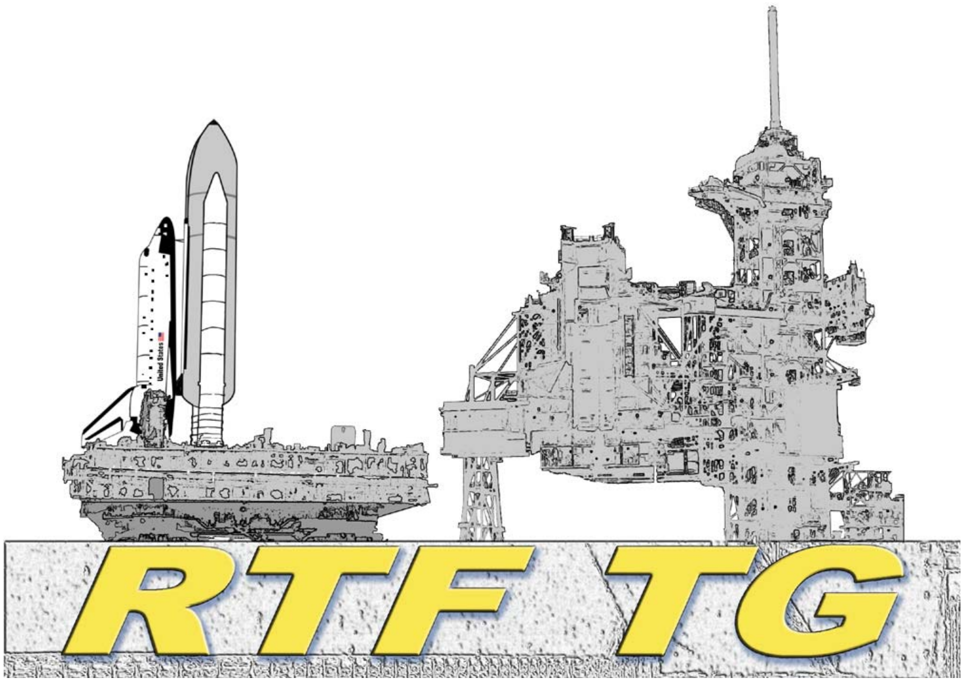
Second Interim Report

Return to Flight Task Group



May 19, 2004

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Return to Flight Task Group
Second Interim Report

Approved by

Ro Covey

Richard O. Covey
Task Group Co-Chairman

May 19, 2004

Date

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SUMMARY

There have been several significant changes in NASA's Space Shuttle return to flight effort since the last plenary meeting of the Return to Flight Task Group (RTF TG) in December. First, and most immediately, the schedule for the next launch was moved from September 2004 to March-April 2005. See Figure 1 below. This schedule change was prompted by three developments:

1. additional testing of the susceptibility of the Thermal Protection System (TPS), especially the Reinforced Carbon-Carbon, coupled with advanced analysis of the airflows around the Orbiter, External Tank (ET) and Solid Rocket Boosters indicated that the foam on a larger area of the ET should be stripped and reapplied;

2. some rudder speed brake actuators were discovered to have been incorrectly assembled during the original assembly over 20 years ago. Further, the gears in the actuators have generally suffered some damage with use and time. Therefore, all the actuators are being replaced or refurbished; and

3. design and building of a new camera/laser boom that would be used by the Space Shuttle's robotic arm to help inspect for possible damage while in orbit.

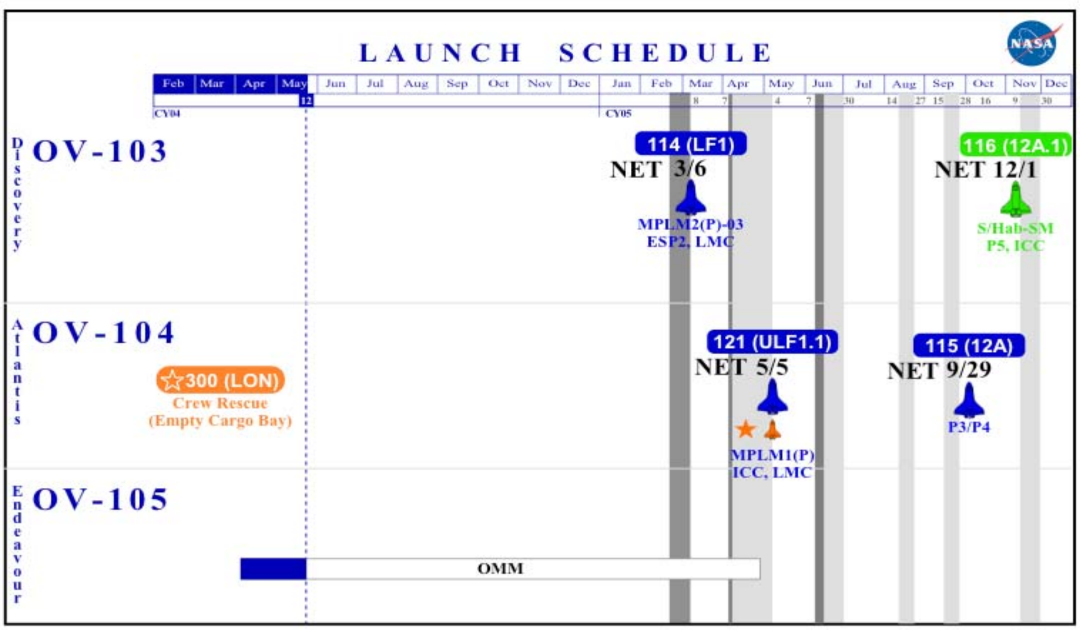

Figure 1 – Shuttle Launch Schedule

This change in schedule means that NASA will have additional time to implement the Columbia

Accident Investigation Board (CAIB) return to flight 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 Engineering Authority—it is expected those plans will now be implemented, at least for the Office of Space Flight, before next year.

The expanded time before the next launch also allows NASA additional time to select and perfect methods of, for example, inspecting the TPS 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 initiative, or vision, for the future of human space flight. The President proposed to utilize the Space Shuttle to finish the International Space Station (ISS) and then retire the Shuttle. In its place would be continued reliance on international partners to service the ISS 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 presence, and move on to explore Mars within the next 20 years.

While the President's vision has obvious implications for the long-run use of the Shuttle, its effects on the return to flight efforts have not been fully examined. However, no matter how long the Shuttle is used in the future, it must first be safely returned to flight. Therefore, except for potential competition for human 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 utilizing the ISS as a shelter for Shuttle Crew Contingency Support in the event of potentially catastrophic damage on the next flight, 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 this capability much as if it were a CAIB recommendation.

Finally, the Task Group instituted a "sub-panel" to examine the implications of the increased flow of data resulting from many of the CAIB recommendations and other return to flight initiatives.

The Task Group is encouraged by NASA's progress since its last plenary in December. 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 out three CAIB recommendations. "Closing out" a recommendation means that NASA has responded adequately to a specific CAIB return to flight recommendation. "Conditionally" means that the close out is dependent on the delivery of final information and the assurance of NASA that it will keep the RTF TG up-to-date on any new developments pertaining to those recommendations. The three recommendations being conditionally closed out with this second interim report are: 3.3-1: Reinforced Carbon-Carbon Non-Destructive Inspection; 4.2-3: Closeout Inspection; and 6.3-2: NASA/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 substantial 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 return to flight. The various new organizations, from the NASA Engineering and Safety Center, to the Independent Technical Authority, to the Space Shuttle 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 to be efforts to eliminate critical ascent debris. If it could be guaranteed that no critical debris would come from the ET, the immediate cause of the loss of Columbia would be rectified. But such a guarantee is impossible short of extensive testing in flight. Analytical and testing techniques 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 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 ISS will become an important consideration for the next launch.

INTRODUCTION

The Return to Flight Task Group

On April 14, 2003, the NASA Administrator, Sean O'Keefe, tasked Lt. Gen. Thomas Stafford, U.S. Air Force (Ret.), with conducting an independent assessment of NASA's actions to implement the recommendations of the Columbia Accident Investigation Board (CAIB). As a result, a Return to Flight Task Group (RTF TG) was chartered under the Federal Advisory Committee Act (FACA). Mr. Richard Covey and Lt. Gen. Stafford were asked to co-chair this committee. Using expertise from the Stafford-International Space Station Operational Readiness Task Force, personnel from the aerospace industry, federal government, academia, and the military, the RTF TG is reviewing the actions of the Agency in implementing the CAIB recommendations. They will report their evaluations to the Space Flight Leadership Council (SFLC) and deliver a final report to the NASA Administrator one month before the planned return to flight of the Space Shuttle. This report is strictly advisory to the Administrator and not a prerequisite for return to flight.

While the Task Group is ancillary to the CAIB, it is a modest enterprise by comparison—all RTF TG members are part-time; the support staff is significantly smaller; outside consultants will be rare; the impingement on NASA resources will be small; and the budget is a fraction of the CAIB's.

Federal Advisory Committee Act

NASA is among several federal agencies that currently enlarge their access to the insights and experiences of accomplished citizens by establishing advisory committees. The FACA 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 as they impact the designation and conduct of advisory committee members.

The legislative history of FACA (Public Law 92-463, 1972) makes it clear that Congress intended with this statue to lift the "veil of secrecy" surrounding over 35,000 then-existing federal advisory committees, ensuring that such groups did not function for purposes other than "giving advice." Examples of "other purposes" which Congress sought to prevent included "lobbying programs and partisan political activity" and enabling persons from "outside the government and not answerable to the people or to Congress for their actions" to "assume the functions of directors or indirectly [to] usurp the managerial functions which are the responsibility of the governmental agency."

The federal administrative requirements associated with agency use and management of advisory committees exist to preserve three fundamental principles that must govern the special access to federal decision-makers afforded to advisory committee members: public accountability, transparency, and assurances that advisory committee members serve in the public interest rather than for personal financial gain.

Purpose and Duties of the Task Group

The Task Group is performing an independent assessment of NASA's actions to implement the recommendations of the CAIB, as they relate to the safety and operational readiness of STS-114. As necessary to its activities, the Task Group consults with former members of the CAIB. While the Task Group is not attempting to assess the adequacy of the CAIB recommendations, it is reporting on the progress of NASA's response to meet the intent. The Task Group may make other such observations on safety or operational readiness, as it believes appropriate. The Task Group draws on the expertise of its members and other sources to provide its assessment to the Administrator. The Task Group holds meetings and makes site visits as necessary to accomplish its fact-finding. The Task Group has been providing information necessary to perform its advisory functions, including activities of both the Agency and its contractors. The Task Group functions solely as an advisory body and complies fully with the provisions of the FACA. The Task Group will terminate two years from the date of establishment, unless terminated earlier or renewed by the NASA Administrator.

Panels and Sub-Panels of the Task Group

The RTF TG is comprised of three panels: the Technical Panel, the Management Panel, and the Operations Panel; and two sub-panels: the Editorial Sub-Panel and the Integrated Vehicle Assessment Sub-Panel (IVASP). These are shown in Appendix C.

Technical Panel

The Technical Panel is focusing on NASA's compliance with the CAIB's findings and recommendations in the material condition of the Space Shuttle. This includes technical requirements (development of and compliance with), vehicle engineering, hardware and software development/verification, and overall vehicle certification status involved in the following:

CAIB Recommendations

3.2-1 External Tank Debris Shedding
3.3-1 Reinforced Carbon-Carbon Non-Destructive Inspection
3.3-2 Orbiter Hardening
4.2-1 Solid Rocket Booster Bolt Catcher
4.2-3 Closeout Inspection
6.4-1 Thermal Protection System Inspection and Repair - Materials Only

Management Panel

The Management Panel focuses on NASA's compliance with the CAIB's findings and recommendations in Space Shuttle Program (SSP) management, return to flight integrated schedule, and program/project risk management involved in:

CAIB Recommendations

- 6.2-1 Consistency with Resources
- 6.3-1 Mission Management Team Improvements
- 6.3-2 National Imaging and Mapping Agency/NASA Memorandum of Agreement
- 9.1-1 Detailed Plan for Organizational Change
  - 7.5-1: Independent Technical Engineering Authority
  - 7.5-2: Safety and Mission Assurance Organization
  - 7.5-3: Space Shuttle Integration Office Reorganization

Operations Panel

The Operations Panel focuses on NASA's compliance with the CAIB's findings and recommendations in SSP crew/controller operations and procedures to support operations involved in:

CAIB Recommendations

- 3.4-1 Ground-based Imagery
- 3.4-2 Hi-resolution Images of External Tank
- 3.4-3 Hi-resolution Images of Orbiter
- 4.2-5 Kennedy Space Center Foreign Object Debris Definition
- 6.4-1 Thermal Protection System Inspection and Repair -- Repairs Only
- 10.3-1 Digitize Closeout Photos
- SSP-3 Space Shuttle Program Action - Contingency Shuttle Crew Support

Integrated Vehicle Assessment Sub-Panel

This sub-panel combines insights from the Operations, Technical, and Management Panels to assess NASA's ability 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.

The IVASP focuses on crosscutting vehicle assessment actions, specifically including assessment of the Thermal Protection System (TPS). The sub-panel assessment will consider the broad interactions of allowable debris, critical damage size, damage detection and assessment via imagery and sensors, and the development of the associated MMT improvements to support real-time operations. This sub-panel assesses NASA's ability to integrate the information from this critical, and heavily related, set of changes driven by the NASA Implementation Plan. The set of NASA actions considered by this sub-panel includes:

CAIB Recommendations

3.2-1 External Tank Debris Shedding
3.3-2 Orbiter Hardening
3.4-1 Ground-based Imagery
3.4-2 Hi-resolution Images of External Tank
3.4-3 Hi-resolution Images of Orbiter
6.4-1 Thermal Protection System Inspection and Repair
6.3-1 Mission Management Team Improvements
SSP-3 Space Shuttle Program Action - Contingency Shuttle Crew Support

Two members of the sub-panel will review the operational aspects of NASA's response to CAIB Recommendation 6.3-2 that NASA modify the Memorandum of Agreement with the National Imagery and Mapping Agency.

Editorial Sub-Panel

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

Conduct of the Inquiry

For all three panels, review and assessment of the NASA Implementation Plan items shall include those items the CAIB identified as mandatory prior to return to flight. Items that are not required for return to flight, but that are in the NASA Implementation Plan, are considered to be open work items that will be passed on to the Aerospace Safety Advisory Panel. On a very selective basis, the RTF TG will assess the non-return to flight SSP items, known as "raising the bar" items in the NASA Implementation Plan, after notifying NASA of this decision.

The diverse nature of the recommendations requires a unique approach to the evaluation of each item in the NASA Implementation Plan. This is a result of the presence of process change, hardware changes, organizational changes, and documentation of all of these, often in a single item. However, the criterion for acceptance, and closure by RTF TG/NASA, is uniform and defined below.

In general, the lead panel conducts fact-finding by field trips to appropriate sites, meeting with NASA personnel, discussions with contractors, issuing formal Requests for Information (RFIs) to NASA, and consulting with other experts.

Requests for Information

The issuing and closing of RFIs is the formal process of requesting and receiving information from NASA. An RFI could be a simple request for existing facts, or a complex inquiry on operations. RFIs can include specific actions of NASA to develop information, such as conducting workshops or making specific presentations. A more complete explanation of the RFI process, including a flowchart and sample forms is included in Appendix G. Appendix E is a list of RFIs issued thus far and their status. All RFIs are required to be closed prior to the formal acceptance of the NASA Implementation Plan item for closure.

