

## 4 TRANSITION TO THE ASAP

The Aerospace Safety Advisory Panel (ASAP) is a senior advisory committee that reports to the NASA Administrator and Congress. The Panel was established by Congress after the Apollo 204 Command Module (“Apollo 1”) spacecraft fire in January 1967 to advise NASA on the safety of operations, facilities, and personnel.

The statutory duties of the ASAP, as prescribed in Section 6 of the NASA Authorization Act of 1968, Public Law 90-67, as amended, 42 U.S.C. 2477, are:

“The Panel shall review safety studies and operations plans that are referred to it and shall make reports thereon, shall advise the Administrator with respect to the hazards of proposed operations and with respect to the adequacy of proposed or existing safety standards, and shall perform such other duties as the Administrator may request.”

The ASAP consists of nine members appointed to two year terms, reaffirmed annually, by the NASA Administrator. The NASA Chief Safety and Mission Assurance Officer participates as an *ex-officio* member in Panel activities. The ASAP meets as a group four times per year, and conducts independent fact-finding as needed.

Given that the ASAP meets only quarterly, and has no full-time investigative staff, the RTF TG recognizes that this volume of forward work may be beyond the resources of the ASAP. It is possible that ASAP may be assisted by other independent entities to assess the Agency’s performance of the tasks described in the subsequent sections. For example, the ASAP could make arrangements with the NASA Engineering and Safety Center (NESC), the Independent Technical Authority (ITA), the National Research Council, the National Academies, or other independent organizations to assist in its evaluations.

### 4.1 Conditions for Transition

It became clear early-on that the ASAP would ultimately become involved with monitoring the NASA implementation of the Columbia Accident Investigation Board (CAIB) recommendations. The RTF TG was responsible for assessing only the CAIB recommendations marked “return to flight,” and the Task Group limited itself to this subset of 15 items. The remaining 14 (non-return to flight) CAIB recommendations, as well as other findings, observations, and NASA “raising the bar” actions would need to be assessed by another organization, such as the ASAP. CAIB believed that all 29 of their recommendations captured “thinking on what changes are necessary to operate the Shuttle and future spacecraft safely in the mid- to long-term.” While the RTF TG, by charter, focused solely on CAIB return-to-flight recommendations, the CAIB report focused more broadly on the needs of the Space Shuttle and future program needs.

As the RTF TG completed their assessments, it also became apparent that some of the return-to-flight implementations contained forward work that would require monitoring by another organization, and the RTF TG negotiated a Memorandum of Agreement with the ASAP to continue this work. In the case of the return-to-flight recommendations, the RTF TG only assessed those portions of the NASA implementation that was specifically intended for STS-114 – any future work was largely outside the scope of the Task Group. The conditions that predicated a need to transition a CAIB recommendation to the ASAP were:

1. A CAIB recommendation had a phased implementation approach, some being implemented before return-to-flight and some planned for implementation afterwards. For those phases of implementation not planned for STS-114, the ASAP will need to monitor and evaluate the future implementation.

**Final Report of the Return to Flight Task Group**

2. The implementation of a CAIB recommendation will be available for the return-to-flight, but the implementation needs to be demonstrated in the flight environment. An example includes the reduction of debris shedding from the External Tank. Since the RTF TG completed its assessments prior to STS-114, the ASAP will have to assess the results of the flight data to verify the performance is as expected.
3. A CAIB recommendation has a temporary implementation for STS-114 which cannot be used on a specific later flight, such as the proposed Hubble servicing mission. While the RTF TG has assessed the STS-114 implementation, the ASAP will need to monitor and evaluate the final implementation.

May 17, 2005

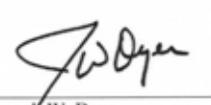
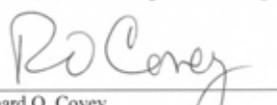
**MEMORANDUM OF AGREEMENT**

Members of the Return to Flight (RTF) Task Group and the Aerospace Safety Advisory Panel (ASAP) met on September 14, 2004, to discuss ideas to ensure a smooth transition between the panels after the Space Shuttle returns to flight. The focus of this transition effort was to capture knowledge and ensure continuity on critical safety issues as the RTF Task Group concludes. Followup activity on RTF issues and actions will be incorporated into the ASAP's working plan.

The following are essential elements of the agreement:

1. The RTF Task Group will deliver its final report before return to flight and will conclude its assessment, fact-finding, and reporting.
2. RTF Task Group Members will continue to be administratively available to support the ASAP, as requested, until their charter is terminated sometime after the STS-114 launch.
3. The RTF Task Group Co-Chairs will be available as spokespersons for the Task Group, if required, during the duration of the return to flight launch. In addition, Dr. Dan Crippen and Dr. Amy Donahue, who are members of both the RTF Task Group and the ASAP, will have authority to speak for the RTF Task Group on matters of interpretation of the RTF Task Group's final report.
4. Copies of required RTF Task Group electronic and paper records will be transferred to the ASAP.
5. After delivery of the RTF Task Group's final report, RTF Task Group panel leads will meet with ASAP members to conduct a transition briefing, identifying specific areas that the ASAP may consider for further observation.

We believe the proposed actions will ensure a smooth transition between the RTF Task Group and the ASAP.

 Thomas P. Stafford Lieutenant General, USAF, (Ret.) Co-Chair, Return to Flight Task Group	 Joseph W. Dyer Vice Admiral, USN, (Ret.) Chair, Aerospace Safety Advisory Panel
 Richard O. Covey Co-Chair, Return to Flight Task Group	

To assist in the turnover of activities from the RTF TG to the ASAP, several ASAP members were invited to observe the final two plenary meetings of the Task Group and witnessed at least one Mission Management Team (MMT) simulation. The turnover is also assisted by the fact that two Task Group members (Dr. Dan L. Crippen and Dr. Amy K. Donahue) are also members of the ASAP.

## 4.2 Items to be Transitioned

Several of the CAIB return-to-flight recommendations contain items the RTF TG believes the ASAP should continue to monitor. In addition, the Task Group has several items – not related to specific recommendations – that it believes require future monitoring or assessment. The ASAP might also wish to review the “RTF TG Observation” portion of each assessment.

### 4.2.1 Integrated Vehicle

The *STS-114 Operations Integrated Plan for Thermal Protection System Assessment* (or simply, the OIP) and its *Damage Assessment Annex* greatly enhanced the ability of the Space Shuttle Program to perform an integrated vehicle external damage assessment in support of decision-making, primarily within the MMT. The RTF TG believes that NASA should continue to develop the OIP and its Annex for all future flights, not just for STS-114. The information, understanding, and experience gained from producing the document for STS-114 will be invaluable for future mission data integration. The ASAP should monitor the continued development of the OIP and its Annex, as well as how the processes and timelines described in the documents are used for decision-making within the MMT and other groups.

### 4.2.2 CAIB Recommendation 3.2-1, External Tank Debris Shedding

Debris from the External Tank was the physical cause of the *Columbia* accident, and NASA has gone to tremendous lengths in their attempts to cure the problem. According to the NASA May 2005 document *The Integrated Risk Assessment Approach for Return to Flight*, “... The External Tank debris allowable requirements currently do not protect against catastrophic damage of the Orbiter Thermal Protection System.” NASA developed a three-phase approach to correcting the flaws in the External Tank; Phase 1 was implemented for return-to-flight and Phase 3 has been deferred because of the pending 2010 retirement date for the Space Shuttle. Phase 2 is currently slated as post-return-to-flight work, and the RTF TG believes the ASAP should closely monitor the implementation of these changes.

In addition, each of the tanks being used on the first eight launches was substantially completed prior to 2003 and has been modified – at least in the details – differently. Therefore, each is somewhat unique in its configuration. Although NASA plans to use data from the STS-114 flight to further characterize debris from the ET, it is possible that these differences will require additional data collection from future missions.

The RTF TG believes the results of analyses conducted after the STS-114 launch should be closely monitored, as well the applicability of any anomalies to the tanks scheduled for future missions. The ASAP should continue to track the Program’s efforts to eliminate critical debris by aggressively working off the limitations documented in NSTS 60555, *Verification Limitations for the External Tank Thermal Protection System*.

The Task Group suggests the ASAP monitor the continued use of the labor-intensive thermal protection system application processes enacted for the return-to-flight.

### 4.2.3 CAIB Recommendation 3.3-1, Reinforced Carbon-Carbon Non-Destructive Inspection

Understanding the condition of the RCC panels used on the Orbiter is essential for safe flight operations. NASA has identified future work including finishing the documentation of flight-to-flight inspections in the Operations and Maintenance Requirements Document (OMRSD) and competing the development of applicable non-destructive inspection standards.

The RTF TG believes the ASAP should monitor the Agency’s progress toward finishing the

documentation, and also ensure that meaningful non-destructive inspections continue for the remainder of the Space Shuttle Program. The Task Group is also concerned that NASA has only a single ship-set of spare RCC panels in inventory; something made troublesome by the long lead-times involved in manufacturing additional panels.

#### **4.2.4 CAIB Recommendation 3.3-2, Orbiter Hardening**

NASA decided to implement this recommendation in three phases. The first phase of changes to the Orbiters has been completed in time for STS-114. The second phase consists of two changes which could not be completed in time for the return to flight. They are the completion of the remaining “sneak flow” protection changes on RCC panels 1-4 and 14-22, and main landing gear door perimeter tile material change. The risk analysis of the tile damage tolerance indicated that the main landing gear door is one of the critical areas with which to deal. According of the NASA May 2005 document, *The Integrated Risk Assessment Approach for Return to Flight* (p. 11), their “... goal was to demonstrate that the capability of the Orbiter greater than the expected debris environment; however, we fell short in a number of cases.”

It is important for the ASAP to monitor the progress of the BRI-18 tile material certification and the completion of this change on all three Orbiters. The third phase involves more extensive changes to the Orbiters, but these are being reconsidered in light of the scheduled 2010 end of the program.

