunctions or mishaps, this plan must comply with specific language in the NASA Authorization Act of 2005 concerning Human Space Flight Independent Investigations. NASA has tentatively identified the entities that would investigate various types of mishaps during the five mission phases. Under the current Authorization language, a Presidential Commission would be required in all cases involving loss of the flight crew as well as in all cases involving loss of the vehicle, even if the flight crew is not injured. Use of a Presidential Commission in the latter cases appears excessive.

Mr. Frost proposed the following recommendation.

The Authorization language should be reviewed with today’s systems in mind. Also, more details appear appropriate for the NASA implementation document. These details would include the level of vehicle damage requiring investigation, the temporal issues of when mission phases begin and end, and NASA’s oversight role in mishap investigations conducted by its providers, as well as when the need for outside oversight is required. The mishap response procedures should be thought through, documented, and in place well before any actual flights.

Mr. Frost noted that other Panel members have pointed out that sometimes NASA does need outside oversight. Dr. James Bagian has made a strong case for it. This issue is broader than commercial crew, and we need to think about how to handle other vehicles such as Orion. The proposed language covers that.

Dr. Bagian agreed that the language covers outside oversight. He highlighted the importance of identifying when it is appropriate to have this type of oversight, because it is extremely important.

There was no further discussion, and the Panel members agreed to move forward with the recommendation. Dr. Sanders adjourned the meeting at 3:47 pm.

ASAP RECOMMENDATIONS
Public Telecon Meeting
December 14, 2015

2015-05-01: Orion Risk Assessment

Finding:

Since 2010, numerous changes have been made to the Orion test and qualification plan. The first major change was made during the uncertainty of whether Orion would survive the cancellation of the Constellation Program. In an effort to reduce Orion's development cost, NASA decided to switch from a dedicated qualification test article approach to a distributed qualification approach, where the high-fidelity test articles would subsequently be used for flights, including the first crew mission. The decision, while saving money, resulted in 18 issues (or gaps) in the qualification and test program. One of the most significant gaps was the deletion of pyro shock/separation testing at the integrated system level.

While working to close the 18 issues, NASA also continued to modify the Orion test and qualification plan to deal with cost and schedule pressures. Two recent changes caught the attention of the Panel:

- the reduced fidelity of the Ascent Abort 2 (AA2) test, and
- the use of module-level, direct field testing for vibro-acoustic qualification as opposed to integrated reverberant testing.

NASA informed the Panel that the change to AA2 was made to reduce cost. Also according to NASA, the change to vibro-acoustic qualification was made to reduce schedule risk for Exploration Mission (EM)-1 and enable acceptance testing for subsequent missions to be performed at the Kennedy Space Center (KSC), saving time and money.

Recommendation:

The ASAP strongly recommends that NASA evaluate the combined effects and aggregate risk increase associated with the multiple changes to the Orion test and qualification plan. The Panel especially recommends NASA review decisions that were driven, in part, by a constraint to hold the EM-2 schedule and content for 2021. As part of the review, the Panel recommends that NASA fully assess the alternative of schedule relief and/or EM-2 content change as opposed to accepting the additional risk associated with the modified test / qualification.

Rationale:

Taken individually, the decision to use a "boilerplate" or "non-flight-like" crew module instead of a high-fidelity crew module for AA2 is the most concerning to the Panel. AA2 is the only opportunity to flight test the Launch Abort System (LAS) and its interactions with many other Orion systems in the challenging transonic flight environment. Qualification of the abort system ultimately relies on analytical models that are very complicated and have some degree of uncertainty. The new test plan

misses a valuable opportunity to obtain a high-fidelity test point for analytical model validation as part of a complete “end-to-end” system test. The LAS is a primary safety feature that is allocated 95 percent reliability and will be flown on every mission for the next 40 years. It is the last hope for the crew if something goes wrong during the early phase of ascent.

Considering the test and qualification changes collectively, the Panel notes that the rationale used to justify one decision can be affected by subsequent decisions. For example, when NASA accepted the elimination of integrated pyro shock testing, part of the rationale presented to the Panel was that the “full vehicle would experience shock events at least once during flight prior to a manned flight.” However, the subsequent AA-2 decision eliminates a critical data point for the forward bay cover, which would have combined the actual acoustic and pyro shock environments of a transonic abort.

Finally, the Panel is also concerned that NASA has not fully assessed the aggregate increase in risk that is being accepted to hold schedule and content for EM-2. While each change to the test and qualification plan, considered individually, may appear to be a rational approach to dealing with cost and schedule issues, the cumulative effect is often not evaluated. While the desire to fly crew on Orion as soon as possible is understandable, NASA is building a long-term exploration program, and adjustments to the near-term schedule or mission content that result in far safer systems can be an advantageous trade.

2015-05-02: Human Space Flight Mishap Response Procedures

Finding:

The Commercial Crew Program is now developing a formal plan for how it will respond in the event of a major malfunction or mishap. In addition to optimizing what can be learned by proper investigation of malfunctions or mishaps, this plan must comply with specific language in the NASA Authorization Act of 2005 concerning Human Space Flight Independent Investigations. NASA has tentatively identified the entities that would investigate various types of mishaps during the five mission phases. Under the current Authorization language, a Presidential Commission would be required in all cases involving loss of the flight crew as well as in all cases involving loss of the vehicle, even if the flight crew is not injured. Use of a Presidential Commission in the latter cases appears excessive.

Recommendation:

The Authorization language should be reviewed with today’s systems in mind. Also, more details appear appropriate for the NASA implementation document. These details would include the level of vehicle damage requiring investigation, the temporal issues of when mission phases begin and end, and NASA’s oversight role in mishap investigations conducted by its providers, as well as when the need for outside oversight is required. The mishap response procedures should be thought through, documented, and in place well before any actual flights.

Rationale:

The requirement for a Presidential Commission was logical for International Space Station or Space Shuttle missions, because they were reusable national assets. It would, however, appear excessive in some cases for commercially provided vehicles or other vehicles not planned for reuse. One example would be the sinking of a non-reusable vehicle after the flight crew had been safely recovered and were on their way home.