RTF TG/NASA Closure Process

While the panels are pursuing fact-finding activities, NASA is executing a detailed plan to implement the CAIB recommendations. These plans are differentiated from the NASA Implementation Plan by the level of detail. When NASA concludes it has a mature plan, NASA will present the plan, details specified below, to the appropriate panel(s) of the RTF TG. This submittal will be in the form of a Return to Flight Action Closure Package. This package and its supporting documentation are auditable documents that provide NASA's complete and comprehensive strategy for closing out the CAIB recommendation. Each Return to Flight Action Closure Package shall contain, as a minimum, the following elements:

1. Signatory Sheet
    a. Relevant element or project manager(s)
    b. Space Shuttle Program Manager
    c. Lead - Return to Flight Planning Team
    d. Deputy Associate Administrator for Space Station/Space Shuttle Programs
    e. Associate Administrator, Office of Safety and Mission Assurance
    f. SFLC Co-Chairs

2. Transmittal Letter from SFLC Co-Chairs to RTF TG Co-Chairs

3. Executive Summary of the Closure Rationale
    a. Background Information, to include assumptions and interpretation of the CAIB recommendation
    b. Corrective Measures and Results
    c. Open Issues
    d. Verification

4. Chart Package for Closure Presentation to RTF TG, including back up charts

During the plenary meetings in April, the RTF TG had the opportunity to exercise the closure process. It was further refined to reflect the following changes:

1. The definition of tasks, requirements, and results would be developed from the most recent release of the NASA Implementation Plan (currently Revision 1.2).

2. The metrics and audit trail specified above would include the use of the current Space

Shuttle Program Office (SSPO) 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. Agreement on the appropriate level at which to track, verify, and certify the activities to be included in the closure package

Risk Reduction Framework

The single most critical return to flight issue is eliminating ascent debris. The problem is not solved at this time. A plan is in place for an External Tank (ET) to be delivered in time to support a March 2005 flight. The SSPO Safety and Mission Assurance Manager described the framework for TPS risk reduction to the RTF TG at the April 2004 Plenary Meeting. This approach to defining the core return to flight issue is well-documented in NASA's Space Shuttle Methodology for Conduct of Space Shuttle Program Hazard Analyses, NSTS 22254, Revision B.

This framework, shown in Figure 2, starting with primary hazard controls, further delineates appropriate warning devices and special procedures required to mitigate the risk of the primary hazard control not being completely satisfied.

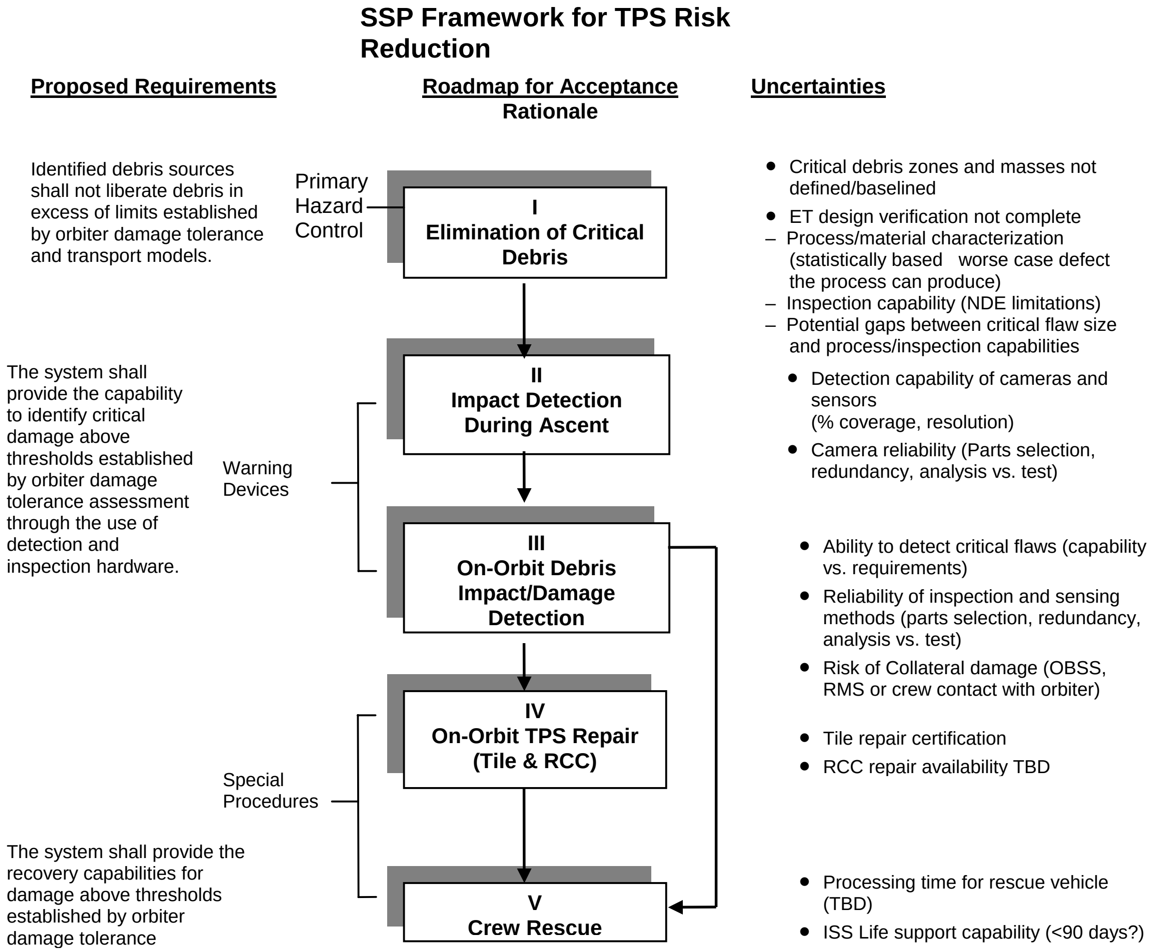

Figure 2 - Space Shuttle Program Framework for TPS Risk Reduction

The RTF TG is satisfied with this "top-down" approach as applied to this hazard reduction program. The same "top-down" approach needs to be implemented across NASA as a whole. In particular, the RTF TG is interested in seeing this implementation specifically applied to all the NASA Implementation Plan items. Failure by NASA to do this will result in the inability to address the interfaces and interconnection between and among the items. Such missed opportunities created the perceived need in the RTF TG to institute the IVASP. This higher-level requirements recognition will assure that the approach NASA implements will satisfy the issues that could not be addressed in a "bottom up" fashion.

Consideration might be given to a "top down" requirements flow down as shown in Figure 3 and Figure 4 below. This approach recognizes the relationship between seemingly disconnected system elements that have crosscutting functional connectivity. The ability to construct this hierarchical diagram would only be possible if a "top-down" approach had been successfully developed.

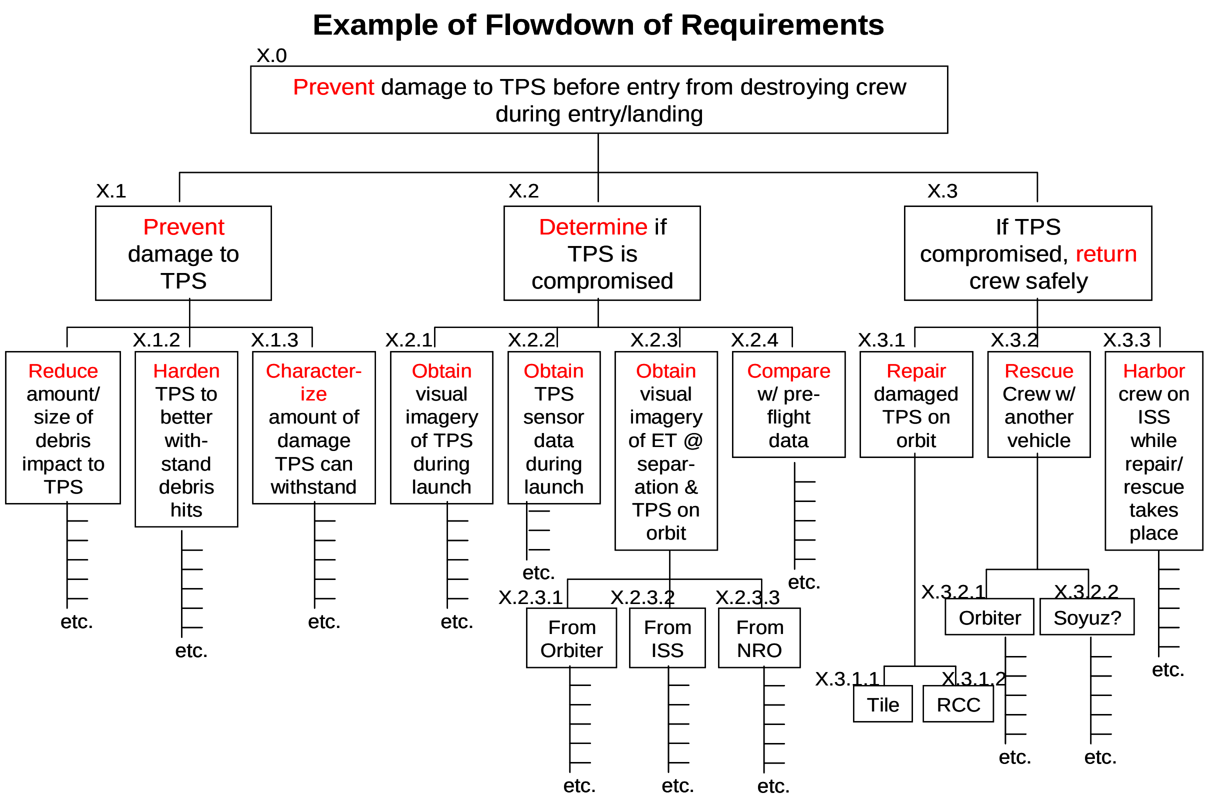

Figure 3 – Example of Flow down of Requirements

(HAZARD SEVERITY LEVEL AND LIKELIHOOD OF OCCURRENCE WITH CONTROLS IN PLACE)

LIKELIHOOD	MARGINAL	CRITICAL	CATASTROPHIC
PROBABLE	ACCEPTED RISKS	ACCEPTED RISKS	UNACCEPTABLE RISK
INFREQUENT	ACCEPTED RISKS	ACCEPTED RISKS	ACCEPTED RISKS
REMOTE	CONTROLLED	ACCEPTED RISKS	ACCEPTED RISKS
IMPROBABLE	CONTROLLED	CONTROLLED	CONTROLLED

SEVERITY LEVELS

Figure 4 – Risk Matrix

An excellent example from STS-107 would be the perceived versus the real risk to the Shuttle stack from ET debris. The Orbiter vulnerability to debris was specified and well documented. The historical TPS flight anomalies were also well documented. The persistent problems with foam issues and debris shedding from the ET were also well documented, although the source and root cause were not fully investigated. The prevailing logic was that the debris was an ET problem that should be solved, but that there was no criticality or elevated risk to the Orbiter or Solid Rocket Boosters (SRBs), since there was a programmatic history of acceptable damage to the Orbiter, and SRBs.

The actual risk level at the launch of STS-107 was not aligned with the facts because the integrated analysis was not accurate. The perception of risk, which could be portrayed in Figure 4, was in the lower ACCEPTED RISK box, with catastrophic consequences, but with remote likelihood. In fact, the functionality and interface considerations of the Orbiter (in this case, potentially catastrophic damage, but with a probable likelihood) were misunderstood, their actual risk level was in the upper right corner, UNACCEPTABLE. Only with a "top-down" look across all the elements, associated requirements, and performance, could the actual unbiased risk level be ascertained. The RTF TG anticipates NASA will continue to expand this approach with the attendant positive results as the more complex NASA Implementation Plan items are brought forward for closure.

Organization of this Report

This report is organized numerically by CAIB recommendation. First, the original language of the CAIB recommendation is provided followed by the RTF TG's interpretation of that recommendation. Next a summary of NASA's plans to address the CAIB recommendation is as stated in the document "NASA's Implementation Plan for Space Shuttle Return to Flight and Beyond" coupled with the RTF TG's assessment of NASA's progress to date. The RTF TG's future plans for completing each evaluation are then overviewed. Finally, a current status is given for:

1. The detailed plan the RTF TG deems necessary for compliance with CAIB;
2. The status of the implementation of such a plan;
3. The status of formal RFIs; and
4. The overall status.

Reporting

This interim report was prepared by the Editorial Sub-Panel consisting of RADM Walt Cantrell, Dr. Dan Crippen, and Dr. Rosemary O'Leary. The panels provided the primary substance of the report. The report was submitted for comments to the entire RTF TG and NASA (for technical comment only). RTF TG Co-Chair Richard Covey approved the final version.

CAIB Recommendation 3.2-1 - External Tank Debris Shedding

Initiate an aggressive program to eliminate all External Tank Thermal Protection System debris shedding at the source with particular emphasis on the region where the bipod struts attach to the External Tank.

RTF TG Interpretation

Eliminate all sources of critical debris by eliminating the bi-pod strut foam and determine the void size that correlates with a debris size that is acceptable, based on the transport and energy analysis.

NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)

Initiate three-phase approach to eliminate potential for External Tank (ET) Thermal Protection System (TPS) debris loss. Enhance or redesign areas of known critical debris sources including: redesign forward bipod fitting, eliminate ice from the liquid oxygen (LO2) feed line bellows, and eliminate debris from the liquid hydrogen (LH2) intertank flange closeout. Reassess all TPS areas to validate TPS configurations. Pursue comprehensive testing program to understand the root cause of foam shedding and develop alternative design solutions to reduce the debris loss potential. Pursue development of TPS Non-Destructive Inspection (NDI) techniques for LO2 and LH2 Protuberance Air Load (PAL) ramps and LH2 intertank flange manual closeout. Phase 2 of the plan investigates automation of critical manual TPS spray processes, and Phase 3 of plan investigates redesign of the ET to further eliminate sources of debris shedding. Initiate a process for NDI and probability of detection for NDI models.

Assessment

Since last Plenary, the Technical Panel completed the following fact-finding:

- ET Request for Information (RFI) Mini-Technical Interchange Meeting at the Michoud Assembly Facility on February 3, 2004
- ET Monthly Status Meeting on April 1, 2004
- ET Tank Certification discussion on April 1, 2004

The ET Project Office is executing a three-phase plan to allow for continued improvements in the TPS application and inspection processes.

Phase 1: Develop, design, certify, and implement the required modifications to the ET that will allow for a safe return to flight, depicted in Figure 5.