Future work that NASA has identified includes continuing the verification of the analytical models used in determining the impact resistance of the Orbiter, as well as the continuing refinement of the definition for “critical debris.” The RTF TG believes the ASAP should monitor the progress of each of these items, with particular attention on model verification and configuration management. Abandoning future upgrades to the Orbiter may be appropriate given the limited number of missions expected to be flown, but an independent assessment of this approach should be carried out. ASAP should review the correlation of the remaining risk of damage to potential future Orbiter hardening concepts.

#### **4.2.5 CAIB Recommendation 3.4-1, Ground-Based Imagery**

Future work that NASA has identified for this recommendation includes the continued refurbishment and procurement of imagery assets at the Kennedy Space Center and the Eastern Range. The RTF TG believes that the ASAP should continue to assess the availability of adequate imagery assets to ensure there are three useful views of the Space Shuttle available for all future launches.

#### **4.2.6 CAIB Recommendation 3.4-2, High-Resolution Images of External Tank**

Future work that NASA identified for this recommendation includes installing additional cameras on the External Tank and Solid Rocket Boosters to provide better imagery of the Orbiter and its environment during ascent. The RTF TG believes that the ASAP should assess the implementation of the ET attach ring and SRB forward skirt cameras, along with the SRB solid-state recorders, planned for STS-115 and subsequent flights.

#### **4.2.7 CAIB Recommendation 3.4-3, High-Resolution Images of Orbiter**

NASA has predicated much of its return-to-flight planning on conducting detailed inspections of the Orbiter once it is on orbit. These inspections are accomplished, for the most part, using the Orbiter Boom Sensor System (OBSS) installed in the payload bay and photography from the International Space Station.

The RTF TG believes that the ASAP should continue to assess what constitutes “adequate resolution” as the Orbiter critical damage size evolves. Also, NASA only plans to use the OBSS for a limited number of flights; the ASAP should review the plan to discontinue its use and ensure that other adequate means exist to acquire the necessary imagery.

**4.2.8 CAIB Recommendation 4.2-1, Solid Rocket Booster Bolt Catcher**

The implementation of this item was straight-forward and has been completed. The RTF TG is satisfied that no ASAP involvement is needed.

**4.2.9 CAIB Recommendation 4.2-3, Closeout Inspection**

Ensuring that at least two people observe the final close-out of all Space Shuttle flight hardware provided additional assurances that processes were accomplished correctly. The NASA implementation of this recommendation seems complete and appropriate. However, the RTF TG believes that the ASAP should sponsor periodic monitoring to ensure the process is still being followed across the program, particularly as the program winds down.

**4.2.10 CAIB Recommendation 4.2-5, Kennedy Space Center Foreign Object Debris Definition**

The implementation of this item was straight-forward and has been completed. The RTF TG is satisfied that no ASAP involvement is needed.

**4.2.11 CAIB Recommendation 6.2-1, Consistency with Resources**

The RTF TG believes that NASA should devote continued attention to ensure undue schedule pressure does not arise. The Task Group further believes that the ASAP should monitor the NASA budget and workforce metrics to ensure sufficient resources are available to meet the Space Shuttle mission manifest, especially given the likely resource requirements of the new Vision for Space Exploration.

**4.2.12 CAIB Recommendation 6.3-1, Mission Management Team Improvements**

The Task Group believes that the ASAP should observe selected MMT simulations, with particular emphasis on team performance and the MMT processes and tools necessary to effect integrated time-sensitive critical risk-versus-risk trades and decisions.

**4.2.13 CAIB Recommendation 6.3-2, National Imagery and Mapping Agency Memorandum of Agreement**

The implementation of this item was straight-forward and has been completed. The RTF TG is satisfied that no ASAP involvement is needed.

**4.2.14 CAIB Recommendation 6.4-1, Thermal Protection System Inspection and Repair**

The ASAP should review the development of comprehensive autonomous (independent of ISS) inspection and repair capabilities; this is particularly important for non-ISS missions (i.e., Hubble Space Telescope Servicing Mission 4), but also protects against the possibility that an ISS mission fails to achieve the correct orbit, fails to dock successfully, or is damaged during or after undocking. Even for nominal ISS missions, NASA has work remaining in the inspection and repair areas; the Task Group believes that the ASAP should closely monitor these efforts. With the suspension of CSCS and rescue missions after the first few flights, the issue of a certified and operational inspection and repair capability must be addressed. The

Task Group feels that the ASAP should make this a high priority when reviewing the Space Shuttle Program.

As the Task Group currently understands the situation, the Space Shuttle Program intends to discontinue the use of OBSS three or four flight after STS-114. In the view of the Task Group, this would require that other methods of detecting damage – such as the wing leading edge sensors – would have to be elevated from “Criticality 3” status to “Criticality 1.”

The Task Group feels that ASAP should assess progress with respect to selecting, developing, and certifying long-term RCC and tile repair capabilities.

#### **4.2.15 CAIB Recommendation 9.1-1, Detailed Plan for Organizational Change**

While the CAIB did not make specific “cultural” change recommendations (other than three specific recommendations to be included in the plan required for R9.1-1), they provided numerous pages of text, findings, and observations to underscore their concerns in this area. To their credit and in response, over the past 29 months, NASA revised some pre-*Columbia* initiatives and undertook many other new initiatives (both for the Space Shuttle Program and NASA wide) to address the CAIB concerns. As the scope of these initiatives were beyond the RTF TG charter, the Task Group recommends that ASAP might wish to discern how these varied initiatives fit into an integrated senior leadership plan or vision. For the future, it is critical that NASA establish a foundation that can carry its vision forward.

##### **4.2.15.1 CAIB Recommendation 7.5-1, Independent Technical Authority**

The ASAP should monitor the progress toward completing the establishment of the ITA and its Technical Warrant Holders, whether the ITA is working as CAIB intended, whether the CAIB organizational concept is workable, and whether the “independent” funding sources are working. Additionally, the ASAP should monitor the process by which NASA grants waivers to technical requirements to ensure it meets the intent of the CAIB recommendations

##### **4.2.15.2 CAIB Recommendation 7.5-2, Safety and Mission Assurance**

ASAP should monitor to ensure SMA continues to be an “independent” voice, and the Agency’s alternative implementation of “direct line authority” will require continued ASAP oversight. Since the Space Shuttle Program SMA Manager is a voting member on the MMT (but does not possess “suspension authority”), further ASAP monitoring might be prudent to verify that those Center and SMA Directors with “suspension authority” recognize their responsibility and authority and are willing to use it if needed. In addition, ASAP needs to be cognizant of the historical trend to diminish the SMA role. Over time, without continued Headquarters leadership emphasis on the importance of the SMA role (including Quality Assurance), NASA history unfortunately portends that SMA roles become diminished.

##### **4.2.15.3 CAIB Recommendation 7.5-3, Systems Engineering and Integration**

The ASAP should assess the progress toward establishing a truly effective Systems Engineering and Integration Office. Items remaining include demanding rigorous documentation that sustains effective systems integration and engineering, and requiring improvements in standards for (and standardization of) validation, verification, and certification requirements for the development and use of analytical models.

#### **4.2.16 CAIB Recommendation 10.3-1, Digitize Closeout Photos**

The implementation of this item was straight-forward and has been completed. However, the RTF TG believes that, periodically, the ASAP should evaluate the digital imagery database

and closeout photography procedures at the Kennedy Space Center and other NASA installations to ensure its continued effectiveness. Should the Shuttle Program be extended past 2010, the decision for no further non-critical updates to the drawings should also be reconsidered.

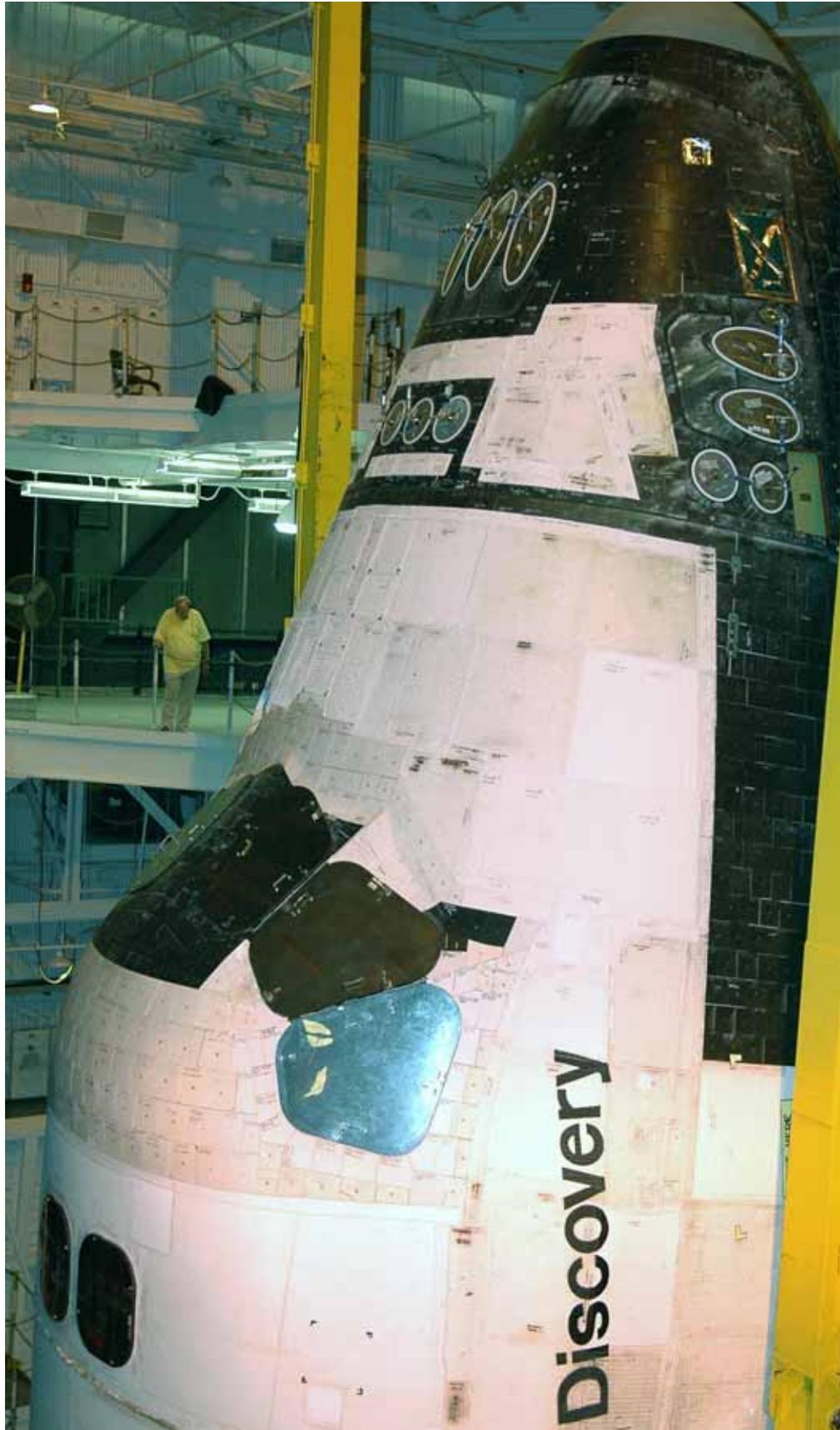
#### 4.2.17 SSP-3, Contingency Shuttle Crew Support

Because of the risks entailed, and the most-likely negative programmatic effects, the Task Group believes that CSCS should never be relied upon to overcome risks that could have been mitigated by other actions. The CSCS capability should be used only in the most extreme emergency where there is no other viable option for saving the crew of a stricken Orbiter.