Phase 2: Implement additional enhancements to reduce debris risk

Phase 3: Develop, design, certify, and implement modifications to the ET that will minimize debris sources in the critical debris zone

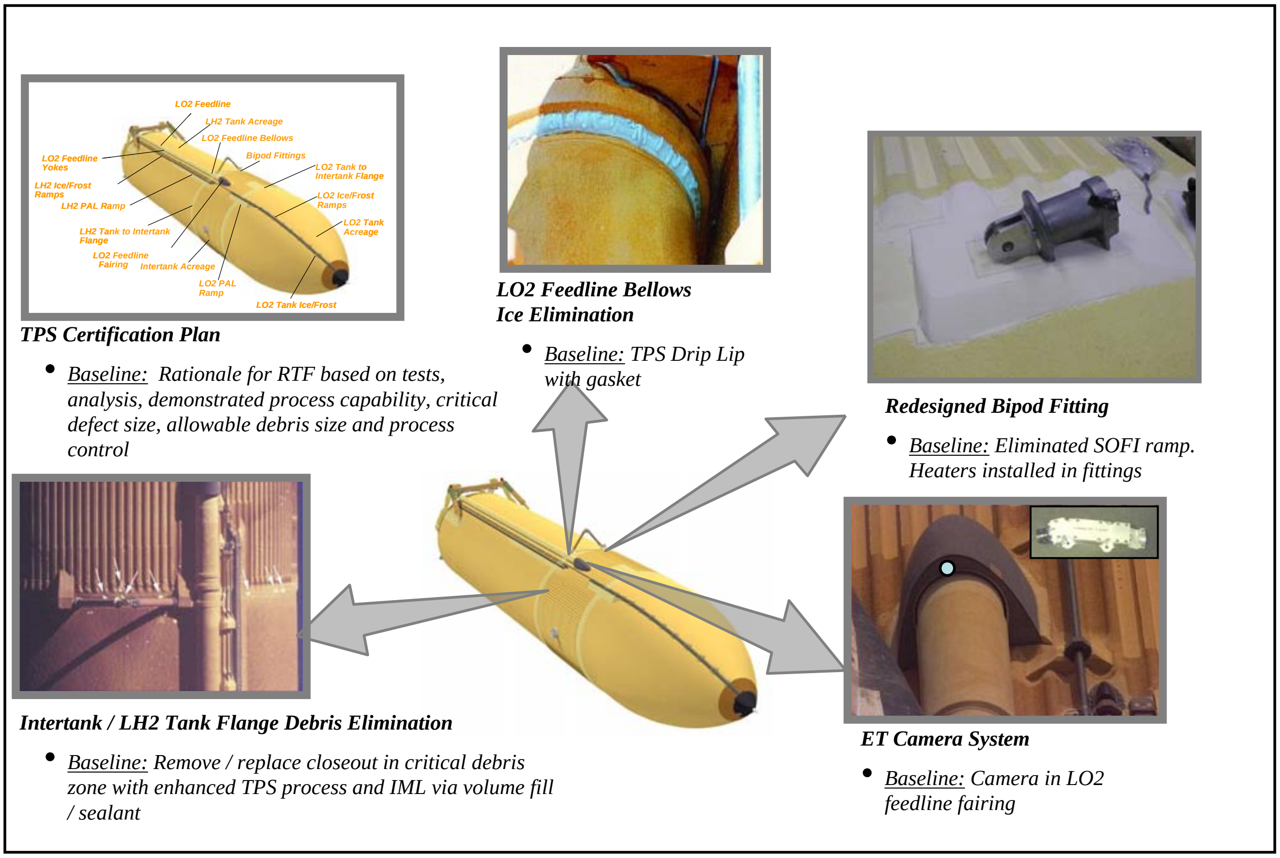

Figure 5 - ET Return to Flight Baseline

Led by the Systems Engineering and Integration Office, the Space Shuttle Program Office (SSPO) is conducting an integrated systems analysis to assess the critical debris size and flow dynamics. This activity will ultimately lead to the development of a comprehensive model of potential debris flow and risk to critical areas of the Space Shuttle. This effort has progressed significantly since the last report and is close to completion.

Impact tests are continuing to obtain allowable energy impacts. The transport analyses of debris paths from the ET to other elements have determined the preliminary debris size allowable as a function of location on the ET. Panel and coupon tests are determining root cause of debris loss to determine a relationship between void size and debris divot size and then determine a debris weight. These activities are correlated to develop void size and debris weight allowables.

A revised TPS process verification and validation plan is currently under review. Flight verification will be based on process verification. Each flight tank manual application will be preceded by a lead-in test panel and followed by a lead-out test panel. Both will be dissected and examined for voids. If any voids exceed a predetermined value the flight tank application will be reworked.

NASA has determined that NDI void detection is limited to voids greater than 0.5 inches. Also, NASA currently believes that the largest defect that will be produced in the foam will be less than 0.5 inches. Therefore, NDI will still be pursued but only will be used as a confidence tool on PAL ramps.

The current plan for tying the debris sources, impact testing, transport analysis, NDI, and void testing is displayed in Figure 6.

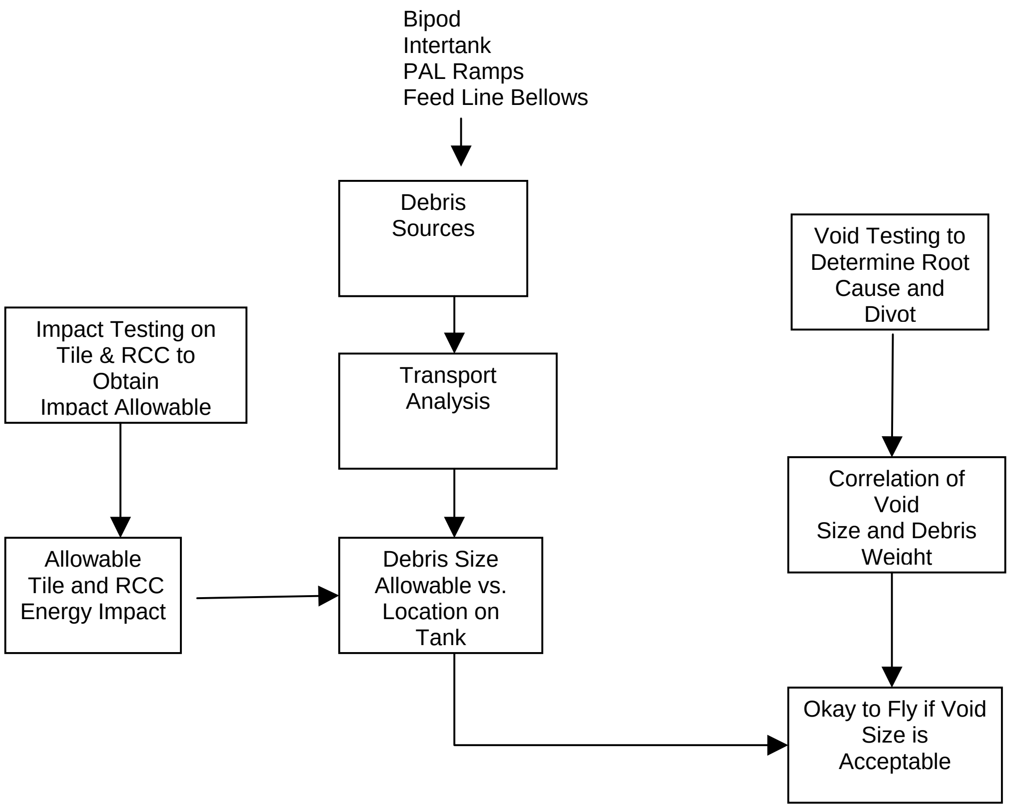

Figure 6 – ET Test Plan

Additionally NASA has:

- Re-planned L02 feed line bellows activity
- Developed volume fill for Nitrogen displacement in intertank Y joint
- Established a plan that will ensure that at least two employees attend all critical hand-spraying procedures and all final closeouts
- Decided to rework intertank flange critical debris zone to +/- 112 degrees from Z-axis to include thrust panels (Figure 7)

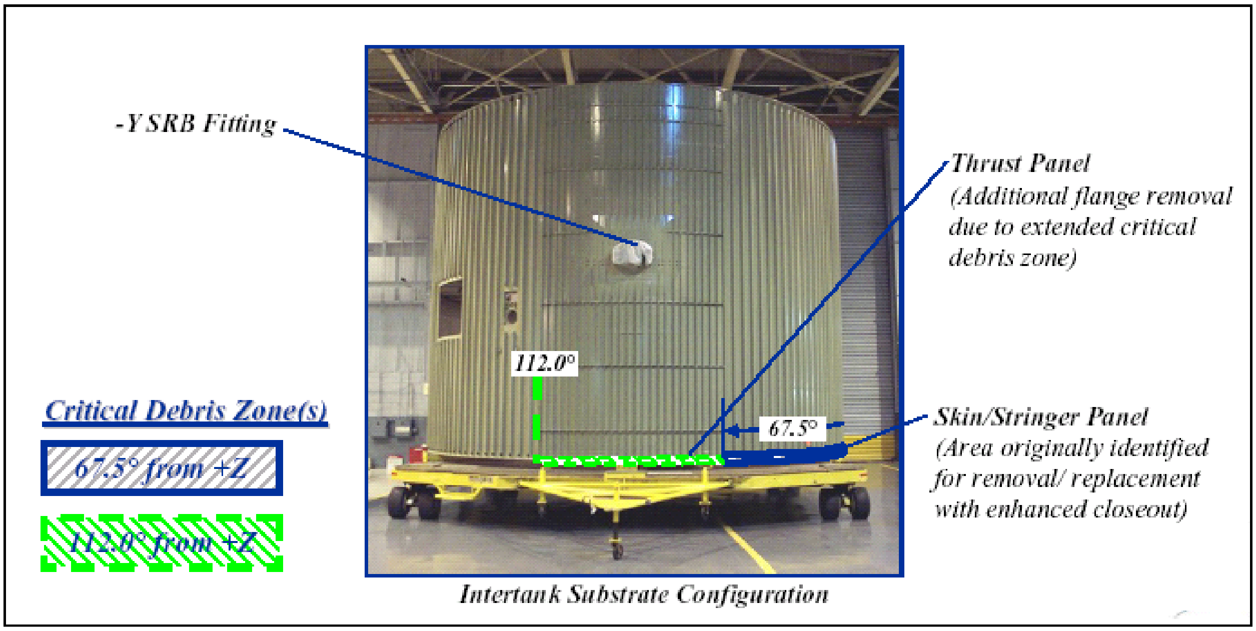

Figure 7 – Extended Debris Zone

Future

The Technical Panel will continue to review NASA's Implementation Plan and assess the responses to outstanding RFIs. The most critical information remaining to be provided by NASA is documentation of the approved Process Verification and Validation Plan and documentation of the approved flight TPS application procedures.

Status

Plan – Overall Established. Verification and Validation Plan under review.
Implementation – In Progress and/or review.
RFIs Outstanding – 9
Overall Status – Open

CAIB Recommendation 3.3-1 – Reinforced Carbon-Carbon Non-Destructive Inspection

Develop and implement a comprehensive inspection plan to determine the structural integrity of all Reinforced Carbon-Carbon system components. This inspection plan should take advantage of advanced non-destructive inspection technology.

<u>RTF TG Interpretation</u>

Rebaseline Reinforced Carbon-Carbon (RCC) components by recycling through original manufacture process. Use advanced technology as appropriate.

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

Pursue inspection capability improvements with newer technologies to allow Non-Destructive Inspection (NDI) of RCC without removal. Assess commercially available equipment and develop standards for use on flight hardware. Perform Non-Destructive Inspection (NDI) on select Discovery (OV-103) and Atlantis (OV-104) components. Perform certification of all RCC panels by inspection prior to return to flight. Develop NDI and associated inspection criterion for RCC and nose cap.

<u>Assessment</u>

NASA has identified a three-phase approach for implementing the CAIB recommendation. Phase 1 is focused on return to flight. Phase 2 is to develop NDI methods for RCC inspection during turn-around and Orbiter Major Modification with a goal of developing and certifying an on-wing technique for use at the Kennedy Space Center (KSC). Phase 3 will continue evaluation of NDI technology for future improvements.

Excellent progress has been made in the development and implementation of an inspection plan for all RCC. Phase 1 is to quantitatively determine viability of each technique based on existing manufacturer acceptability testing capabilities and Leading Edge Support Structure (LESS) localize convective oxidation NDI criteria. Phase 2 is to develop selected techniques into "turn-key" systems. NASA has selected three NDI technologies for on-vehicle RCC inspection between missions: thermography, x-ray, and eddy current. These technologies will be developed and fielded at Kennedy Space Center (KSC) for use before the second flight of each vehicle and before all flights thereafter. The data produced will complement and enhance the protection against abnormal flight and processing damage offered by current visual and tactile inspections.

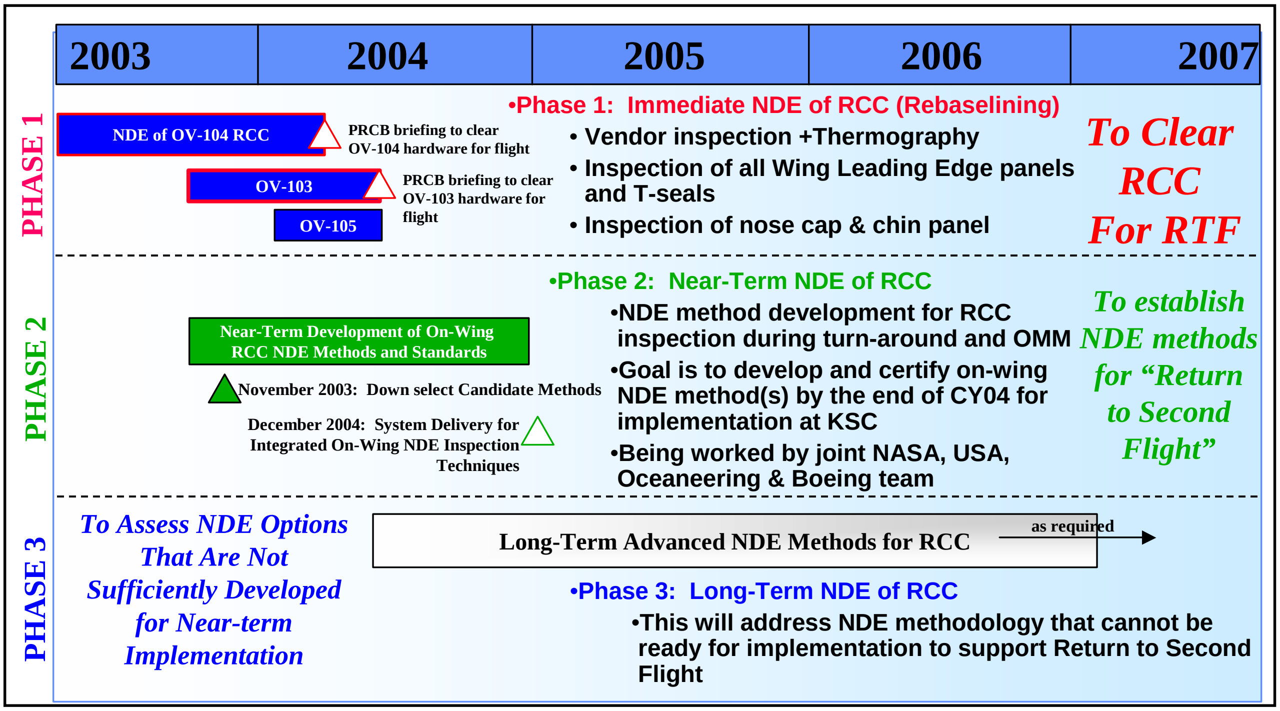

Figure 8 – NDI Inspection Plans

The manufacturer has rebaselined all RCC components for OV-103 and OV-104, and thermography has also been completed at KSC (Figures 9 and 10). Endeavour (OV-105) components are in process. In the process of rebaselining, the original oxidation life reduction curves have been validated and the established schedules for refurbishing and replacing RCC panels and attach hardware have also been verified. No significant accumulated impact damage has been discovered in any RCC components. No corrosion issues were found through examination of attachment hardware. The manufacturer found a few minor voids that were introduced at manufacturing, but went undocumented in the original acceptance screening. Some of these voids were analyzed in detail and found acceptable; others remain to be analyzed. Analysis is being performed to the heavy weight performance enhancement loads requirements.