The Task Group believes the ASAP should conduct an independent evaluation of the desirability of maintaining a CSCS capability for flights after STS-121. If the capability does continue into the future, the ASAP should ensure that it does not become a “crutch” for the program and lead to a tendency toward negative changes to the flight rules and operations.



*Discovery sitting at LC-39B.*



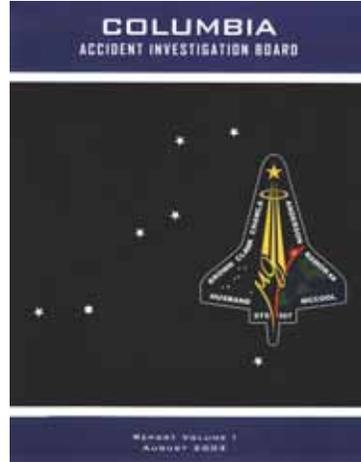
*Discovery hangs in the VAB as it is being removed from its original External Tank in the Vehicle Assembly Building at KSC. The Orbiter was later mated with ET-121 prior to the launch of STS-114.*

## 5 THE RETURN TO FLIGHT TASK GROUP

On February 1, 2003, the Space Shuttle *Columbia* disintegrated while returning to Earth during the STS-107 mission, killing the crew of seven. Within hours, the independent Columbia Accident Investigation Board (CAIB) was appointed to determine the cause of the accident. What followed was, perhaps, the most far-reaching accident investigation ever conducted. The CAIB released the first volume of their final report on August 26, 2003, containing 29 specific recommendations for changes to the vehicle, the Space Shuttle Program, and to NASA in general. Among those recommendations were 15 that the accident board believed should be implemented prior to returning the Space Shuttle fleet to flight.

On April 14, 2003, then-NASA-Administrator Sean O’Keefe wrote Lt. Gen. Thomas P. Stafford, U.S. Air Force (Ret.), requesting that the Stafford Task Force on International Space Station Operational Readiness initiate an assessment of NASA’s plans to return the Space Shuttle to flight. The Stafford Task Force is a standing group chartered by the NASA Advisory Council, an independent advisory group to the NASA Administrator.

One month later Lt. Gen. Stafford responded to the Administrator with a plan to activate a sub-organization with Col. Richard O. Covey, U.S. Air Force (Ret.), leading the day-to-day effort of conducting an independent assessment of the 15 CAIB return-to-flight recommendations. As a result, on July 18, 2003, a Return to Flight Task Group (RTF TG) was chartered under the Federal Advisory Committee Act with Lt. Gen. Stafford and Col. Covey as co-chairs.



The Columbia Accident Investigation Board final report was issued on August 26, 2003.

Over the course of the past two years, using expertise from the aerospace industry, federal government, academia, and the military, the RTF TG assessed the actions taken by NASA to implement the CAIB return-to-flight recommendations. During this time the Task Group conducted fact-finding activities, reviewed documentation, held public meetings, reported their assessments to the Space Flight Leadership Council, and released three interim reports on the progress toward launching the first Space Shuttle mission since the *Columbia* accident, designated STS-114. The assessments of the Task Group, although based primarily on data provided by the Space Shuttle Program, are independent of that program and are intended to provide the NASA Administrator an evaluation of the progress NASA has made toward meeting the intent of the 15 CAIB return-to-flight recommendations.

As the Task Group delivers this final report to the NASA Administrator, Congress, and the American public, we take this opportunity to reemphasize that this report is strictly advisory and is not a prerequisite for returning to flight. Only NASA can make the determination if the vehicle, supporting infrastructure, and organization are sufficiently robust to resume flying.

### 5.1 Federal Advisory Committee Act

NASA is among several federal agencies that access the insights and experiences of accomplished citizens by establishing advisory committees. The Federal Advisory Committee Act (FACA – Public Law 92-463 as amended; 5 U.S.C. App. §§1 *et seq*) governs the creation, management, and termination of such advisory committees when they report directly to federal officials. The General Services Administration provides government-wide administrative guidance for FACA, while the Office of Government Ethics oversees “conflict of interest” matters associated with the designation and conduct of advisory committee members.

For the purposes of the FACA, the RTF TG was composed of two voting Co-Chairs and multiple voting members. In addition, the Task Group had one non-voting *ex-officio* member – the NASA Deputy Chief Safety and Mission Assurance Officer. The Executive Secretary of the Task Group was a Civil Service employee who performed as the Designated Federal Official required by the FACA.

None of the voting members were NASA employees. However, the Co-Chairs and some members were appointed as Special Government Employees under the federal personnel system. All members were reimbursed for travel expenses in accordance with normal government policy.

Under the FACA, the members can not have any vested interest in the outcome of the assessment. The NASA General Counsel determined that the members of the RTF TG had no interest that would prevent them from exercising individual or representative judgment.

## **5.2 Purpose and Duties of the Task Group**

The RTF TG was chartered to perform an independent assessment of NASA's actions to implement the CAIB return-to-flight recommendations. However, this assessment is strictly advisory, and NASA remains responsible for the overall safety and operational readiness of STS-114 and all subsequent Space Shuttle missions. Perhaps as important as what the Task Group was asked to do, is what it was not asked to do:

1. The Task Group was not asked to pass judgment on the appropriateness or validity of the CAIB recommendations.
2. The Task Group was not asked to pass judgment on the methods chosen by NASA to implement the recommendations (i.e., were the selected methods the best); we were only asked to assess whether the selected methods met the intent of the CAIB recommendation.
3. Other than assessing the return-to-flight schedules for “undue pressure,” the Task Group was not asked to pass judgment on when the return-to-flight mission should occur.

To fully understand the intent of the accident board, the RTF TG conducted fact-finding interviews with former members and staff from the CAIB. The Task Group did not, however, attempt to assess the adequacy or appropriateness of the CAIB recommendations.

The Task Group has also made several independent observations on safety and operational readiness that it believes are appropriate.

The RTF TG relied on the expertise of its members and other sources to provide this assessment. Fact-finding was accomplished using written data and briefings supplied by NASA and its contractors, meetings with other persons and organizations as deemed appropriate, and site visits to NASA and contractor facilities. In carrying out its responsibilities, the Task Group:

- Focused on the Agency's actions to implement the 15 CAIB return-to-flight recommendations as related to the safety and operational readiness of STS-114.
- Used, as it deemed appropriate, the Space Shuttle Program Office and Space Shuttle Return to Flight Planning Team, working groups, and supporting facilities to conduct the assessment. These included staff advisors, as required, for expertise in such areas as engineering, public affairs, law, and security.

- Analyzed the facts and opinions considered relevant in the CAIB final report and reviewed the supporting documents and databases as needed.
  
- Documented and reported RTF TG assessment findings in public meetings, three interim reports, and a final report.

In addition to the 15 return-to-flight recommendations made by the CAIB, after the April 2004 plenary meeting the Task Group notified NASA of its intention to assess one additional “raising the bar” action that NASA assigned itself as part of its return to flight efforts. This task, called SSP-3, Contingency Shuttle Crew Support, is documented in *NASA’s Implementation Plan for the Space Shuttle Return to Flight and Beyond*. Essentially, this “raising the bar” action addresses the use of the International Space Station as a safe haven for a Space Shuttle crew in case an Orbiter is damaged and deemed unsafe for entry. Because of the potential for this being a mitigating or supportive capability for return to flight, the Task Group felt the need to formally assess NASA’s actions relative to establishing the capability.

The CAIB had indicated that NASA need only develop a detailed plan to change certain aspects of its organization prior to return-to-flight. However, because the return-to-flight activities have taken much longer than the CAIB anticipated, NASA has had the opportunity to begin implementing the planned reorganization. Therefore, in addition to R9.1-1 (which the CAIB marked as a return-to-flight item), the Task Group is assessing the progress made on the three organizational recommendations (R7.5-1, R7.5-2, and R7.5-3). These three CAIB recommendations are assessed within the context of the R9.1-1 planning recommendation and may be found in that section of this report.