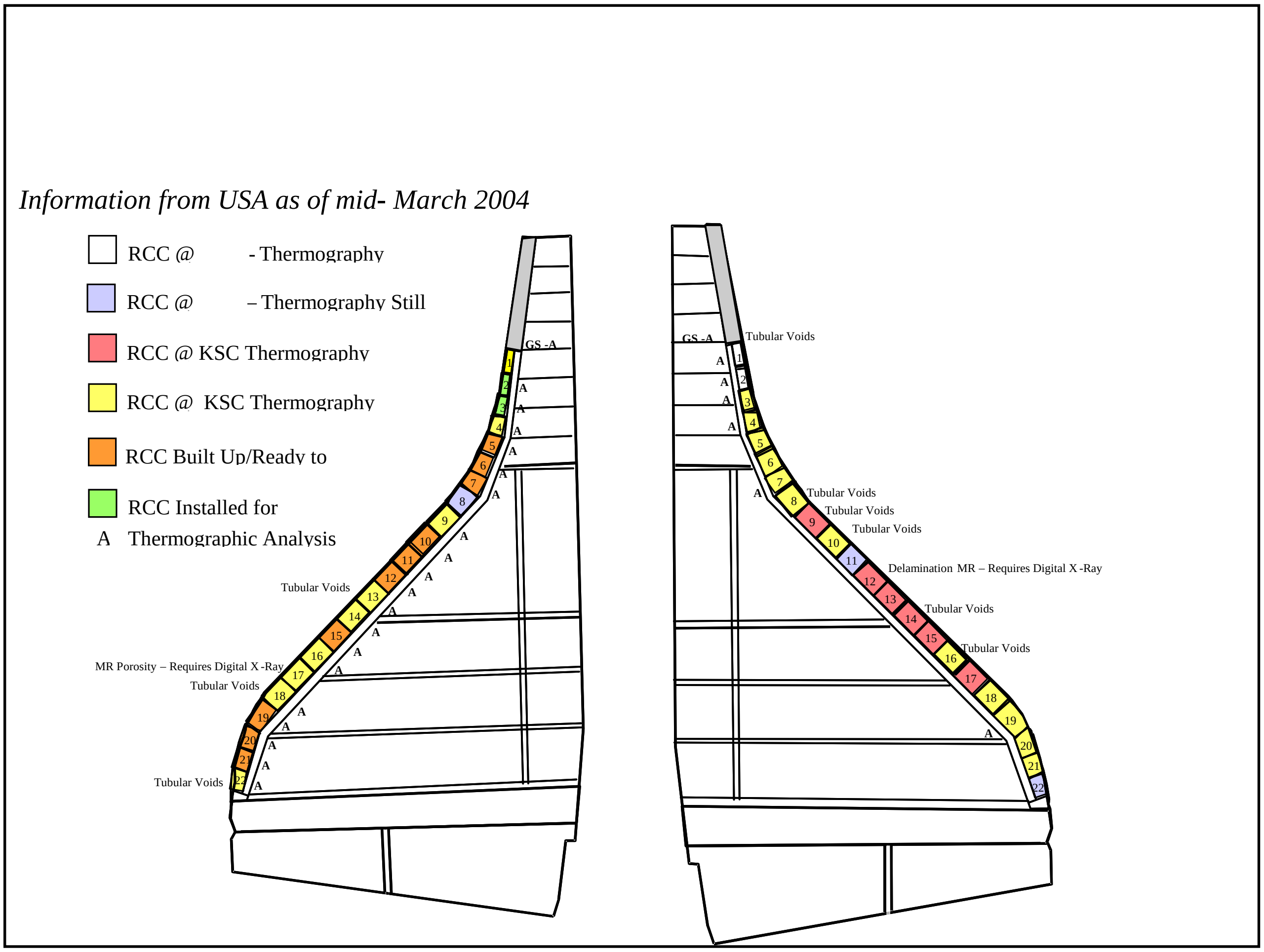

Figure 9 – OV-103 RCC Inspection and Installation Status

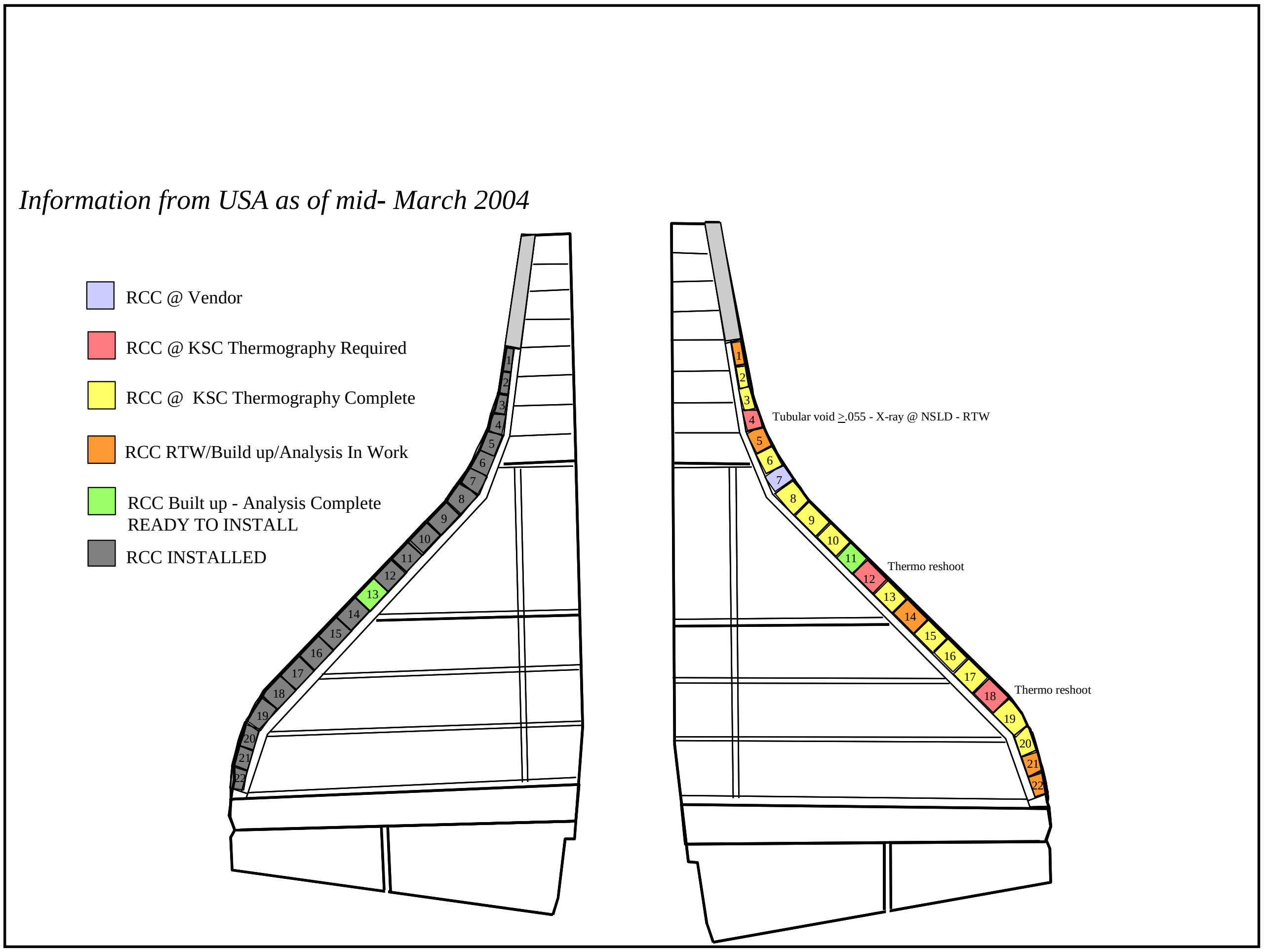

Figure 10 – OV-104 RCC Inspection and Installation Status

After components are NDI inspected at the vendor and shipped to KSC, an additional NDI technique, thermography, is being used to establish a baseline and compare to original NDI acceptance criteria. NASA's plan is to correlate the thermography data to the vendor NDI data and to other sensor data. To aid in the development of these technologies, NASA is establishing a server-based RCC NDI database for easy retrieval of stored data as well as developing a Data Fusion visualization tool to accommodate the overlay of RCC NDI data onto Catia Computer-Aided Design (CAD) model. This will enable visualization of NDI features using the structure CAD model, comparison of new NDI data with baseline data to evaluate changes in hardware condition, streamlining of data evaluation for Problem Report/Material Review disposition, and remote access to NDI data via the NDI database server.

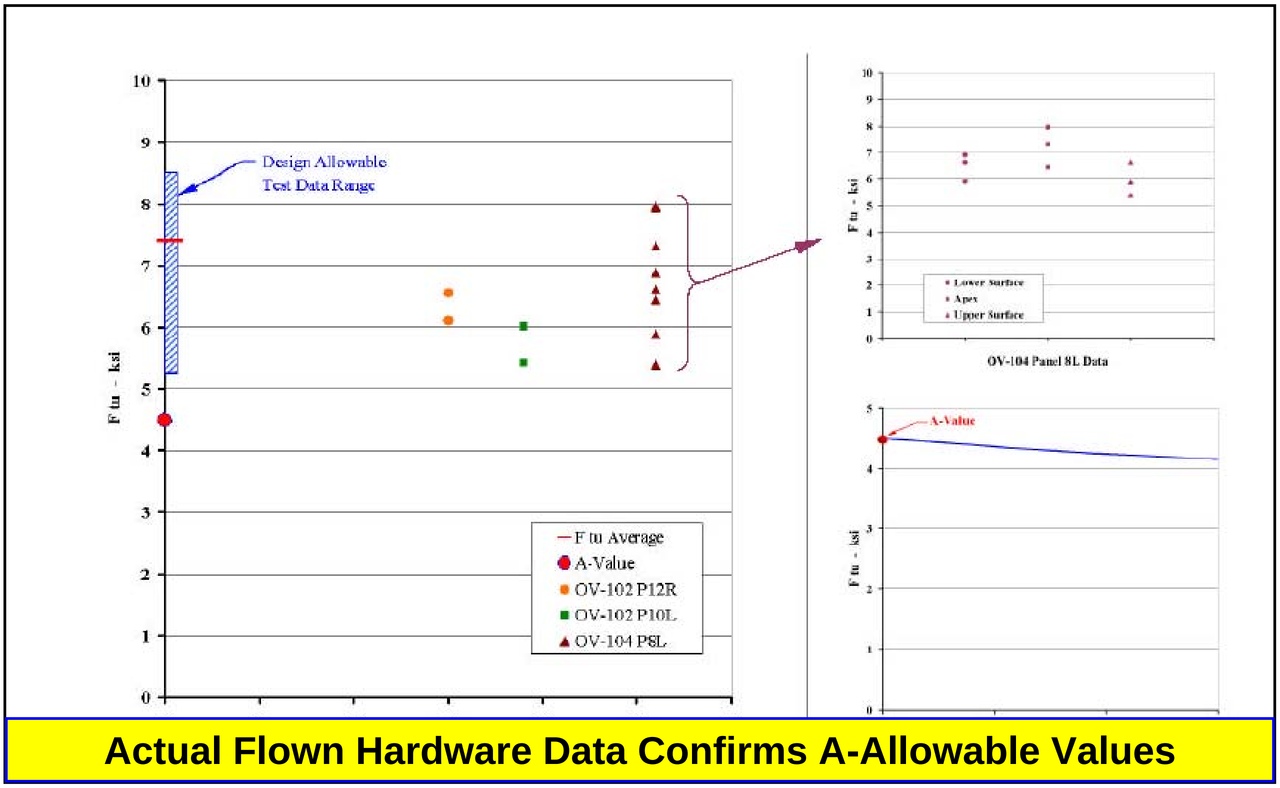

Figure 11 - Flight Data Strength Tables

Future

The Technical Panel will evaluate any changes from the closeout package submitted by NASA.

Status

Plan: Inspection procedures in development. RCC standards in development (generic, technique-specific, validation process). Flaw detection requirements are being defined. Data storage, reduction and analysis process in development.

Implementation: Near and long-term technologies identified. “Turn-key” systems for in-situ techniques are under development.

Overall Status – NASA submitted a request for closure of this item. Based on the closure package submitted, the status of the hardware tests, and its own fact finding, the RTF TG conditionally accepted closure of this recommendation. The verification criteria for this item have been defined and will be monitored.

CAIB Recommendation 3.3-2 – Orbiter Hardening

Initiate a program designed to increase the Orbiter's ability to sustain minor debris damage by measures such as improved impact-resistant Reinforced Carbon-Carbon and acreage tiles. This program should determine the actual impact resistance of current materials and the effect of likely debris strikes.

RTF TG Interpretation

Develop a detail plan to define the hardening program including the detail testing and modeling to determine the impact resistance of the Thermal Protection System (TPS). For the first Orbiter returning to flight, the actual impact resistance of installed material will be known. Implement hardware changes as defined in the hardening program.

NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)

Define candidate redesigns that will reduce impact damage risk to vulnerable TPS areas. Develop a forward-looking assessment plan for TPS/wing leading edge enhancement redesign options and examine other enhancements including durable tile, landing gear door and External Tank (ET) door redesign, TPS instrumentation, toughened unipiece fibrous insulation (TUFI), and carrier panel redesign. Establish plan to determine impact resistance of Reinforced Carbon-Carbon (RCC) and tiles including: identify debris sources, provide transport analyses of debris sources, and conduct test program to determine impact resistance of RCC and tile. This activity is broken into three phases where Phase 2 has items that are possibly Phase 1 depending on debris sources and critical debris size.

Assessment

Overall eight families of TPS enhancement targets have been identified:

1. Wing Leading Edge Support Structure Redesign
2. Durable Tile (BRI 8, BRI 20)
3. Gear and ET Door Thermal Barrier Redesign
4. Carrier Panel Upgrades
5. TPS Instrumentation
6. Elevon Leading Edge Redesigns
7. White TUFI
8. Vertical Tail Advanced Flexible Reusable Surface Insulation High Emittance Coating

NASA plans to implement these enhancements in three phases. Phase 1 consists of those items that must be completed prior to return to flight, Phase 2 includes those items that require additional tests and analyses (the results of which may require that some items be moved into Phase 1), and Phase 3 consists of long-term options to increase Orbiter robustness.

Three projects have been identified as Phase 1 and will be implemented before STS-114. These include front spar protection for RCC panels 5 through 13, main landing gear corner void elimination, and forward Reaction Control System carrier panel redesign to eliminate bonded studs. The front spar protection is in final design; the other two are already being implemented. These options will increase the robustness of the Orbiter at highly critical areas such as the wing spar and main landing gear door (MLGD) to reduce existing design vulnerabilities.

There are two Phase 2 options, "sneak flow" front spar protection for RCC panels 1 through 4 and 4 through 22, and MLDG enhanced thermal barrier redesign. Both of these projects are in the final design phase. These are not being held as constraints to flight, but would enhance overall Orbiter hardening. Ongoing tile and RCC impact tests may elevate one or both of these to Phase 1. Testing has cleared the MLGD thermal barrier design impact resistance as acceptable for return to flight. Implementation of the Phase 2 modifications may begin as early as one year after return to flight, and will be executed during Orbiter Major Modification periods or during extended between-mission flows.

Finally, the remaining Phase 3 options are those that are less mature but hold promise for increasing the robustness of the Orbiter. These options will be implemented as designs mature and implementation opportunities become available. For instance, NASA is actively developing new toughened tiles for the Orbiter TPS. These tiles will be installed as soon as possible around critical areas such as the landing gear doors. In less critical areas, they will be installed as existing tile require replacement.

The Technical Panel conducted fact-finding sessions including the witnessing of an RCC panel installation and the Phase 1 changes at the Orbiter Processing Facility and a briefing from the Orbiter Project Office in April 2004.

Impact testing continues on both RCC and tile. Foam impact tests are being conducted presently at Southwest Research Institute, with ice and metal testing at White Sands Test Facility and ablator impact testing at the Kennedy Space Center to begin shortly.

Foam TPS tile testing is very well along. Over 700 tests have been planned and approximately 130 are complete to date. In six tests, tiles have been broken completely at the densification layer interface. NASA needs to define how this will affect the debris allowables. The RCC test program and modeling activity has been defined in detail. Testing is in the early stages.

NASA has several impact assessment tools under development including those for rapid assessment, and more detailed analysis and test data are being used to verify and validate these models.

Future

The Technical Panel recommended three areas for consideration by the Shuttle Program before return to flight, in addition to the work already planned to support this task:

1. Understand results of impact testing, especially instances where one or more tile broke completely at the densification layer interface.
2. Impact tests only consider the effects of a single object impacting the vehicle, whereas the historical record reflects clusters of objects impacting an area on the Orbiter. NASA should consider effects of impact of clusters of objects on the Orbiter.
3. Develop a detailed validation plan for the impact assessment tools with an explanation of how the impact testing is being used to validate the tools.

Status

Plan – Well designed. Test plan and modeling activity to determine the actual impact resistance is defined in detail and will form the basis for the majority of work activity required for return to flight.
Implementation – Most of the engineering work is released and modifications either completed or in work.
Open RFIs - 0
Overall Status – Open

CAIB Recommendation 3.4-1 – Ground-Based Imagery

Upgrade the imaging system to be capable of providing a minimum of three useful views of the Space Shuttle from liftoff to at least Solid Rocket Booster separation, along any expected ascent azimuth. The operational status of these assets should be included in the Launch Commit Criteria for future launches. Consider using ships or aircraft to provide additional views of the Shuttle during ascent.