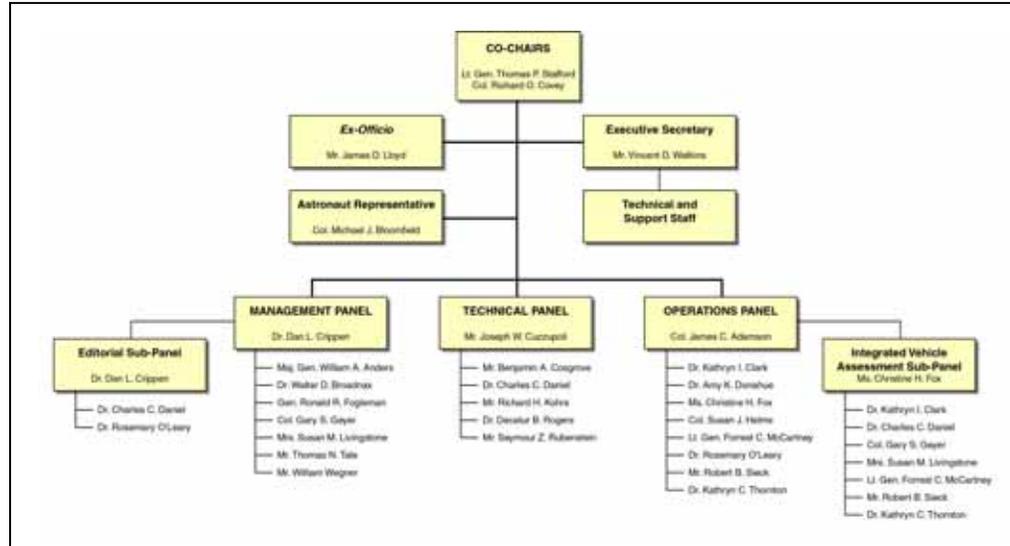
Aside from the one non-CAIB-recommendation noted above, the RTF TG did not assess any other Space Shuttle Program hardware, software, processes, organizations, or procedures. For instance, the Task Group did not evaluate the readiness or safety of the Space Shuttle Main Engines, Solid Rocket Boosters, auxiliary power units, fuel cells, or other element hardware. Nor did the Task Group assess the PASS or BFS flight software. It is NASA, and NASA alone, that can adequately evaluate the Space Shuttle Program as a whole and determine its readiness to resume flying.

### **5.3 Organization of the Task Group**

The RTF TG membership consisted of select representatives from the Stafford Task Force on International Space Station Operational Readiness, under which it was chartered, and additional members selected by the Co-Chairs and appointed by the NASA Administrator. These members provided a knowledge base appropriate to the assessment of NASA’s implementation of the CAIB return-to-flight recommendations.

After reviewing the nature of the CAIB recommendations, the RTF TG organized itself into three panels: the Management Panel, Operations Panel, and Technical Panel. Subsequently, an Integrated Vehicle Assessment Sub-Panel and Editorial Sub-Panel were established for specific tasks. Each of the Panels was responsible for leading the assessment of specific CAIB recommendations, and prepared a final presentation for the assembled Task Group to detail NASA’s implementation of each recommendation in preparation for the final deliberations and vote.

## Final Report of the Return to Flight Task Group



### 5.3.1 Management Panel

The Management Panel focused on the NASA compliance with the CAIB recommendations concerning Space Shuttle Program management, the return-to-flight integrated schedule, program/project risk management, and public safety policy. This assessment included CAIB recommendations:

- R6.2-1 Consistency with Resources
- R6.3-1 Mission Management Team Improvements
- R6.3-2 National Imaging and Mapping Agency Memorandum of Agreement
- R9.1-1 Detailed Plan for Organizational Change, including:
  - R7.5-1 Independent Technical Engineering Authority
  - R7.5-2 Safety and Mission Assurance Organization
  - R7.5-3 Space Shuttle Integration Office Reorganization

### 5.3.2 Operations Panel

The Operations Panel focused on the NASA compliance with the CAIB findings and recommendations concerning Space Shuttle Program crew and controller operations, processing and launch operations, and procedures to support operations. This assessment included CAIB Recommendations:

- R3.4-1 Ground-Based Imagery
- R3.4-2 High-Resolution Images of External Tank
- R3.4-3 High-Resolution Images of Orbiter
- R4.2-5 Kennedy Space Center Foreign Object Debris Definition
- R6.4-1 Thermal Protection System Inspection and Repair (operations only)
- R10.3-1 Digitize Closeout Photos
- SSP-3 Space Shuttle Program Action – Contingency Shuttle Crew Support

### 5.3.3 Technical Panel

The Technical Panel focused on the NASA compliance with the CAIB recommendations concerning the material condition of the Space Shuttle. This included the development of and compliance with technical requirements, vehicle engineering, hardware and software development/verification, and overall vehicle certification status. This assessment included CAIB recommendations:

- R3.2-1 External Tank Debris Shedding
- R3.3-1 Reinforced Carbon-Carbon Non-Destructive Inspection
- R3.3-2 Orbiter Hardening
- R4.2-1 Solid Rocket Booster Bolt Catcher
- R4.2-3 Closeout Inspection
- R6.4-1 Thermal Protection System Inspection and Repair (system hardware development only)

#### **5.3.4 Integrated Vehicle Assessment Sub-Panel**

The Integrated Vehicle Assessment Sub-Panel combined insights from the Management, Operations, and Technical Panels to assess the ability of NASA to perform an integrated vehicle external damage assessment, based on a variety of imagery and sensor sources in support of decision-making during launch and flight.

This sub-panel focused on cross-cutting vehicle assessment actions, specifically including an assessment of the Orbiter Thermal Protection System. The sub-panel assessment considered the broad interactions of allowable debris, critical damage size, damage detection and assessment via imagery and sensors, as well as the development of the Mission Management Team improvements needed to support real-time operations. This assessment included CAIB recommendations:

- R3.2-1 External Tank Debris Shedding
- R3.3-2 Orbiter Hardening
- R3.4-1 Ground-Based Imagery
- R3.4-2 High-Resolution Images of External Tank
- R3.4-3 High-Resolution Images of Orbiter
- R6.3-2 National Imaging and Mapping Agency Memorandum of Agreement
- R6.4-1 Thermal Protection System Inspection and Repair (integrated data flow only)
- R6.3-1 Mission Management Team Improvements
- SSP-3 Space Shuttle Program Action – Contingency Shuttle Crew Support

#### **5.3.5 Editorial Sub-Panel**

The Editorial Sub-Panel coordinated the preparation of the RTF TG interim and final reports.

#### **5.3.6 Staff and Other Personnel**

The Task Group maintained offices outside the Johnson Space Center in Houston, Texas, for use by the permanent staff and visiting members. The members generally worked out of their home offices except when on fact-finding trips or attending Task Group plenary and public meetings.

The Executive Secretary performed as the Designated Federal Official (DFO) per FACA regulations by fulfilling all functions required by statute, including recordkeeping and compliance with FACA procedures. The DFO served as the Government's agent for all matters related to RTF TG activities.

Support personnel facilitated the Task Group fact-finding activities and were assigned to each panel and sub-panel. A NASA General Counsel was provided by the Johnson Space Center and was available for legal advice and interpretations concerning technical and programmatic issues relevant to the NASA implementation of the CAIB findings and recommendations. A NASA Public Affairs Officer from the Marshall Space Flight Center provided support to the Task Group and served as an interface with the news media and the public. Specialists,

contractors, consultants, and other personnel were provided to the RTF TG as needed during its assessment activities. Administrative, travel, and secretarial support was provided at the Houston office. Valador, Inc., of Herndon, Virginia, was retained as the Task Group support-contractor to provide consultants, maintain the RTF TG web site, and other duties as needed.

### 5.3.7 Personnel Changes

As with any group that operates over a long period of time, personnel changes on the RTF TG were inevitable. In June 2003, as the Task Group was initially being organized, there were 20 members of the Task Group; all except the *ex-officio* were voting members:

Lt. Gen. Thomas P. Stafford, U.S. Air Force (Ret.), *Co-Chair*  
Col. Richard O. Covey, U.S. Air Force (Ret.), *Co-Chair*  
Col. James C. Adamson, U.S. Army (Ret.)  
Maj. Gen. William A. Anders, U.S. Air Force Reserve (Ret.)  
RADM Walter H. Cantrell, U.S. Navy (Ret.)  
Mr. Benjamin A. Cosgrove  
Dr. Dan L. Crippen  
Mr. Joseph W. Cuzzupoli  
Dr. Charles C. Daniel  
Dr. Richard Danzig  
Gen. Ronald R. Fogleman, U.S. Air Force (Ret.)  
Col. Gary S. Geyer, U.S. Air Force (Ret.)  
Maj. Gen. Ralph H. Jacobson, U.S. Air Force (Ret.)  
Mr. Richard H. Kohrs  
Mr. James D. Lloyd, *ex-officio*  
Lt. Gen. Forrest C. McCartney, U.S. Air Force (Ret.)  
Mr. David Raspet  
Mr. Seymour Z. Rubenstein  
Mr. Robert B. Sieck  
Mr. William Wegner

By the end of July 2003, seven additional voting members who brought specific expertise had been added to the Task Group:

Dr. Walter D. Broadnax  
Dr. Kathryn I. Clark  
Dr. Amy K. Donahue  
Ms. Susan M. Livingstone  
Dr. Rosemary O'Leary  
Dr. Decatur B. Rogers  
Mr. Thomas N. Tate

On September 12, 2003, it was announced that three new voting members had been added to the Task Group, bringing the total to 29 voting members and 1 *ex-officio*.

Ms. Christine H. Fox  
Col. Susan J. Helms, U.S. Air Force  
Dr. Kathryn C. Thornton

However, later during September 2003, two members resigned from the Task Group for personal reasons:

Maj. Gen. Ralph H. Jacobson, U.S. Air Force (Ret.)  
Mr. David Raspet

Since the Task Group still had a sufficiently broad cross-section of necessary skills, these members were not replaced. At this time, Dr. Dan L. Crippen took the Lead of the Management Panel formerly held by Maj. Gen. Jacobson.

On May 3, 2004, NASA Headquarters reassigned the Task Group Executive Secretary, Mr. David Lengyel, to the Office of the Chief Engineer at Headquarters because it was felt his skills and expertise were needed in that office. Mr. Vincent D. Watkins, from the Johnson Space Center, succeeded him as Executive Secretary.

In June 2004, RADM Walter H. Cantrell, U.S. Navy (Ret.) left the Task Group to become Deputy Chief Engineer for NASA's new Independent Technical Authority. Since the Co-Chairs felt that the Task Group still had sufficient membership, no successor was named for RADM Cantrell. Dr. Charles Daniel replaced RADM Cantrell on the Integrated Vehicle Assessment Sub-Panel and Editorial Sub-Panel.

In September 2004, Dr. Richard Danzig left the Task Group because "the press of other activities involving national security problems has left me without time to perform as a member of the Group." Since the Task Group believed it was close to completing its activities, no successor was selected.

The first representative from the Astronaut Office, Lt. Col. Carlos L. Noriega, U.S. Marine Corps (Ret.), left the Task Group after he received a flight assignment on STS-121 in December, 2003. Lt. Col. Noriega is currently the Manager of the Exploration Systems Engineering Office at the Johnson Space Center. He was replaced on the Task Group by Col. Michael J. Bloomfield, U.S. Air Force.

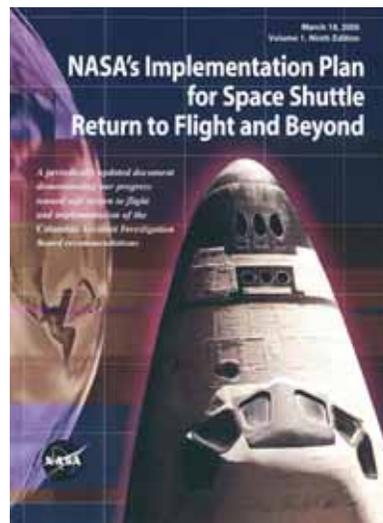
Participation of at least 51 percent of the voting members was required to constitute a quorum of the Task Group.

### 5.4 Relationship to the NASA Implementation Plan

At the same time that the CAIB was conducting its investigation, NASA began pursuing an Agency-wide effort to improve human space flight. Part of this effort was taking a fresh look at all aspects of the Space Shuttle Program, from technical requirements to managerial processes. The outcome was a set of NASA-generated actions that complement the CAIB recommendations. These are documented in *NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond*. (For brevity, the RTF TG generally called this the *NASA Implementation Plan*.)

The *NASA Implementation Plan* integrates both the CAIB recommendations and NASA-generated actions into a single document. Many of the NASA-generated actions "raise the bar" beyond what the CAIB recommended. With a single exception, the RTF TG did not assess these raising-the-bar actions – that exception is SSP-3, Contingency Shuttle Crew Support. It should be noted that some of the raise-the-bar items in the *NASA Implementation Plan* overlapped various CAIB requirements, but the RTF TG assessed the CAIB requirements as written.

In general, the *NASA Implementation Plan* provides high-level description of the steps taken by NASA to implement the CAIB recommendations and the NASA-generated actions. The implementation plan is revised



periodically, with the latest version being the Tenth Edition on June 3, 2005. The *NASA Implementation Plan* went from its December 3, 2004, “Revision C” to the March 18, 2005, “Ninth Edition.” This was explained to the Task Group as an attempt to correct the previous system of revisions that did not track intermediate releases (e.g., 1.1); there had been eight releases prior to March 2005, so this version was called the Ninth Edition.

The RTF TG has not independently verified or validated any information contained in *NASA’s Implementation Plan for Space Shuttle Return to Flight and Beyond*.

## **5.5 Conduct of the Assessment**

The diverse nature of the CAIB recommendations required a unique approach to the assessment of each item. This was a result of the presence of process enhancements, hardware modifications, organizational changes, and documentation revisions, often in a single item. In general, the lead panel conducted fact-finding through field trips to relevant sites, meetings with NASA personnel, discussions with contractors, issuing formal Requests for Information (RFI) to NASA, and consultations with other experts.

### **5.5.1 Coordination with NASA**

NASA provided primary points-of-contact to manage the flow of information between the Task Group and the NASA community. Requests for fact-finding meetings, supporting data via Requests for Information (detailed in the next section) and coordination of schedules and product deliveries was filtered through these contacts. These NASA representatives also developed and provided the official input to the RTF TG for each recommendation in a closure package (this process is discussed further in Section 6.6). Meetings between NASA and the Task Group included formal briefings directly to the members and those where Task Group members were simply part of the audience of a regularly-scheduled meeting.

All material provided to the RTF TG became a part of the permanent Task Group record. Some of this material will not be made available to the public because it contains data restricted under the International Traffic in Arms Regulations (ITAR, 22 CFR Parts 120-130) or company-proprietary information that the contractors have a right to protect under their existing agreements with NASA. All data not restricted by security, ITAR, or company-proprietary considerations were entered into the Process-Based Mission Assurance (PBMA) database to facilitate sharing among Task Group personnel. These data will be archived at the National Archives and Records Administration.

### **5.5.2 Requests for Information**

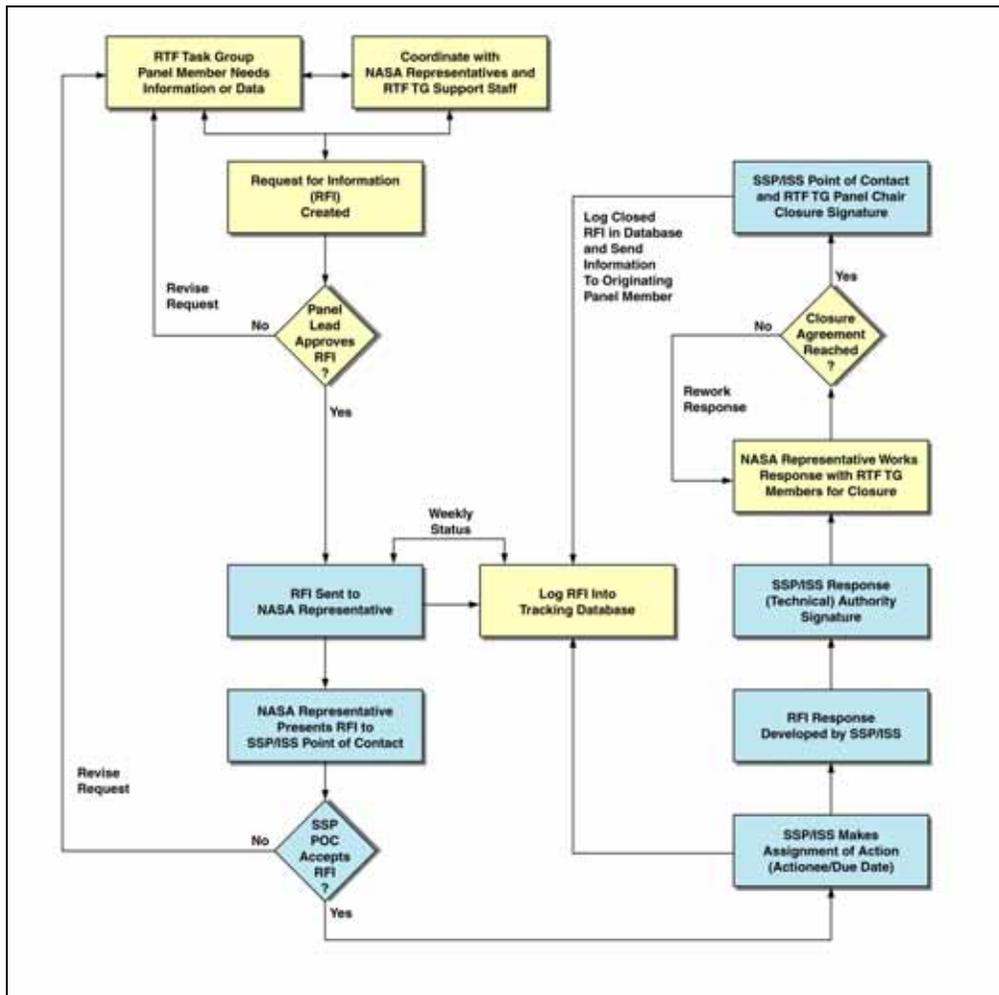
The primary means of requesting and transmitting information between the Program Office and the Task Group was called a “Request for Information” form. This process was similar to that used by the CAIB to request data. An RFI could be a simple request for existing facts or a complex inquiry on operations. In response to an RFI, NASA could provide information, or make specific make presentations to the Task Group. The RTF TG intended that all RFIs be completed prior to final deliberations on individual return-to-flight recommendation assessments.

When a Task Group member needed information, the member or staff completed an RFI form. This form detailed the information required, along with a date by which the information was needed. After the RFI was approved by the appropriate Panel Lead, it was logged into an RTF TG database. The RFI was then sent to the NASA point-of-contact via the NASA representative to the RTG TG. The NASA point-of-contact had the authority to accept or reject the RFI. Rejection was usually caused by the RFI being too broad and placing too great a burden on the NASA organization that was already working to implement the required

## Final Report of the Return to Flight Task Group

return-to-flight changes. If the NASA point-of-contact rejected an RFI, they worked with the Task Group member to revise the request, which was then resubmitted through the process. Once the NASA point-of-contact accepted the RFI, the request was transferred to the appropriate NASA organization. This information was then fed back to the RTF TG staff to update the tracking database.

The assigned NASA organization developed a response that was then reviewed and approved by a process within NASA. A response to an RFI was only considered official when it was signed by designated officials of the Space Shuttle Program Office. At this point, the NASA point-of-contact sent the data to the RTF TG. If the information was deemed acceptable, the NASA point-of-contact and the RTF TG Panel Lead signed the RFI form for official closure. The RFI form and associated response was then uploaded into PBMA and the RTF TG tracking database was updated.



### 5.6 Assessment Closure Process

While the Task Group was conducting fact-finding activities, NASA was developing and implementing plans to satisfy the CAIB recommendations. When NASA was satisfied with its implementation, the Agency presented a Return to Flight Action Closure Package and its supporting documentation to the Task Group. These were auditable documents that chronicled NASA's implementation of each CAIB return-to-flight recommendation. Each Return to Flight Action Closure Package contained, at a minimum, the following elements:

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1. Signature sheet, including:
  - a. Relevant element or project manager(s)
  - b. Space Shuttle Program Manager
  - c. Deputy Associate Administrator for International Space Station and Space Shuttle Programs
  - d. Chief Safety and Mission Assurance Officer
  - e. Space Flight Leadership Council Co-Chairs
2. Transmittal letter from the Space Flight Leadership Council Co-Chairs to the RTF TG Co-Chairs
3. Executive Summary, including:
  - a. Background information (including assumptions and interpretation of the CAIB recommendation)
  - b. Corrective measures and results
  - c. Open issues
  - d. Verification
4. Presentation package for the RTF TG (including back-up charts)

During the plenary meeting in April 2004, the Task Group had the opportunity to exercise this process for the first time. Although deemed generally successful, the process was further refined with the following changes:

1. The definition of tasks, requirements, and results would be developed from the most recent release of the *NASA Implementation Plan*.
2. The metrics and audit trail specified above would include the use of the current Space Shuttle Program Office configuration management system to provide tracking on any required:
  - a. Test plans, results and reports
  - b. Design data and documentation
  - c. Programmatic documentation, including Directives, Actions, and Change Requests
  - d. Documentation and documentation traceability, starting with the programmatic documentation, NSTS 07700
  - e. Detailed audit trail and plan for these activities, but not the completion of activities prior to submittal for approval
3. Agreements on the appropriate level at which to track, verify, and certify the activities to be included in the closure package.