<u>RTF TG Interpretation</u>

The CAIB image analysis was hampered by the lack of high-resolution and high-speed ground-based cameras. The existing camera locations were a legacy of earlier NASA programs and were not optimum for the exit trajectory of Space Shuttle missions. Further, often cameras were not operating or were out of focus (as was the case for the Columbia launch). The CAIB was concerned about the need to have an adequate number of ground cameras, located and operating properly, to provide photographic coverage from more than one view of the Space Shuttle during the launch trajectory through separation of the Solid Rocket Boosters. Supporting this, the CAIB made the following finding:

F3.4-4 *The current long-range camera assets on the Kennedy Space Center and the Eastern Range do not provide best possible engineering data during Space Shuttle ascents.*

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

NASA has formulated a plan to address the issues/recommendation of the CAIB. This effort will lead to significant additional locations of cameras to cover, from different viewing angles, all phases of the Space Shuttle ascent trajectory. A Marshall Space Flight Center computer program has been used to simulate the view that will be obtained from each camera site to permit coverage evaluation of camera locations. The camera equipment is being refurbished/upgraded as appropriate to improve reliability. High Definition Television is being added to the ground locations. The use of airborne cameras aboard a NASA B-57 aircraft is being explored. The Air Force has corrected the out of focus problem encountered on one of the range cameras during the Columbia launch. The criteria/process for evaluating and reporting camera operational status during the Launch Commit phase of the launch process is in the planning phase. The criteria/processes for evaluating the impact of weather on camera coverage of the ascent trajectory are also in development and should be available for review in early Spring 2004.

<u>Assessment</u>

In addition to a series of fact-finding meetings with Kennedy Space Center and Air Force personnel (including the appropriate contractor personnel) held in 2003, three new fact-finding meetings have been held to date in 2004 to review the plans for addressing the recommendation. The Program Requirements Control Board actions regarding recommendations have also been reviewed.

The high volume of information from ground and airborne-based imagery, along with other sensor data, will require development of an integrated process that analyzes the data and integrates the results for mission operations decision-making.

The panel concludes that NASA is making solid progress toward fulfilling this CAIB recommendation.

Future

The RTF TG is continuing its review of the program requirements documents that contain the minimum launch camera coverage, the plans for assuring operation status of the ground-based cameras, and the Launch Commit criteria to include weather constraints. In addition, the RTF TG is monitoring the implementation of those plans.

Status

Plan – Mature
Implementation – Near Completion
Outstanding RFIs – 3
Overall Status – Open

CAIB Recommendation 3.4-2 – High-Resolution Images of External Tank

Provide a capability to obtain and downlink high-resolution images of the External Tank after it separates.

RTF TG Interpretation

Engineering quality imagery of the External Tank taken from Columbia would have been of great significance in the Columbia investigations. Columbia carried the standard on-board film still camera installed in the umbilical well that provides images of the ET following separation from the Orbiter. The camera provides images of sufficient quality and resolution to permit an engineering evaluation of the performance of the ET Thermal Protection System (TPS) including foam shedding. Additionally, following ET separation, the Orbiter is maneuvered into a position that permits a crew member to take images, using a hand-held digital camera, of the ET that also provides data regarding foam shedding. Following landing, the film from the umbilical well and hand-held crew cameras is removed and developed for evaluation. Neither of these two cameras was recovered from the Columbia debris. The CAIB investigators believed the images from these two cameras would have provided valuable engineering information and would have helped in determining the cause of the accident. This triggered the following finding:

F3.4-3 *There is a requirement to obtain and downlink on-board engineering quality imaging from the Shuttle during launch and ascent.*

NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)

NASA has revised procedures to optimize and facilitate crew hand-held camera imagery. In addition, NASA has completed its umbilical well camera feasibility study and conducted the appropriate critical design review. Installation of these cameras is scheduled for May 2004 and NASA is committed to incorporating the cameras on STS-114. The images from both the umbilical well and crew cameras will be electronically retrieved and downlinked for evaluation following orbit insertion.

Assessment

The RTF TG conducted fact-finding with the CAIB and at an Imagery Technical Interchange Meeting early in 2004. These activities complemented prior meetings and fact-finding with Space Shuttle Program staff. In addition, RTF TG Operations Panel experts have reviewed all documents and plans pertaining to this recommendation.

The high volume of information from ground and airborne-based imagery, along with other sensor data, will require development of an integrated process that analyzes the data and integrates the results for mission operations decision-making.
The panel concludes that NASA is making solid progress toward fulfilling this CAIB recommendation.

Future

The RTF TG will monitor the installation of these cameras, as well as all follow-up activities.

Status

Plan – Mature
Implementation – In Progress
Outstanding RFIs – 4
Overall Status – Open

CAIB Recommendation 3.4-3 – High-Resolution Images of Orbiter

Provide a capability to obtain and downlink high-resolution images of the underside of the Orbiter wing leading edge and forward section of both wings' Thermal Protection System.

<u>RTF TG Interpretation</u>

The CAIB investigations of the Columbia accident were hampered by the lack of high-resolution images of the launch ascent trajectory. The only images available were from ground cameras that were inadequate in number, placement, and resolution to permit a meaningful and timely engineering analysis of the External Tank (ET) Thermal Protection System (TPS) performance. Accordingly, the CAIB made the following findings:

F3.4-3 *There is a requirement to obtain and downlink on-board engineering quality imaging from the Shuttle during launch and ascent.*

F3.4-4 *The current long-range camera assets on the Kennedy Space Center and Eastern Range do not provide best possible engineering data during Space Shuttle ascents.*

F3.4-5 *Evaluation of STS-107 debris impact was hampered by lack of high resolution, high speed cameras (temporal and spatial imagery data).*

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

To meet the requirement to assess the health and status of the Orbiter TPS, NASA will rely primarily on on-orbit inspections that will be augmented by on-vehicle ascent cameras. On flight day two of STS-114, the Shuttle crew will perform the first inspection of the Wing Leading Edge (WLE) and nose cap Reinforced Carbon-Carbon (RCC) using cameras and laser sensors. These sensors are part of the Obiter Boom Sensor System (OBSS), mounted on a 50-foot extension boom that will be carried in the Shuttle payload bay and grappled by the Shuttle's robotic arm. The extension boom, which is currently under development, will allow the crew to view the WLE and nose cap RCC. The International Space Station (ISS) crew will perform a subsequent inspection of the Shuttle's tile by taking digital photos of the Shuttle during rendezvous as it performs a rotational maneuver about 600 feet from the ISS. Both sets of high-resolution imagery will be downlinked to the ground for evaluation. *(See also NASA's response to CAIB Recommendation 6.4-1 in this volume.)*

In addition to the primary on-orbit inspection techniques, NASA will use a suite of cameras in various locations on the Space Shuttle. These cameras will supplement ground-based imagery until Solid Rocket Booster (SRB) separation and provide the primary views through ET separation. Before return to flight, a camera with downlink capability will be added to the ET to view the bipod area and Orbiter lower tile acreage. In addition, cameras are installed on each SRB to view the ET intertank area.

<u>Assessment</u>

The RTF TG conducted fact-finding with the CAIB, and conducted an Imagery Technical Interchange Meeting in February 2004. These activities complemented a prior review by Operations Panel members of the response of the Space Shuttle Program Office to this recommendation.

The high volume of information from ground and airborne-based imagery, along with other sensor data, will require development of an integrated process that analyzes the data, and integrates the results for mission operations and Mission Management Team (MMT) decision-making processes.

The panel concludes that NASA is making solid progress toward fulfilling this CAIB recommendation. There remains a considerable amount of process engineering to be completed prior to an in situ evaluation via an MMT simulation.

Future

The Operations Panel members will continue to monitor the progress of the development and implementation of these additional cameras and the OBSS. In addition, the integrated process development will be monitored through the Integrated Vehicle Assessment Sub-Panel.

Status

Plan – Mature
Implementation – In Progress. Schedule for the OBSS is very aggressive.
Outstanding RFIs – 2
Overall Status – Open

CAIB Recommendation 4.2-1 – Solid Rocket Booster Bolt Catcher

Test and qualify the flight hardware bolt catchers.

RTF TG Interpretation

Meaning of the CAIB recommendation is clear.

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Design and qualify the Solid Rocket Booster Bolt Catcher by testing it as a complete system. Fabricate the bolt catcher housing from a single piece of aluminum with no weld. Select a new energy-absorbing material. Reassess the bolt catcher thermal protection material. Redesign and resize the External Tank (ET) attachment bolts and inserts.

Assessment

The bolt catcher for the Solid Rocket Booster (SRB) to ET separation bolt has been modified to correct the initial design, which did not demonstrate an adequate safety factor. The original design was a two-piece welded assembly and the new design is based on a one-piece forging. The energy absorber used to attenuate the bolt impact load has been redesigned as well. Additionally, the Thermal Protection System (TPS) has been changed from sprayed-on TPS to bonded cork. The NASA Standard Initiator (NSI) in the pressure cartridge had exhibited an ejection failure mode during several tests. This can result in damage to the energy absorber prior to bolt impact. This issue has been addressed by the incorporation of a locking ring assembly to aid in retention of the NSI.

- **Forging – 7050 Aluminum**
- **Housing – Single piece construction with integral o-ring carrier**
- **Energy Absorber – 5052 Aluminum with crush strength 746 – 910 psi**
- **Thermal Protection – Machined cork 0.4 inch thickness**
- **Fasteners – 9/16 inch MP35N**

Figure 12 - Pre-CDR Bolt Catcher Design

The first Critical Design Review (CDR) for the modified assembly was held during November 2003. The final CDR began April 14, 2004, and will be complete by the end of April. Bolt Catcher design changes since November 2003 CDR include:

Minor changes
- Corrected dimensions
- Clarified drawing notes
- Added RT-455 to closeout over the fasteners to prevent ice formation

Major changes
- Extended the length of the energy absorber from 10.260 inches to 12.690 inches

NSI Pressure Cartridge changes
- Change in materials of the pressure cartridge body, retaining washer, and retaining cap
- Interior of cartridge body contoured
- Retaining washer inner diameter decreased

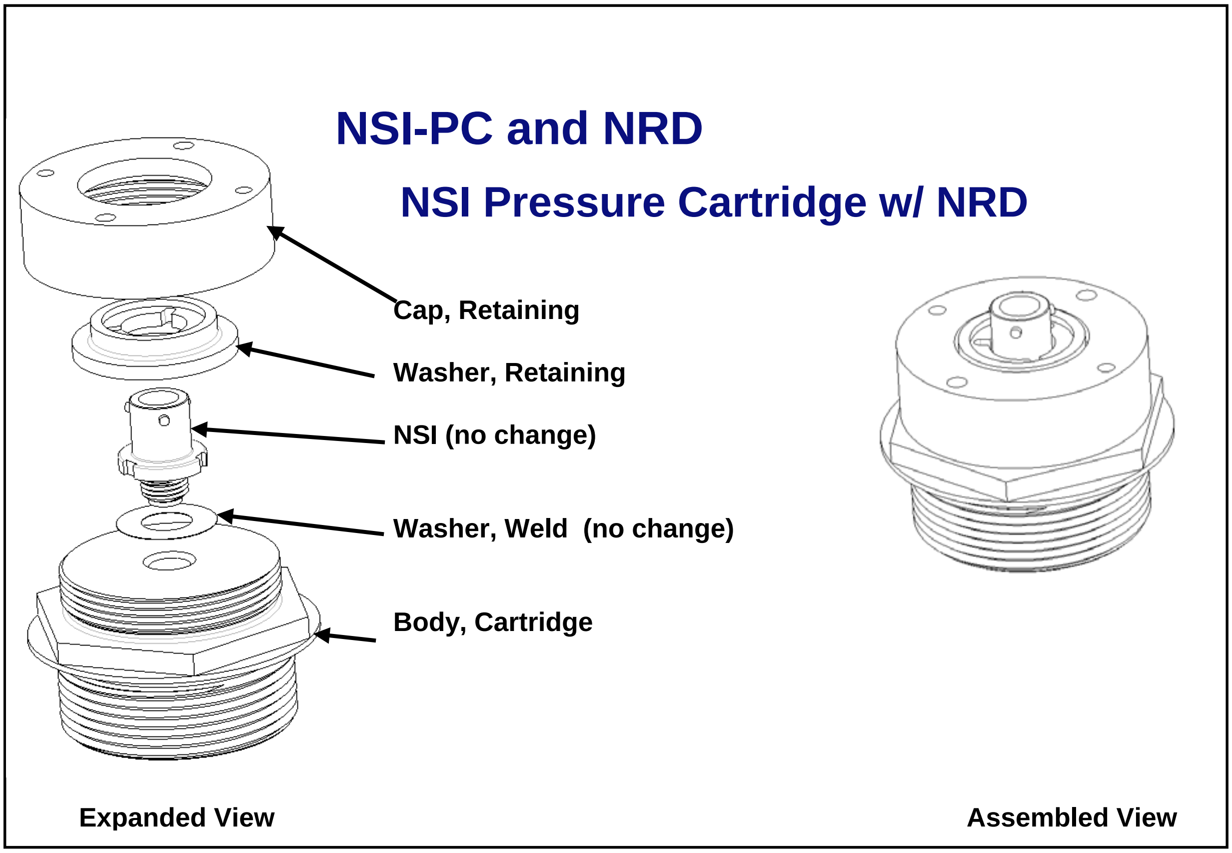

Figure 13 - Solid Rocket Booster Bolt Catchers

The Technical Panel is in general agreement with the approach being taken to redesign the SRB/ET bolt catcher and the associated NSI retaining ring. The proposed design incorporates significant improvements over the previous design. Testing and analysis indicates that the resultant design will have a structural safety factor of at least 1.4 with margin. Testing to be performed will include maximum ejection velocities for the separation bolt and combined environments testing for the bolt catcher assembly. Design and test work are complete with regard to the load limits, design velocities, combined environments testing, and inspection and acceptance criteria. Progress indicates an anticipated request for closure from NASA for this item before the next Plenary.

Future

The Technical Panel will monitor the CDR activity associated with the redesigned hardware.

Status

Plan – Complete
Implementation – Good Progress
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 4.2-3 – Closeout Inspection

Require that at least two employees attend all final closeouts and intertank area hand spraying procedures.

The CAIB subsequently provided the following clarification: This recommendation was intended to apply to the entire Space Transportation System for all types of close outs. The external tank intertank was specifically called out, but the recommendation was not limited to the tank.

RTF TG Interpretation

- NASA will review and update process controls
- Two trained and certified employees to attend all final closeouts and critical hand-spraying procedures
- At the Michoud Assembly Facility (MAF), Material Processing Procedures (MPPs) to be modified in accordance with two-person closeout requirement. Quality control and Government Mandated Inspection Points are also to be included in MPPs.
- Recent Space Shuttle Program Office (SSPO) direction (March 3, 2004), for each project manager to review/audit all flight hardware final closeouts at the Shuttle element manufacturing sites and during launch preparation at the Kennedy Space Center (KSC) is consistent with Implementation Plan and CAIB intent.

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Thermal Protection System (TPS) Verification Team to develop minimum requirements for foam processing. Enhance TPS parameters and requirements. Add requirements for observation and documentation of processes. Review and update process controls. Two employees to attend all critical hand-spraying procedures and all final closeouts.

Assessment

Excellent progress has been made with regard to two-person closeout of critical areas. In particular, the ET Project has amended all manufacturing processes and procedures to ensure that at least two employees, and in most cases several more, are present at all manufacturing steps. This includes manual foam applications and all other flight closeouts, both at MAF and at KSC. Furthermore, NASA is satisfying more stringent quality assurance requirements through additional employee training, certification, and work documentation of inspections and imagery, all of which have significant security benefits. NASA has produced a draft MPP for RTF TG review. The Task Group has provided comments. MPPs will be revised and subsequently released.