After being received, the Return to Flight Action Closure Package was evaluated by the appropriate RTF TG Panel(s). When the Panel(s) was satisfied that the package was complete, it reported to the full Task Group. While the presentation by NASA to the Panel was usually by teleconference, the Panel's reporting to the full Task Group could be either by teleconference or during a face-to-face plenary. The process was the same regardless of the forum.

At the conclusion of the deliberations, the RTF TG formally notified the Space Flight Leadership Council of the Task Group's determination via correspondence; the assessment could be considered "closed" or "conditionally closed," or it could remain open. If an

assessment was “conditionally closed,” the Task Group identified in the same correspondence what action or documentation was required for full closure.

As the Task Group completed its activities, however, it was eventually recognized that this nomenclature was misleading. Both NASA and the press had interpreted the term “closed” as applying to the recommendation itself; the Task Group had no power, nor intent, to “close” a CAIB recommendation. Rather, it was the assessment being conducted by the Task Group that was either “open” or “closed.” In this context, “closed” meant that the Task Group’s assessment was complete.

Although the three interim reports used different terminology, this final report uses a more appropriate nomenclature. By definition, all the Task Group’s assessments are now “closed” since the RTF TG has disbanded at the end of its charter. In each case, the determination is that the NASA implementation met the intent of the CAIB recommendation or that it did not meet the intent.

## **5.7 Summary of Interim Reports**

The first two interim reports were prepared by the Editorial Sub-Panel, consisting of Dr. Dan Crippen, RADM Walt Cantrell, and Dr. Rosemary O’Leary. For the third interim report, RADM Cantrell was replaced by Dr. Charles Daniel. The Technical, Management, and Operations panels provided the primary substance of the reports. The reports were submitted for comments to the entire Task Group, and to NASA for technical review only. Co-Chair Col. Richard Covey approved the final version of each interim report prior to its release.

The first interim report was released on January 20, 2004. This report presented the assessment status of each CAIB return-to-flight recommendation as of early 2004. All of the assessments were still open at this point in time.

The second interim report was released on May 19, 2004, and it updated the assessment status of each recommendation. NASA had submitted closure packages for R3.3-1, R4.2-3, and R6.3-2, and the Task Group’s assessments of these recommendations were conditionally closed. The Task Group felt that there had been substantial progress across the board relative to all of the return-to-flight recommendations. To support this conclusion, the second interim report noted that several other recommendations were far enough along that the assessments could likely be closed at an anticipated August plenary.

The third interim report was released on January 28, 2005, and it again updated the assessment status of each recommendation. The report noted that the assessment of R3.3-1, which had been conditionally closed in the second interim report, had not changed status. NASA had submitted five new closure packages, resulting in the assessments of R3.4-2, R4.2-1, R4.2-5, and R10.3-1 being fully closed and R3.4-1 being conditionally closed. NASA supplied additional data for R4.2-3 and R6.3-2, which had been conditionally closed in the second interim report, so the Task Group revised the status of its assessment in these cases to fully closed.

At the conclusion of its final plenary meeting on June 27, 2005, the Task Group delivered a copy of the Executive Summary only to the NASA Administrator, and copies were transmitted to Congress and the White House. The Executive Summary was also posted to the Task Group’s web site for public distribution. The Executive Summary contained at the beginning of this Final Report is a slightly edited revision of the version released on July 27 – the edits were minor in nature and did not change the content.



The American flag on the Vehicle Assembly Building at the Kennedy Space Center, Florida.

## 6 SUMMARY OF THE RTF TG PLENARY MEETINGS

Over the course of two years, the Return to Flight Task Group held 11 plenary meetings to discuss its assessment of NASA's implementation of the Columbia Accident Investigation Board (CAIB) return-to-flight recommendations. Nine of these meetings were conducted face-to-face, and two were via teleconference. All of these included fact-finding sessions among the members, and eight included public meetings to deliberate results. The minutes of the public meetings are public record, and video and/or audio of the meetings is available on the RTF TG website.

Three of the following summaries were previously published in the interim reports that were issued immediately after the meetings, and are provided here mostly verbatim (only minor editorial corrections). For that reason, they are written in the present tense, even though the events they discuss are long past. All of these descriptions discuss the events as they were presented at the time; many things have changed over the course of the Task Group's work and the descriptions presented here do not necessarily reflect the current or final status.

### 6.1 Summary of August 2003 Plenary

This plenary was held August 5-7, 2003, at the Kennedy Space Center, Florida. This meeting was largely administrative in nature as the Task Group received briefings and developed operating procedures, plans, and schedules. During fact-finding, the Task Group received briefings from the Space Shuttle Program regarding its organization, vehicle processing, and the Certificate of Flight Readiness (CoFR) process. The Task Group received a presentation on the coatings used on the launch pad structures and their effects on the reinforced carbon-carbon wing leading edge. NASA also provided a briefing on ascent imagery and the Agency's preliminary plans regarding how to implement the CAIB imagery recommendations. The Space Shuttle Program Manager and his staff made a presentation explaining the purpose and scope of *NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond* [Revision 1 was current when this plenary was held] and NASA's current schedule for implementing the CAIB recommendations. Following the fact-finding, the Task Group held its first public meeting. This event was covered by the news media and the Task Group introduced itself and discussed its roles and responsibilities.



From the beginning, the Return to Flight Task Group was in the public eye. Here the news media, both print and broadcast, cover the Task Group's first public meeting at the Debus Center, Kennedy Space Center Visitor Complex August 7, 2003. The RTF TG was at KSC to conduct organizational activities, tour Space Shuttle facilities, and receive briefings on Space Shuttle-related topics.

## 6.2 Summary of September 2003 Plenary

This plenary was held September 9-11, 2003, in Houston, Texas. Again, this fact-finding meeting was partly administrative in nature, with the members receiving a briefing on the Freedom of Information Act (FOIA) and a presentation by the NASA Inspector General. In addition, NASA briefed the Task Group on the current status of *NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond* [Revision 1.1 was current when this plenary was held], and a discussion of each CAIB return-to-flight recommendation followed. NASA officials then provided a top-level overview of the approach they were using for return-to-flight planning. The core objective was to eliminate critical debris from the External Tank, with a long-term goal of eliminating all debris. Additional efforts centered on imagery, inspection, and repair. The Task Group also discussed the roles and responsibilities of the three panels along with which assessment each panel would lead. Splinter fact-finding meetings dedicated to each panel occupied the remainder of the plenary. Since there were no items to deliberate, the Task Group did not hold a public meeting. However, members of the media were briefed during a teleconference.

## 6.3 Summary of December 2003 Plenary

This plenary was held December 9-11, 2003, in Houston, Texas. This meeting began, in earnest, the long road to assessing NASA's implementation of the CAIB return-to-flight recommendations.

The CAIB uncovered some very specific conditions that led to the demise of the *Columbia* along with process and management failures that contributed to the accident. In a sense, the loss of the *Columbia* was caused primarily by two faulty assumptions:

Foam shed from the External Tank would be "transported" around the leading edge of the wing by the aerodynamics of the Orbiter; and,

The foam was not substantial enough to develop a ballistic moment capable of puncturing the reinforced carbon-carbon on the wing leading edge.



Return to Flight Task Group members participate in fact-finding meeting in Houston September 10, 2003.

It turns out that both assumptions – long-held and widely shared within NASA – were wrong, despite previous launches in which foam was shed and little damage was done, seemingly validating the assumptions. Thus, the “conditioned” response of senior managers to more junior members, who questioned these assumptions after the *Columbia* launched, was one of discouraging dissent and of comfort with established technical and operational assumption. The problem was exacerbated by systemic failures that prevented critical information getting to the right people at the right time.

In this light, the technical and operational challenges for NASA are to rectify the consequences of these faulty assumptions by, for example, removing debris sources, enhancing photography, improving on-orbit inspections, and developing on-orbit Thermal Protection System repair. The primary challenge for the Agency’s management is to devise an organization with embedded processes to identify other faulty assumptions.

The Return to Flight Task Group is charged with assessing the implementation of the CAIB recommendations. The RTF TG is not in the business of suggesting specific remedies. As one member put it, the Task Group is in the position of an umpire calling balls and strikes in a zone defined by the CAIB recommendations. The RTF TG is not in the position of evaluating the overall readiness or safety of the next flight, just the implementation of the CAIB return-to-flight recommendations.

Because of the substantial changes to the foam insulation and inspection techniques for the External Tank, and the current lack of understanding of the foam shedding phenomena, the STS-114 ascent must be considered a test flight. As such, the RTF TG expects NASA to capture as much test data as possible during ascent, particularly in regard to the imaging recommendations of the CAIB.

NASA has responded to all the recommendations the CAIB identified as necessary for accomplishment before the next Space Shuttle flight in *NASA’s Implementation Plan for Space Shuttle Return to Flight and Beyond* [Revision 1.1 was current when this plenary was held]. Not surprisingly, progress on the many recommendations has been uneven. Several of the technical responses to specific recommendations have indicated substantial progress, although none have been completed. Others, such as preparation of a detailed plan for the implementation of an Independent Technical Authority, are still in planning and some time away from implementation and a long time away from evaluation.