The scope of this action was widened to conduct a comprehensive audit of all processes and controls for all Space Shuttle Program projects and elements by the following letter from the SSP Manager to all hardware and processing elements:

> "Columbia Accident Investigation Board Recommendation 4.2-3 Audit," Letter from SSP Manager to Flight Hardware Elements, dated March 3, 2004.

The audit will review quality assurance closeout protocols and protection against non-compliance with technical requirements and/or willful damage. Attributes include:

- Audit conducted by Quality Assurance, Safety and Mission Assurance, and Engineering
- Results reviewed by each project manager
- Results compiled and assessed by Program Integration
- Results presented to SSP Manager. Deficiencies identified will result in an SSP action to the responsible project
- Presentation will show each project individually
- Audit results due April 30, 2004
- Unexpected audit findings will be presented to RTF TG
- Audit fidelity should identify exceptions, if any
- Further measures will be considered if necessary after evaluation of audit results

For correcting deficiencies, SSP Manager will levy actions through the normal SSP action tracking and configuration management processes

Future

Audit of all projects for two-person closeout of critical areas is to be completed by April 30, 2004. All revised requirements will be incorporated into appropriate documentation by January 2005. NASA will review the program requirements and determine the appropriate location for a program-level requirement. The Technical Panel will review submittals identified by NASA request for closure letter.

Status

NASA submitted a request for closure on this item. Based on the closure package submitted, the status of the audit of all projects for two-person closeout of critical areas, and its own fact finding, the RTF TG conditionally accepted closure of this recommendation. The verification criteria for this item have been defined and will be monitored.

CAIB Recommendation 4.2-5 – Kennedy Space Center Foreign Object Debris Definition

Kennedy Space Center Quality Assurance and United Space Alliance must return to straightforward, industry-standard definition of 'Foreign Object Debris' and eliminate any alternate or statistically deceptive definitions like "processing debris."

RTF TG Interpretation

During their investigation and interviews with personnel involved with processing the Space Shuttle for flight, the CAIB determined that NASA, in 2001, generated new and non-standard definitions for Foreign Object Debris (FOD). The term "processing debris" was applied to debris found during the routine processing of the flight hardware. The term FOD applied only to debris found in flight hardware after final closeout inspections. These definitions were unique to the Space Shuttle Program at the Kennedy Space Center (KSC). Because debris of any kind has critical safety implications, these definitions are important. Accordingly, the CAIB wanted the standard, industry-wide definitions re-established for FOD. In support of this conclusion, the CAIB made the following finding:

F4.2-18 *Since 2001, Kennedy Space Center has used a non-standard approach to define foreign object debris. The industry standard term "Foreign Object Damage" has been divided into two categories, one of which is much more permissive.*

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KSC will adopt the FOD definition derived by National Aerospace FOD Prevention, Inc (a non-profit educational organization recognized within industry as the authority for FOD matters) across all processing activities and will change the operational procedures accordingly. Current metrics to measure such debris will be improved. In order to identify where and when FOD was discovered so that appropriate correction action can be taken, FOD will be noted as found: 1) at end of shift, 2) at closeout, or 3) in process. FOD is defined as unaccompanied foreign material. The revised definition will not alter the current policy of "clean as you go" but will result in more emphasis on the procedure of cleaning up the work area as the work progresses rather than cleaning up the work area after the work is completed. A joint KSC and United Space Alliance (USA) team visited Air Force aircraft modification centers, a Grumman Aerospace Facility, and the Gulf Stream aircraft factory to study how the FOD issue was addressed by those organizations. Lessons learned will be incorporated into the KSC procedures and processes. A major education effort regarding the revised definition will be undertaken at the appropriate time to make sure the definitions and the accompanying rationale are understood by the entire KSC (NASA) and USA work force.

Assessment

The RTF TG Operations Panel experts conducted fact-finding during a mini-Technical Interchange Meeting at KSC in March. This complemented previous meetings with KSC quality assurance and USA personnel in 2003.

NASA has removed the misleading category of processing debris that caused concern. They are working toward improving the training of the work force and obtaining buy-in at all levels for both NASA and contractor employees.

The panel concludes that NASA is making solid progress toward fulfilling this CAIB recommendation.

Future

The RTF TG Operations Panel's next assessment will occur after the new FOD program is introduced to the NASA workforce (Summer 2004). A baseline audit is planned approximately two months after this introduction and will be monitored by the RTF TG. Website updates are still pending and will be monitored.

Status

Plan – Mature
Implementation – In Progress
Outstanding RFIs – 3
Overall Status – Open; May close as early as August 2004

CAIB Recommendation 6.2-1 – Consistency with Resources

Adopt and maintain a Shuttle flight schedule that is consistent with available resources. Although schedule deadlines are an important management tool, those deadlines must be regularly evaluated to ensure that any additional risk incurred to meet the schedule is recognized, understood, and acceptable.

<u>RTF TG Interpretation</u>

The CAIB explicitly recognized the legitimacy of the use of schedules to drive a process. They were concerned, however, when the line between "beneficial" schedule pressures and those that become detrimental cannot be defined or measured. The CAIB further observed that budget constraints inherently intensify the conflicts between schedule and safety.

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Among the activities NASA plans to undertake are more routinely assessing schedule risk (to minimize surprises), incorporating more margin into the schedule and manifest to accommodate changes, potentially adopting some of the risk management tools used for the International Space Station, and revising databases so schedule and risk indicators can be assessed real-time by managers.

<u>Assessment</u>

NASA and its contractors have developed a number of new tools to help assess schedule and safety risk—the budget process will attempt to quantify future budgetary risk. The Task Group has been consistently told throughout NASA that there are adequate budgetary resources to return to flight. RTF TG observations thus far support these assertions. The RTF TG will need to continue to monitor resource requirements throughout return-to-flight. The Task Group is concerned, however, that adequate personnel are not yet in place to implement the CAIB's various recommendations. Ultimately, the primary resource constraint to return to flight may be the sufficiency of qualified personnel.

<u>Future</u>

The ability to sustain a reasonable and appropriate launch schedule in the future will be determined by future appropriations and the development of the President's plan for future space exploration. The Space Shuttle Program Office is evaluating the Space Shuttle requirements for the next five years as part of the development of the Fiscal Year 2006 budget.

Status

Plan – Ongoing
Implementation – In Progress
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 6.3-1 – Mission Management Team Improvements

Implement an expanded training program in which the Mission Management Team faces potential crew and vehicle safety contingencies beyond launch and ascent. These contingencies should involve potential loss of Shuttle or crew, contain numerous uncertainties and unknowns, and require the Mission Management Team to assemble and interact with support organizations across NASA/Contractor lines and in various locations.

<u>RTF TG Interpretation</u>

Mission Management Team (MMT) activities during the flight of Columbia have been widely criticized. Many of the additional capabilities embedded in other CAIB recommendations, such as imagery from various sources, are intended to support MMT activities for the next and subsequent flights. In addition to enhanced training for participants in the MMT, NASA will need to exercise these many new sources of data and information.

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

The first action by NASA was to form a team in June 2003 to address the recommendation. The team focused on revising MMT guidance and organizational issues to make more formal all MMT proceedings and meetings. In addition, the new organization is to "strengthen" the process for receiving and reviewing dissenting views concerning safety, operations and engineering, and to expand the process of evaluation of problems that arise either during the MMT's pre-launch phase or after a Space Shuttle is launched. An integral part of the corrective actions is the development of a training approach that focused on both individual and team effectiveness. The plan includes classroom sessions, individual study of recommended literature, and group dynamics training in the form of simulations involving the convening of the MMT.

<u>Assessment</u>

NASA has responded proactively and seriously to the CAIB's concerns regarding the MMT, going beyond the specifics of the CAIB recommendation. MMT membership has been expanded, senior level participation has been made mandatory, roles and responsibilities have been revised and baselined, and MMT pre-launch and in-flight procedures and activities have been made more disciplined (to include opening clear avenues for dissent and documenting minority opinion), and MMT changes are being tested in simulation exercises prior to return to flight.

NASA has gone from minimally required MMT formal training, to a published formal training plan that has pre-certification and sustained certification requirements. MMT training will now include formal classroom training, required annual simulation testing and validation, self-instructional requirements, and evaluation.

Representatives of the Management Panel have observed selected classroom training sessions and the first four of a currently-planned seven or more pre-return to flight simulations. The simulations are becoming more realistic, and test far more than new MMT members, roles and procedures as new post-Columbia capabilities resulting from the CAIB report become available for simulation exercise at the MMT level. In addition, "full up" simulations have been held or are planned, involving all NASA personnel (civil service, contractor, the International Space Station team, and other government agencies) that normally would be involved at the specific simulation timeframe.

While the Management Panel is pleased by the significant and documented progress to date in response to this CAIB recommendation, the testing, validation, clarifications of MMT roles and responsibilities, and refinement of NASA's implementation to date is still maturing. NASA appears to have a plan ahead to do this.

The Management Panel looks forward to specific observation and validated results of (1) the MMT's process and responsiveness to respond to and make course corrections from lessons learned; (2) the criteria by which the MMT will judge its performance and their difficult task of integrating multiple (and vastly expanded) information sources into informed, integrated, and participative decision making; and (3) the MMT's ability to integrate and incorporate enhanced and new decision-making tools and information resulting from other CAIB return to flight recommendations.

The Management Panel also seeks more clarity on the relationship of MMT pre-return to flight simulation objectives and how success is being evaluated.

Bottom line: Great progress, more to follow. From the Management Panel's perspective, it wants to ensure that the expanded MMT training plan is sufficiently matured to sustain and improve its effectiveness over time and have the metrics and processes to do so.

Future

The formalized new MMT training plan continues to be implemented, additional simulations are planned, certification of MMT members continues, and refinement of MMT roles and responsibilities continues. The MMT role of the independent technical authority, the NASA Engineering and Safety Center, and independent safety and mission assurance, among other MMT roles, are still being refined. At least three more pre-return to flight MMT simulations are planned. A dress rehearsal may be added. As the simulations mature, the training role of the simulations should be supplemented with the exercise and testing of new capabilities such as enhanced imaging. In the process, the simulations should become effective in identifying critical issues.

The MMT is also at least a portion of the verification of other CAIB recommendations and return to flight activities. For example, the assimilation of enhanced imagery and Thermal Protection System inspection and repair during the next flight can be demonstrated through the MMT simulations. Therefore, while a strict reading of this CAIB recommendation—"…implement an expanded training program…"—would suggest it has been fulfilled, this particular CAIB return to flight recommendation encompasses significant other opportunities for NASA for experimentation, test, validation, and training. As such, the Management Panel finds further observation will be necessary.

Status

Plan – Published as a baseline
Implementation – In progress over next several months.
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 6.3-2 – National Imagery and Mapping Agency Memorandum of Agreement

Modify the Memorandum of Agreement with the National Imagery and Mapping Agency to make the imaging of each Shuttle flight while on orbit a standard requirement.

RTF TG Interpretation

There was considerable public discussion of the decision during the flight of the Columbia to forego requesting the assistance of other federal agencies in assessing the condition of the Space Shuttle. In addition to changes in the Mission Management Team (MMT) discussed above, the CAIB wanted the Space Shuttle Program to have the procedures in place to get all possible data to investigate a potential problem.

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Per agreement with other federal agencies, NASA is seeking all available data that may in the future assist in the resolution of investigations. Plans for all required activities, communications, personnel security access, training, physical receipt and proper storage of classified material, hardware and software to analyze the data, are in place. The capability is to be demonstrated in various stages during simulations later this year.

An engineering test of equipment, including an end-to-end system simulation involving participating personnel has been conducted. Over 50 percent of the necessary security clearances are in place.

Final implementation details have been worked out in a lower level memorandum of understanding.

Assessment

The RTF TG has accepted NASA's documentation that they have met the intention of the CAIB for this recommendation.

Future

The RTF TG will observe the operation of this capability in future MMT simulations.

Status

Conditionally accepted NASA's request for closure. Based on the closure package submitted by NASA, the status of the tests, and its own fact finding, the RTF TG has conditionally accepted closure of this recommendation. The verification criteria for this item have been defined and will be monitored.

CAIB Recommendation 6.4-1 – Thermal Protection System Inspection and Repair

For missions to the International Space Station, develop a practicable capability to inspect and effect emergency repairs to the widest possible range of damage to the Thermal Protection System, including both tile and Reinforced Carbon-Carbon, taking advantage of the additional capabilities available when near to or docked at the International Space Station.

For non-Station missions, develop a comprehensive autonomous (independent of Station) inspection and repair capability to cover the widest possible range of damage scenarios.

Accomplish an on-orbit Thermal Protection System inspection, using appropriate assets and capabilities, early in all missions.

The ultimate objective should be a fully autonomous capability for all missions to address the possibility that an International Space Station mission fails to achieve the correct orbit, fails to dock successfully, or is damaged during or after undocking.

<u>RTF TG Interpretation</u>

RTF TG Technical and Operations Panel members conducted fact-finding on this issue with former CAIB members in January 2004. The intent of the CAIB is clear, subject to accepted definition of "widest possible range of damage."

<u>NASA Implementation Plan (January 30, 2004 Volume 1, Revision 1.2)</u>

In order to meet this CAIB recommendation, NASA is developing the capability to resolve critical Thermal Protection System (TPS) damage in all areas. First, NASA is defining damage thresholds below which no repair is required as well as thresholds above which repair is not deemed feasible. Second, the Agency is implementing a comprehensive in-flight inspection, imagery analysis, and damage assessment strategy through its existing planning process. Next, NASA is investigating the use of optical filters to highlight low-contrast damage. Tied in with this, it is also investigating the use of impact sensors to limit the need for extensive in-flight inspection of the Wing Leading Edge (WLE). The Agency is also developing a repair procedure for Extravehicular Activity (EVA) access while docked to the International Space Station (ISS). Finally, in the long-term, NASA is developing a sensor capable of 3-D damage measurement likely to be used with the Orbiter Boom. Also in the long-term, it is developing stand-alone 3-D detection of tile and Reinforced Carbon-Carbon (RCC) damage, as well as an EVA repair capability independent of the ISS. *(See also NASA's response to CAIB Recommendation 3.4-1 in this volume.)*

<u>Assessment</u>

RTF TG Technical and Operations Panel members conducted a fact-finding trip to the TPS Repair Detailed Test Objective (DTO) Preliminary Design Review in February 2004. Briefings during the April plenary highlighted the preliminary nature of sensor development, as well as the necessary software and ground support for complex processing. These efforts complement RTF TG continued attendance at monthly STS-114 Joint Operations Panel meetings.