While the tone of this interim report is justifiably positive, progress should not be mistaken for accomplishment. As time passes and the next scheduled flight approaches, the enormity of the remaining task looms. Detailed plans for many of the recommendations have not been forthcoming. NASA has not been timely in some of its responses to Task Group requests for information. And while some of the most critical organizational issues raised by the CAIB require only a “detailed plan” before return-to-flight, the RTF TG will be looking for plans and processes that will stand the test of time – not just suffice for the first launch – much as the hardware redesigns are expected to serve the life of the Space Shuttle. It is still much too soon to predict either the success of implementation or the timing of the next flight.

A public meeting was held after this plenary and members of the media were briefed during a press conference.

#### **6.4 Summary of April 2004 Plenary**

This plenary was held April 12-16, 2004, in Houston, Texas. There had been several changes in NASA’s return to flight effort since the previous plenary meeting in December 2003. First, and most immediately, the schedule for the next launch was moved from September 2004 to March-April 2005. This schedule change was prompted by three developments:

1. Additional testing of the susceptibility of the Orbiter Thermal Protection System to damage, especially the reinforced carbon-carbon, coupled with advanced analysis of the airflows around the Orbiter, External Tank, and Solid Rocket Boosters, indicated that the foam on a larger area of the ET should be reassessed;
2. Several rudder speed brake actuators were discovered to have been incorrectly assembled during the original manufacture over 20 years ago. Further, the gears in the actuators have generally suffered minor damage with use and time. Therefore, all the actuators are being replaced or refurbished; and
3. Delays in the design and manufacture of a new camera/laser boom that will be used by the Orbiter's robotic arm to inspect for possible damage while on orbit.

This change in schedule means that NASA will have additional time to implement the CAIB recommendations before return to flight. In many cases this change also allows expected plans to be at least partially implemented. For example, the CAIB called for a detailed plan to, among other things, establish an Independent Technical Authority. It is expected that plan will now be implemented, at least for the Space Operations Mission Directorate [called the Office of Space Flight at the time], before next year.

The expanded period before the next launch also allows NASA additional time to select and perfect methods to implement technical solutions, such as inspecting the Orbiter Thermal Protection System for damage. Since the loss of *Columbia*, NASA has been engaged in a wide-ranging search for corrective and preventive measures of all types. In some cases, the time is approaching when decisions must be made as to the most promising alternatives and resources focused on this smaller set of possibilities – the garden must be thinned. In this sense, the additional time until launch can be seductive and leadership will need to be exercised to sort the many options under consideration.

The second major change since December is the announcement of President Bush's vision for the future of space exploration, particularly the human space flight component. The President proposed to use the Space Shuttle to complete the construction of the International Space Station and then retire the Space Shuttle no later than 2010. In its place would be continued reliance on international partners to service the International Space Station as well as the possibility of private sector development of launch vehicles. During the next decade, NASA would also begin to develop the capability to return astronauts to the moon, establish a lunar presence, and begin the efforts to explore Mars.

While the President's vision has obvious implications for the long-term use of the Space Shuttle, its effects on the current efforts have not been fully examined. However, no matter how long the Space Shuttle is used, it must first be safely returned to flight. Therefore, except for potential competition for human and financial resources, the new program should have minimal impact on the actual return to flight activities and the implementation of CAIB recommendations.

Third, the Task Group determined that the contingency of using the International Space Station as a safe haven in the event of potentially catastrophic vehicle damage is becoming increasingly important in NASA's decision-making for return to flight. Therefore, the Task Group formally notified NASA of its intent to assess the Contingency Shuttle Crew Support capability ("raising the bar" action SSP-3 in the *NASA Implementation Plan*) much as if it were a CAIB recommendation.

The Task Group is encouraged by NASA's progress since its last plenary in December 2003. Throughout the organization, the people of NASA are engaged and dedicated to correcting the deficiencies that led to the demise of *Columbia*.

The RTF TG is conditionally closing its assessment of three CAIB recommendations. "Closing" an assessment means that NASA provided sufficient information concerning the Agency's implementation of a specific CAIB return-to-flight recommendation; "conditionally" means that closing is dependent on the delivery of final documentation. The three assessments being conditionally closed with this second interim report are: R3.3-1, Reinforced Carbon-Carbon Non-Destructive Inspection; R4.2-3, Closeout Inspection; and R6.3-2, National Imagery and Mapping Agency Memorandum of Agreement. The Task Group will continue to monitor the implementation of these recommendations, and NASA has agreed to notify the Task Group if there is any material change in status.

There has been progress on virtually all of the 12 remaining return-to-flight recommendations. It is anticipated that several more recommendations will be substantially met by the time of the next RTF TG plenary in the summer.

One universal concern of the Task Group is the personnel requirements to meet the CAIB recommendations and other return-to-flight activities. The various new organizations, such as the NASA Engineering and Safety Center, the Independent Technical Authority, and the System Engineering and Integration Office, all require talented staff drawn largely from the current NASA and contractor pool. At some point, the ability of the Space Shuttle Program to carry out its mission may be hampered by personnel shortages.

The most important work remains efforts to eliminate critical ascent debris. If it could be guaranteed that no critical debris would come from the External Tank, the immediate cause of the loss of *Columbia* would be rectified. But such a guarantee is impossible short of extensive flight testing. Analyses and simulation will allow a level of comfort before launch, and advances in non-destructive inspection techniques may add to confidence. However, statistically significant results verifying ET debris conditions may not be accomplished even by the end of the Space Shuttle Program.

As such, on-orbit inspection and repair remain necessary to reduce the risk to future flights. Should one or both of these capabilities not be fully developed by the anticipated date of return to flight, the ability for the crew to await a rescue mission at the International Space Station will become an important consideration for the next launch.

A public meeting was held after this plenary and members of the media were briefed during a press conference.

## **6.5 Summary of July 2004 Plenary**

This plenary was held on July 22, 2004, by teleconference since scheduling issues prevented the members from gathering in a common location. Final fact-finding activities were conducted via fax, email, and telephone prior to the public meeting. The public meeting was primarily to deliberate closing two Task Group assessments: R4.2-5, KSC Foreign Object Debris Definition, and R10.3-1, Digitize Closeout Photos.

NASA had submitted closure packages for these recommendations on June 15 (R10.3-1) and July 15 (R4.2-5), and the Task Group evaluated the closure packages and conducted fact-finding to verify the status of each recommendation. After deliberating, the Task Group voted to conditionally close its assessment of each recommendation pending the delivery of final data from NASA. In each case, the Task Group felt the Agency met the intent of the CAIB.

## **6.6 Summary of September 2004 Plenary**

This plenary was held September 14-16, 2004, in Houston, Texas. Even before the plenary convened, the public meeting scheduled for September 16, 2004, was postponed. Several

members of the Task Group lived in the path of Hurricane Ivan and needed to secure their property. Nevertheless, available members of the Task Group met to continue their fact-finding activities. There were no assessments being considered for closure during the planned meeting.

During fact-finding, Lt. Gen. Stafford reviewed the previous week's Congressional testimony by himself and NASA Administrator Sean O'Keefe. Afterwards, there was a brief discussion of the hurricane damage to the Kennedy Space Center and the possible impacts on return-to-flight. At this point the Agency was still expecting a March 2005 launch of STS-114, and believed that data for most, if not all, of the open assessments would be provided in time for the December 2004 plenary. NASA explained that the events for return-to-flight were "milestone driven," not "schedule driven."

An apparent change within NASA was discussed, in which the Agency seemed to be choosing a "best effort" path instead of the more formal certification process. Several members of the Task Group expressed their opinion that NASA should continue the certification process instead of reverting to the less rigorous best effort concept. This plenary was where the Space Shuttle Program first introduced the "capability over environment" (C/E) concept to the Task Group. A long discussion followed about Recommendation R6.4-1, Thermal Protection System Inspection and Repair, attempting to better understand the intent of the CAIB.

Behavioral Science Technology, Inc. (BST) presented a status of its study of the Agency's cultural change initiative. Representatives from BST previewed their conclusions: NASA leadership is committed to making changes in the culture; the safety climate remains very strong; the process has begun on the harder, longer-term job of changing the culture; and if present activities and trends continue, it is likely that NASA will be successful in transforming its culture. BST cautioned, however, that while the commitment is strong at the Space Flight Leadership Council level, it seems less so at the program management level. BST described an important distinction between culture and climate. Culture comprises the common values that drive organizational performance; it is deeply embedded and changes slowly. Climate is much more transient; it is a reflection of current pressures and interests. BST and NASA officials described the initial phases of the NASA initiative to change its culture, as well as less-detailed plans for future phases.

The Space Shuttle Program provided a status of the NASA return-to-flight plans. There were assurances that a limited tile repair capability would be certified prior to the launch of STS-114, along with a certification of the External Tank, although it was cautioned that some uncertainties would remain. It was noted that many certifications were in the yellow (accepted risk) category. The program stated that the non-ET debris allowables were zero; in other words, other elements were not allowed to generate any debris. The ET was treated differently, and there were specific requirements stated for allowable debris. The program provided a status on testing various Orbiter components to determine their ability to withstand debris impacts. It had already been determined through testing at the Glenn Research Center that certain Orbiter windows needed to be replaced with thicker glass. Testing of the tile and reinforced carbon-carbon continued. NASA also provided a status report for ground and flight cameras and on the proposed reorganization to meet CAIB R9.1-1 and its three subordinate recommendations. The Mission Management Team was the subject for a long discussion between Task Group members and NASA representatives. After this the program provided an update on Contingency Shuttle Crew Support, and answered a myriad of questions from the Task Group.

## **6.7 Summary of December 2004 Plenary**

This plenary was held December 14-16, 2004, in Huntsville, Alabama. At the public meeting following two days of fact-finding, it was determined that NASA has made considerable

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progress on meeting the CAIB recommendations for return to flight. The panels recommended, and the assembled Task Group approved, the complete closure of six assessments and the conditional closure of one additional assessment.