NASA is assessing several possible designs to inspect the WLE at a resolution necessary to detect critical damage. A review of the plans for the Orbital Boom Sensor System (OBSS), (see Figure 14) reveals several development risks. First, the OBSS schedule is very aggressive and has no slack time reserve. Second, image stabilization and integration is a high-risk developmental task. Among the current challenges facing NASA are the following:

- detecting low contrast intensity differences
- ranging relatively dark areas
- temporal filtering (averaging)

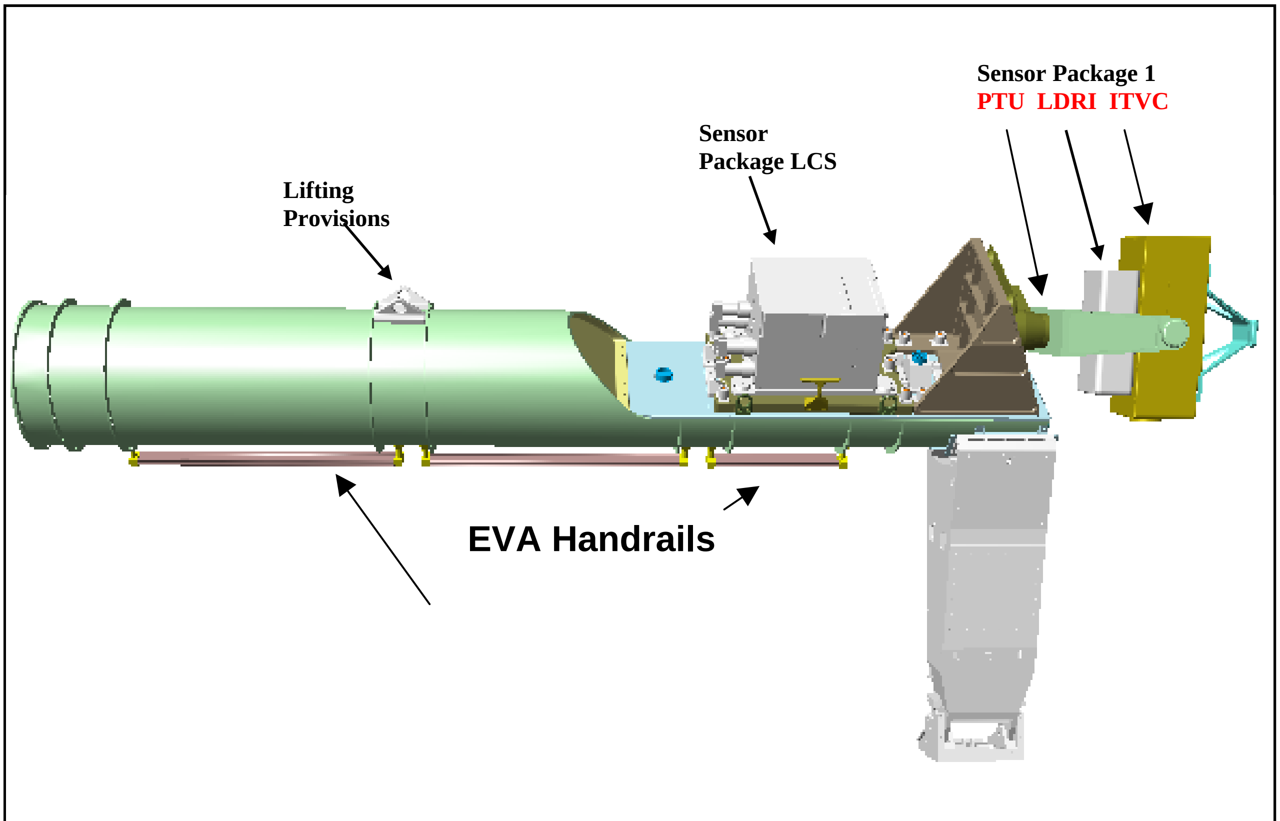

Figure 14 – Orbiter Boom Sensor System (OBSS)
(Laser Camera System (LCS) not in the baseline)

As to NASA's implementation of its enhanced TPS inspection plan, NASA has developed technologies and operations for verification of tile and RCC repair procedures and tools as a DTO on STS-114. For STS-114, NASA has developed a flight plan that includes inspection of TPS on flight days (FD) 2, 3, and 6 in order to test its ability to obtain, downlink, and evaluate information on all areas of the TPS. The flight plan currently contains a flight maneuver for the Shuttle as it approaches the ISS in order to obtain images of the tiles using hand-held digital cameras aboard the ISS. This operational design and the training for this procedure are mature.

Specifically, NASA has:

- OBSS inspections scheduled for FD 2 and FD 6
- designed operations for Rendezvous Pitch Maneuver (RPM) and photography at 600 feet on FD 3
- developed training requirements for RPM photograph
- designed EVA inspection operations using fewer than 100 photos that covers the entire WLE
- analyzed the potential for use of Simplified Aid For EVA Rescue (SAFER)

Note: FD 6 is a placeholder with no firm requirements other than to fill in gaps of FD 2 and FD 3 inspections.

NASA intends to place sensors in the WLE to receive data on impacts to the WLE during ascent. The Space Shuttle Program Office has created a flow chart for the process for all the participants to access and analyze the data coming from the Orbiter, and to make decisions on the health of the TPS and the potential need to repair the Orbiter prior to re-entry. The Mission Management Team has scheduled a number of simulations of increasing complexity to test this flow chart and to determine the data necessary to make these decisions in real time during the STS-114 and future missions.

Concerning NASA's implementation of its tile repair plan, NASA has developed a number of plans of increasing complexity for access to TPS, depending on the location of the damage. The current flight plan is to use the simplest method possible for the given situation. The design and testing of tools and techniques for tile repair is mature including the selection of a material for tile repair. All that is required is the verification of methods on orbit in a planned DTO on STS-114. Operational plans for RCC repair are pending the selection of repair materials and methodology. Three RCC repair concepts have been identified and are being evaluated including the use of a Graber-based material for use in the repair of RCC cracks. The materials, tools, and procedures are being jointly developed by the Engineering Directorate and the EVA Office to facilitate the efficiency of design and implementation.

Both pieces of this recommendation – inspection and repair – present enormous challenges. Many of the steps necessary to develop and prove these capabilities are not yet in place. As a result, at this early stage in development, this recommendation presents the greatest risk to compliance with CAIB recommendations by the scheduled return to flight date.

Future

The Technical and Operations Panels will continue to monitor progress and additional activities associated with this recommendation. It is anticipated that this capability will be included in a future simulation.

Status

Plan – Mature for tile repair. Preliminary for TPS inspection, RCC repair, and OBSS
Implementation – In Progress
Outstanding RFIs – 9
Overall Status – Open

CAIB Recommendation 9.1-1 – Detailed Plan for Organizational Change

Prepare a detailed plan for defining, establishing, transitioning, and implementing an independent Technical Engineering Authority, independent safety program, and a reorganized Space Shuttle Integration Office as described in R7.5-1, R7.5-2, and R7.5-3. In addition, NASA should submit annual reports to Congress, as part of the budget review process, on its implementation activities.

RTF TG Interpretation

The three specific recommendations—organizational changes to be incorporated in the plan—are addressed separately below. The Management Panel believes that embodied in Recommendation 9.1-1, however, are the many less tangible issues raised by the CAIB, including "culture." CAIB used the term "culture" liberally in its report although there are neither specific recommendations to change culture nor any suggestions on how it might be accomplished. Therefore "culture" is not specifically a return-to-flight issue. Nonetheless, the management panel has kept abreast of NASA's initiatives to institute cultural change.

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NASA has committed to strict compliance to create the "independence" and "integration" called for by the CAIB. NASA has also responded in ways not suggested or otherwise required by the CAIB report. For example, the Director of the Goddard Space Flight Center has conducted an analysis of the applicability of the CAIB recommendations to the rest of NASA—the Diaz Team report. In addition, NASA has employed Behavioral Science Technology, Inc. (BST) to assess the attitudes of NASA personnel and suggest a plan to institute change, with assessments along the way. Figure 15 illustrates the many initiatives underway to measure, change, and monitor "culture." NASA views this cultural change effort as "…an integration point to ensure that all the Agency's ongoing efforts related to culture change are aligned in a manner conducive to a comprehensive culture change."

Assessment

The Management Panel has been appraised of many of the activities underway. One initiative, deemed the "Roles, Responsibilities & Structure Team," is looking at broad organizational concepts within NASA—the roles of NASA Centers and center directors, for example—has the potential for far-reaching and profound change.

BST's initial assessment included: "…(NASA's) need to establish the use of manager and supervisor behaviors and team functioning that show: encouragement of open communications, consistency between words and actions, respect and appreciation for individuals, (and) improved supervisory skills." It is important to note that most of the changes called for by BST involve the behavior of managers and supervisors, not the larger work force.

Future

The Management Panel will continue to monitor activities related to “culture,” recognizing that there are no explicit return to flight requirements.

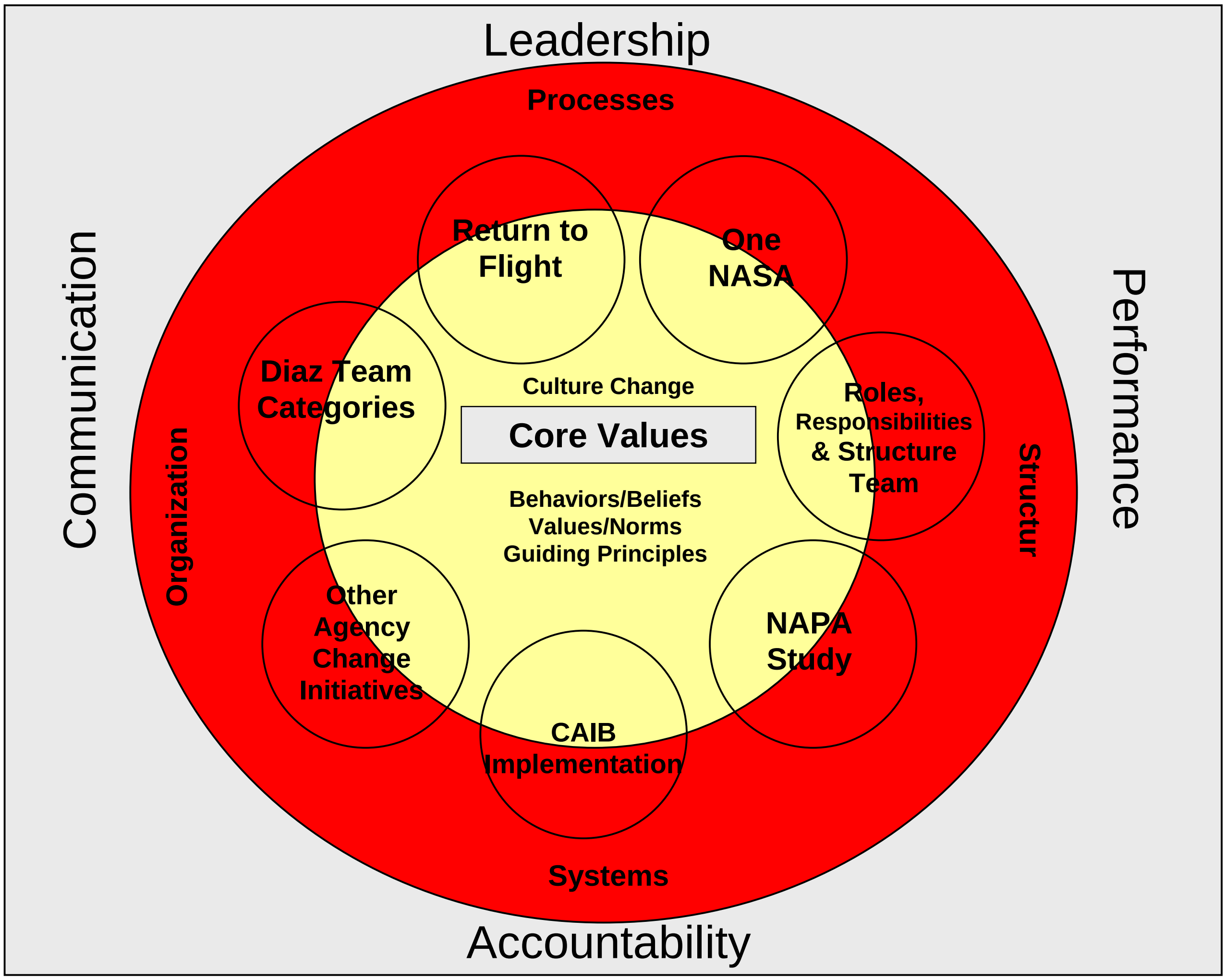

Figure 15 – NASA Culture Change

CAIB Recommendation 7.5-1 – Independent Technical Engineering Authority

Establish an Independent Technical Engineering Authority that is responsible for technical requirements and all waivers to them, and will build a disciplined, systematic approach to identifying, analyzing, and controlling hazards throughout the life cycle of the Shuttle System. The independent technical authority does the following as a minimum:

- *Develop and maintain technical standards for all Space Shuttle Program projects and elements*
- *Be the sole waiver-granting authority for all technical standards*
- *Conduct trend and risk analysis at the sub-system, system, and enterprise levels*
- *Own the failure mode, effects analysis and hazard reporting*
- *Conduct integrated hazard analysis*
- *Decide what is and is not an anomalous event*
- *Independently verify launch readiness*
- *Approve the provisions of the recertification program called for in Recommendation R9.1-1*

The Technical Engineering Authority should be funded directly from NASA Headquarters, and should have no connection to or responsibility for schedule or program cost.

RTF TG Interpretation

Many of the CAIB's Space Shuttle Program (SSP) organization observations are reflected in this recommendation. The CAIB observed that critical technical requirements are routinely waived. The CAIB concluded that the inherent conflicts of schedule, cost, and safety—the balance for which resided essentially with the Shuttle Program Manager—need to be separated to provide safety an independent consideration.

There are several CAIB findings relevant to this recommendation:

> *Finding 7.4-2 – Safety and Mission Assurance organizations supporting the Shuttle Program are largely dependent upon the Program for funding, which hampers their status as independent advisors.*
>
> *Finding 4.7-4 – System safety engineering and management is separated from mainstream engineering, is not vigorous enough to have an impact on system design, and is hidden in the other safety disciplines at NASA Headquarters.*
>
> *Finding 7.4-12 – The dependence of Safety, Reliability and Quality Assurance personnel on*

Shuttle Program support limits their ability to oversee operations and communicate potential problems throughout the organization.

It should be noted that while this recommendation (R7.5-1) requires the establishment of the Independent Technical Engineering Authority (ITEA), the CAIB has not identified it as a return to flight requirement. R9.1-1, which is discussed later, is a return to flight requirement, but only for the creation of a detailed plan for defining, establishing, transitioning, and implementing an ITEA. In discussion with the RTF TG, the CAIB Chair (Admiral Gehman) stated that this position was taken with the understanding that full and effective implementation of R7.5-1 (as well as R7.5-2 and R7.5-3) would require a considerable time. Therefore, prior to return to flight, a well-defined plan would suffice. With the change in schedule, however NASA has committed to implement significant portions of the plan with an eye toward handing off selected program activities to the Independent Technical Authority (ITA) before the next flight. NASA currently plans to implement the ITA for the Office of Space Flight by October 1, 2004.

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

On April 14, 2004, the Management Panel reviewed with Mr. Bryan O'Connor, Associate Administrator for Safety and Mission Assurance and Mr. Theron Bradley, NASA Chief Engineer, the current iteration of the structure of an ITA. There has been much public discussion about the desirability of a Headquarters-oriented ITA versus a center-centric ITA. It will likely be neither... or both depending upon where you sit. It appears there will be Headquarters authority and accountability with a delegation of considerable responsibility to the various NASA Centers. Of note is the explicit recognition that the ITA will have the authority and responsibility for evaluating "…dissenting opinions across the technical community and ensure that valid technical issues are not overlooked or overridden by cost and schedule pressure."

A notional representation of the possible organization is represented in the following chart:

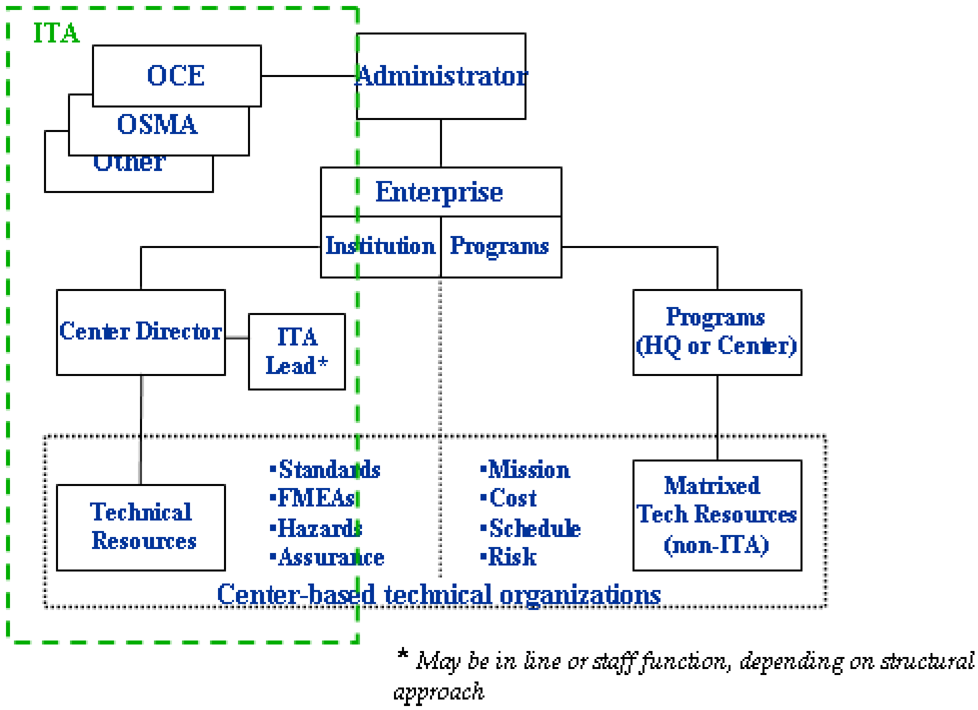

Figure 16 – ITA Organizational Scope

Several NASA Centers, including the Johnson Space Center (JSC), have begun to plan for implementation of the changes that will be necessary to establish an ITA whatever the final organization turns out to be. The following chart illustrates the proposed JSC organization and the staffing resources necessary, should certain technical authority be delegated to individuals at JSC in the ultimate NASA plan.