However, considerable work remains. Eight items remain open, including some of the toughest technological challenges the recommendations present: shedding of debris, strengthening the reinforced carbon-carbon, hardening the Orbiter, and repair of the Thermal Protection System. Most of the operational issues have been addressed, with the largest remaining concern involving the ability to detect and repair damage to the Space Shuttle while on orbit. Some planning remains to be accomplished before the International Space Station can potentially be used as a “safe haven” for the crew of a damaged Orbiter while they await the launch of a rescue mission. NASA has also made substantial progress on the various management issues the CAIB cited as “half” the cause of the demise of *Columbia*, but sufficient detail of plans, exercise of new capabilities and responsibilities, and adequate documentation remain open issues.

Several of the CAIB return-to-flight recommendations involve enhanced imagery of the Space Shuttle during ascent and while on orbit. NASA has made sufficient progress on imagery to allow the RTF TG to fully or conditionally close three assessments (R3.4-1, R3.4-2, R6.3-2) and note substantial progress on a fourth (R3.4-3, which will be formally considered as part of R6.4-1, Thermal Protection System Inspection and Repair).

Taken together, the changes in the capability to observe and examine the Space Shuttle during ascent will allow a more complete evaluation of the adequacy of the design and process changes made to the External Tank in the reduction of critical debris. The enhanced imagery will also contribute to the ability to conduct on-orbit inspections. There will undoubtedly be foam shed from the External Tank during the next and subsequent launches. The questions will be: how large are the pieces, where on the tank did the shedding occur, and where did the debris impact? The ascent imagery will help answer these questions.



The Return to Flight Task Group co-chair and panel leads brief the news media following the December 16, 2004 public meeting in Huntsville, Alabama. From left to right: Mr. Joseph W. Cuzzupoli, Col. James C. Adamson, Dr. Dan L. Crippen, and Col. Richard O. Covey. At the far right is the Task Group's Public Affairs Officer, Mr. David B. Drachlis.

Some months ago, it became clear that the immense amount of new data, much in the form of imagery, would require a new approach to integration. In response, NASA formed a development team that has produced a Thermal Protection System Operations Integration Plan intended to allow the Mission Management Team to make a timely entry readiness,

repair, or safe haven determination. The latest version of the plan, though still needing further simulation and testing, is very robust and a potential model for other integration activities within the Space Shuttle Program, as well as the Agency.

Two assessments affecting closeout procedures (R4.2-3 and R10.3-1) were moved from conditionally closed to fully closed at the plenary. "Closeout" refers to the process of finalizing work on the vehicle, often in an area that is then sealed from further view or inspection. The requirement for two-person closeouts is simply intended to add an additional pair of eyes to the evaluation of the completed work before the area is sealed for flight. The requirement for digitized closeout photos is intended to yield an adequate ability to both examine work after closeouts and the ability to easily recall the images, particularly while the Space Shuttle is on-orbit.

During the course of its investigation, the CAIB uncovered a technical deficiency in the bolt catcher, a device that prevents the explosive bolts used to mate the Solid Rocket Boosters to the External Tank from becoming debris that might impact the Orbiter. Although determined not to have contributed to the *Columbia* accident, the CAIB correctly wrote a recommendation (R4.2-1) requiring NASA to fix the problem. NASA has successfully redesigned, tested, and requalified the SRB bolt catcher, and the Task Group closed its assessment of this recommendation.

Although most of the management-related recommendations remain open, NASA has made substantial progress since the last plenary. Most notably, the response to Recommendation 7.5-1 (assessed as part of R9.1-1) to create an Independent Technical Authority (ITA) has been formulated, and implementation has begun. The first "warrants," the official delegation of authority to specific individuals, have been issued.

The role of the Mission Management Team, which received a great deal of attention immediately after the *Columbia* accident, has been clarified and expanded. The new Mission Management Team conducted 10 simulations of various aspects of the next mission and plans an end-to-end, full-mission simulation beginning in late February and lasting several days.

The systems engineering and integration function, which the CAIB noted had gradually atrophied, has been reinvigorated and has an expansive role in return to flight. However, the RTF TG remains concerned that without adequate documentation, the renewed vigor will dissipate soon after the launch of STS-114.

## **6.8 Summary of February 2005 Plenary**

This plenary was held on February 17, 2005, by teleconference. This public meeting was primarily to deliberate closing the Task Group assessment on R3.3-1, Reinforced Carbon-Carbon Non-destructive Inspection. The Recommendation had been conditionally closed in April 2004, and NASA submitted the requested additional data on February 2, 2005. The Task Group had evaluated the revised closure package and conducted fact-finding to verify the status of the recommendation.

A public meeting was held after this plenary and members of the media were briefed during a press conference. After deliberating, the Task Group closed its assessment of R3.3-1, feeling that NASA had met the intent of the CAIB.

## **6.9 Summary of the March 2005 Plenary**

This plenary was held March 28-30, 2005, in Houston, Texas, and was originally intended to be the final face-to-face meeting of the Task Group prior to writing the final report. However, in the weeks leading up to the meeting, it was apparent that NASA had not made sufficient

progress in documenting its compliance with the CAIB return-to-flight recommendations, and that it was unlikely all of the closure packages would be delivered to the Task Group in time to complete their assessments during the meeting. Therefore, even before the March 2005 meeting convened, it was expected that another plenary would be needed before the launch of STS-114 to evaluate the final closure packages yet to be received from NASA.

As the program's schedules for delivering final closure packages to the Task Group continued to slip, the RTF TG began to wonder if any assessments could be made at the meeting. When the plenary was convened on March 22, 2005, the Task Group's concerns were realized. During two days of fact-finding prior to a scheduled public deliberation scheduled for March 24, the Task Group decided that insufficient documentation existed for any assessments to be made. The public meeting was cancelled.

### 6.10 Summary of the Early June 2005 Plenary

This plenary was held June 6-8, 2005, in Houston, Texas. By this time, NASA had provided preliminary or final closure packages for all of the remaining CAIB recommendations. Fact-finding was held the afternoon of June 6 and all day June 7, with the Space Shuttle Program Manager and various other program officials providing detailed status briefings to the Task Group. The Associate Administrator for Space Operations briefed the Task Group on June 7, presenting the perspective from NASA Headquarters on the upcoming STS-114 mission and the changes being implemented by the new NASA Administrator.

The public meeting was held the morning of June 8, 2005. The Panel responsible for each recommendation provided a status or closure plan to the assembled Task Group, and in the end, the Task Group decided that five CAIB recommendations and the "raising the bar" Space Shuttle Program action had been completed. One of these, R3.4-1, Ground-Based Imagery, had been conditionally accepted during the December 2004 plenary; the Task Group now believed that NASA had provided the remaining data in a satisfactory manner and the recommendation was accepted to have fully met the intent of the CAIB. Four others: R3.4-3, High-Resolution Imagery of Orbiter; R6.2-1, Consistency with Resources; R6.3-1, Mission Management Team Improvements; and R9.1-1, Detailed Plan for Organizational Changes, were deliberated during the meeting. Task Group members agreed that the changes made by NASA for all four recommendations met the intent of the CAIB.



The Return to Flight Task Group conducts a deliberative public meeting on June 8, 2005, in Webster, Texas.

For the SSP-3, Contingency Shuttle Crew Support raising-the-bar action, the Task Group first discussed what criteria to measure against, since this was not a CAIB recommendation. Eventually, the Task Group decided that the original criteria defined by the Space Shuttle

Program would provide the measure, and it was agreed that the Space Shuttle and ISS Programs had both exceeded their initial goals. The Task Group concluded, “NASA set a raising the bar goal for itself and exceeded that goal by a significant margin.”

This left only three recommendations for the Task Group to consider before the return to flight: R3.2-1, External Tank Debris Shedding; R3.3-2, Orbiter Hardening; and R6.4-1, Thermal Protection System Inspection and Repair. The work on these recommendations is ongoing, with design reviews extended into late June. The Task Group decided to allow NASA additional time to complete work on these three recommendations and tentatively set a June 27 date for the last Task Group plenary. It is expected that NASA will have submitted closure packages on these last three CAIB recommendations by the time of the last plenary.

### **6.11 Summary of the Late June 2005 Plenary**

As the scheduled launch date of STS-114 approached, the Task Group and NASA attempted to come to closure on the final three assessments of the CAIB return-to-flight recommendations. These included what many observers considered the most critical recommendations: R3.2-1, External Tank Debris Shedding; R3.3-2, Orbiter Hardening; and R6.4-1, Thermal Protection System Inspection and Repair. The major delay was that NASA’s final debris and design certification reviews were being conducted into late June, and the Task Group wanted to review the results of these reviews prior to completing their assessments. The final closure packages for R3.2-1 and R3.3-2 were not received by the Task Group until during the plenary meeting; R6.4-1 had been received earlier in June.

A meeting was set between the Task Group leadership and the NASA Administrator for the morning of June 28, so the final plenary meeting was scheduled to occur in Washington, D.C., on June 27. This would allow the Task Group to work through the evening to ready the Executive Summary that would be delivered to the Administrator the following morning.

Final fact-finding, including a required annual ethics briefing, was conducted during a closed meeting on the morning of June 27, with a public meeting held in the afternoon. The public meeting location had been changed late the day before because a broken fire sprinkler flooded the original location. The new location was approximately two blocks away.

At the public meeting the Technical Panel recommended closing R3.2-1 and R3.3-2 as having met the intent of the CAIB. However, after spirited discussion, the majority of the Task Group voted that NASA had not met the intent of the CAIB for R3.2-1, although in both cases the Task Group felt that NASA had accomplished some excellent work. The majority of the Task Group also voted that NASA had not met the intent of the CAIB for R3.3-2, although again, the group felt that excellent work had been accomplished and that extenuating circumstances (the mandate to retire the Space Shuttle by 2010) understandably caused NASA to cancel some future work. Relative to R6.4-1, despite extensive efforts on the part of the Tile Repair Project and RCC Repair Project to develop a practicable TPS repair capability, the majority of the Task Group voted that the intent of CAIB Recommendation 6.4-1 had not been met, although there was a minority opinion that may be found elsewhere in this report. A press conference was held after the public meeting.

An Executive Summary of this report was finalized in time to deliver it to the NASA Administrator on the morning of June 28, and copies were subsequently delivered to Congress and the White House. An electronic copy was posted to the Task Group’s website. The version contained at the beginning of this report has been slightly edited for readability without affecting its content.