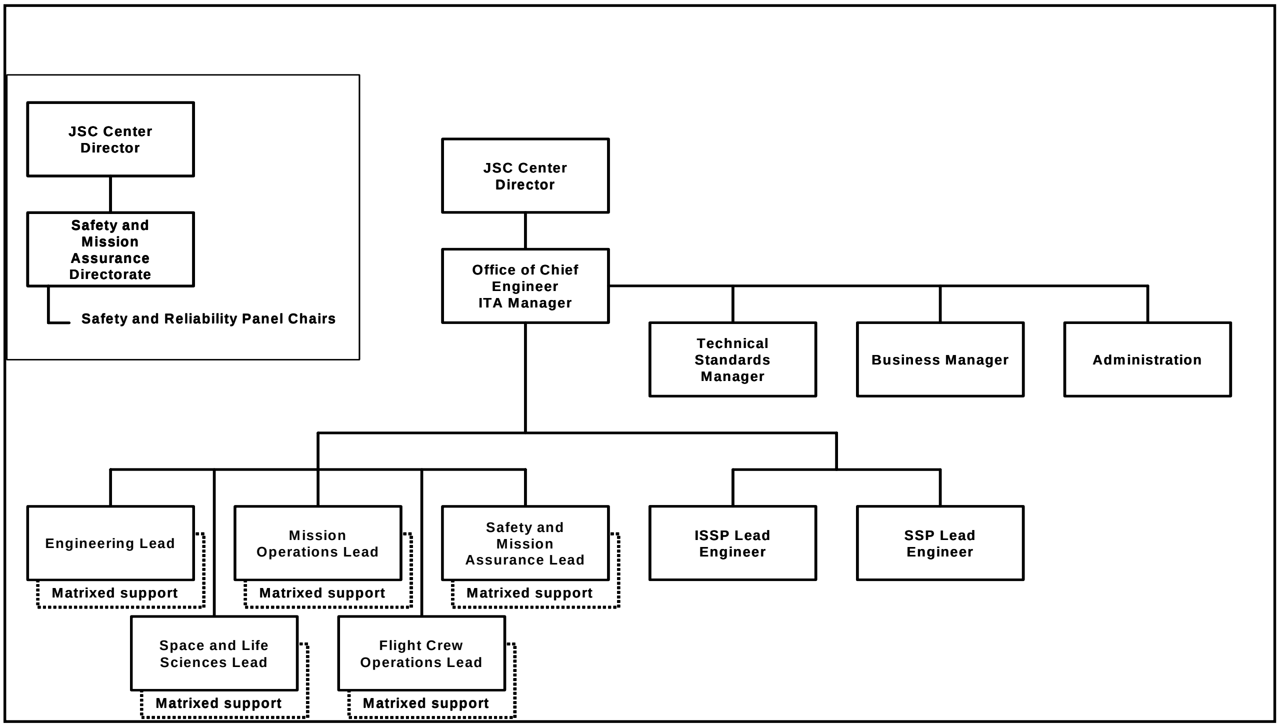

Figure 17 - Proposed JSC ITA Organization

<u>Assessment</u>

While many important details need to be developed to implement the concept and much difficult work remains, the framework promises a clear line of independent authority.

The CAIB was principally interested in separating the authority to waive critical technical requirements from the purview of the Space Shuttle Program Office. In so doing, any ITA must meet the following objectives:

1. Be independent of the SSP;

2. Have the authority to establish and waive technical requirements; and,

3. Provide clarity of scope and accountability.

The most recently proposed structure has the potential to fulfill these objectives. In so doing, however, the responsibilities of the program managers to meet technical, funding and schedule requirements must be preserved; i.e., the Shuttle must fly again, safely and reliably.

Future

NASA requires time to document and disseminate the current iteration of the ITA directives. The NASA Centers will need to develop implementation plans consistent with authority delegated to them. Headquarters needs to define technical requirements, engineering standards, safety standards, process requirements, and other issues necessary for an effective ITA. Program directors need to evaluate how they will comply with and successfully operate within the new structure.

Status

Plan – In Development
Implementation – Partial planning (at selected Centers)
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 7.5-2 – Safety and Mission Assurance Organization

NASA Headquarters Office of Safety and Mission Assurance should have direct line authority over the entire Space Shuttle Program safety organization and should be independently resourced.

<u>RTF TG Interpretation</u>

The CAIB observed that various parts of NASA were nominally responsible for "safety;" each NASA Center has safety organizations; each NASA program, including the Space Shuttle Program, has designated individuals responsible for safety; and, NASA has an Office of Safety and Mission Assurance (S&MA) at Headquarters. This recommendation is intended to create clear lines of authority, responsibility and communication and to help ensure independence of safety assurance by moving funding from the NASA Centers and programs to NASA Headquarters.

Among the CAIB findings supporting this recommendation is:

Finding 7.4-1 – The Associate Administrator for Safety and Mission Assurance is not responsible for safety and mission assurance execution, as intended by the Rogers Commission, but is responsible for Safety and Mission Assurance policy, advice, coordination, and budgets. This view is consistent with NASA's recent philosophy of management at a strategic level at NASA Headquarters but contrary to the Rogers' Commission recommendation.

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

NASA initially proposed to essentially implement the letter of the recommendation. NASA went further by creating a new entity deemed the NASA Engineering and Safety Center (NESC) at Langley Research Center to "…provide independent engineering and safety assessment." This effort will be funded from NASA Headquarters through the Office of S&MA with "policy guidance" from that office.

The notional intention of the NESC is to provide a center for excellence—in this case excellence in engineering—that have been established in many other scientific endeavors. Among its responsibilities are the "independent testing" of analytical models and associated assumptions and the incorporation of safety and engineering trend analysis. NESC personnel are to come from within NASA and are presumed to serve on a rotating basis. It is intended that these temporary assignments will be viewed within the organization as a positive step in career development and advancement.

Further, independent safety organizations, which will report to Center Directors have been established at all (space flight) Centers. The Associate Administrator for S&MA (a Headquarters position) has approval authority for key safety personnel at the Centers, will have concurrent performance evaluation of key S&MA personnel, and serves on the Institutional Council (a Headquarters committee that allocates overhead funding). The Headquarters S&MA is also developing an enhanced capability to perform safety compliance audits.

The following figure represents notional staffing and "authority, independence, and capability summary" as envisioned at the Johnson Space Center (JSC).

JSC S&MA Staffing Analysis

- Increasing staffing for program activities to provide enhanced technical S&MA capability at JSC
  - New S&MA Chief Engineer – Single JSC focal point for technical risk
  - Enhancing System Integration Expertise
  - Enhancing System Knowledge
    - Structures/Thermal Protection System/Mechanical
    - Propulsion/Power
    - Environment Control Life Support System/Active Thermal Control System
    - Avionics
    - Guidance Navigation and Control
    - Robotics
- Adding Operations Expertise
- Enhancing Safety, Reliability, Maintainability, and Quality Assurance Capability

Figure 18 – JSC S&MA Staffing Analysis

JSC S&MA: Authority, Independence, and Capability Summary

- JSC S&MA is independent of Programs as measured by flow of funds and reporting
- JSC S&MA has approval authority via the Safety and Reliability Panel for hazards and CIL's
- JSC S&MA participates in following activities within the program
  - Mission Evaluation Room,
  - Various change boards and panels,
  - Certification of Flight Readiness (CoFR) process.
- JSC S&MA additions since Columbia

Figure 19 – JSC S&MA Authority, Independence & Capability

Assessment

The Headquarters plan is relatively mature and implementation planning has begun at the Centers. The panel reviewed the latest iteration of the overall plan as well as that for JSC. The capabilities of the safety panels will be greatly enhanced and independent from the program, both in terms of funding as well as reporting relationships and performance evaluation. NASA Human Resources is developing an incentive plan to improve S&MA recruiting

Future

Further documentation of the various plans--Headquarters' and Centers'-- will be necessary before a complete assessment of activity can be performed. A critical element of implementation will be staffing—obtaining the authority and budget to hire staff and, more critically, finding the qualified personnel needed for a safety organization in a complex engineering organization.

Status

Plan – Maturing
Implementation – Underway, but incomplete
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 7.5-3 – Space Shuttle Integration Office Reorganization

Reorganize the Space Shuttle Integration Office to make it capable of integrating all elements of the Space Shuttle Program, including the Orbiter.

<u>RTF TG Interpretation</u>

The CAIB found several aspects of Space Shuttle operations believed to be suffering from incomplete integration. Perhaps the most glaring was the apparent division of responsibility for addressing separation of foam from the External Tank (ET). Simplistically stated, the Orbiter Program thought it was up to the tank folks to stop the shedding and the Tank Program assumed that the shedding that was occurring was not injurious to the Space Shuttle because no one told them otherwise.

A more concrete example is the inability of various computer systems to share data across the NASA Centers, programs, and even elements within programs. Trends across flights were not thoroughly examined because of both of these reasons: (1) it was thought to be the responsibility of another part of the Space Shuttle operations; and (2) the databases could not be easily shared to perform the analysis.

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

The Space Shuttle Program (SSP) has established the Space Shuttle Systems Integration & Engineering Office (SEIO). This office was established at the same level of the elements of Shuttle Program (Orbiter, Solid Rocket Booster, Reusable Solid Rocket Motor, Space Shuttle Main Engine, ET, and the Kennedy Space Center Launch and Landing Project). The office is to be responsible for systems engineering and integration of all SSP ground and flight activities containing any two or more of the Space Shuttle project elements. The office reports directly to the SSP Manager.

NASA has reorganized and revitalized the Integration Control Board (ICB). This board will review and approve recommendations and actions to ensure the appropriate integration of activities in the Shuttle Program. Orbiter changes that affect multiple elements must now go through the ICB process. Orbiter changes for return to flight that affect multiple elements, which were not previously reviewed and approved by the ICB, will be routed from the Program Requirements Control Board back to the ICB for review and approval prior to implementation.

Assessment

All of the Management Panel and much of the entire Task Group have seen examples of the analyses underway by the new SEIO. The use of advanced modeling and engineering techniques has aided in the definition of "critical debris size"—an effort that requires integration of data on the transport of material through the airflows the Orbiter and attached elements produce and the test data on the susceptibility of thermal tiles and panels to damage. Altogether, there are upwards of 40 people in the office of SEIO and several projects are simultaneously underway. The primary limitation to assessment thus far has been lack of documentation and opportunities for observation.

Future

Increase opportunities for assessment.

Status

Plan – In development
Implementation – Underway
Outstanding RFIs – 1
Overall Status – Open

CAIB Recommendation 10.3-1 – Digitize Closeout Photos

Develop an interim program of closeout photographs for all critical sub-systems that differ from engineering drawing. Digitize the closeout photograph system so that images are immediately available for on-orbit troubleshooting.

<u>RTF TG Interpretation</u>

During the investigation, the CAIB encountered numerous engineering drawings that were inaccurate. Further, they discovered that a large number of engineering change orders had not been incorporated into the drawings. Tied in with this, CAIB investigators were not able to access needed closeout photography for several weeks. This resulted in the following finding:

F10.3-3 *NASA normally uses closeout photographs but lacks a clear system to define which critical subsystems should have such photographs. The current system does not allow the immediate retrieval of closeout photos.*

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

The NASA Photo Team is working to establish a more precise definition of "closeout photography" and to strengthen program documentation requirements. The Kennedy Space Center (KSC) has an active program involving digitized closeout photography and has, over several years, collected a large database. The database is available to the Marshall Space Flight Center (MSFC) and the Johnson Space Center (JSC) on the Internet in the Shuttle Imaging Management System (SIMS). While the SIMS is not necessarily "user friendly" and requires knowledge of the system, the data is indexed and available to users, including offsite KSC, in a timely manner. An initiative (prior to the Columbia flight) to revise the SIMS index software to make it more "user friendly" was in progress and is now a priority. The new software should greatly improve this problem.

Current camera equipment used by Space Shuttle inspectors is being evaluated to identify possible improvements, including standardization of the cameras at all KSC processing facilities. The inspectors are trained in the use of the equipment and a random "quality check" is made of their photos to determine if additional training is required.

<u>Assessment</u>

RTF TG Operations Panel experts conducted fact-finding concerning the SIMS database in two separate instances early in 2004. These efforts complimented previous meetings with KSC staff and their contractors to review their response to the CAIB recommendation in 2003.

New standardized 6.1 mega pixel cameras have been selected for use in closeout and configuration photography. A subset of generic and return to flight-specific closeout photo requirements has been obtained from program elements. Photography of areas already closed has been deemed adequate. NASA has identified which SIMS enhancements were required and necessary upgrades are in work. Updated training material has been developed for users of the

SIMS database and users have been scheduled for training at KSC, JSC, and MSFC. NASA is still collecting closeout and configuration imagery requirements from users and is documenting these requirements.

The panel concludes that NASA is making solid progress toward fulfilling this CAIB recommendation.

Future

After the user requirements are collected, the Shuttle Program staff should authenticate that these requirements satisfy the needs of the total Shuttle Program. The RTF TG will continue to monitor NASA's progress in meeting this CAIB recommendation.

Status

Plan – Mature
Implementation – In Progress
Outstanding RFIs – 4
Overall Status – Open; Candidate for closure in August 2004

SSP-3: Space Shuttle Program Action – Contingency Shuttle Crew Support

NASA will evaluate the feasibility of providing contingency life support on board the International Space Station (ISS) to stranded Shuttle crewmembers until repair or rescue can be accomplished.

<u>RTF TG Interpretation</u>

Although not a specific recommendation by the CAIB, the possibility of rescue or repair once a Shuttle is launched is discussed in two sections in the CAIB report. Section 6.4 of the CAIB report explores the possibility of repairing damage to a Reinforced Carbon-Carbon panel or tile on orbit via a "space walk." The same section assesses the possibility of rescuing a crew by launching another Shuttle. Section 9.1 of the CAIB report lists as one of several necessary measures for safe flight the exploration of "all options for survival, such as provisions for crew escape systems and safe havens."

<u>NASA Implementation Plan (January 30, 2004, Volume 1, Revision 1.2)</u>

In this plan to implement the CAIB recommendations, NASA declares that it will evaluate the feasibility of providing contingency life support on board the International Space Station (ISS) to stranded Shuttle crew members until repair or rescue can be effected. The idea of Contingency Shuttle Crew Support (CSCS) capability has evolved from best effort basis to a concrete contingency rescue plan (backup Shuttles for STS-114 and STS-121). Future work includes developing and documenting an action plan for coordination with the ISS Program and international partners, and continued analysis of ISS system support for a "safe haven" crew mix with all available consumables to provide maximum available CSCS duration.

<u>Assessment</u>

The key consumables necessary to support a CSCS contingency have been identified and good work is proceeding on characterizing the reliability of the relevant systems. Since the majority of life support systems on ISS are Russian-provided and managed, Russia's Federal Space Agency participation is critical to the development of any CSCS plan. The Launch-on-Need mission, (identified as STS-300 for STS-114 support) has been baselined in the Shuttle Program. Coordination between the ISS and Shuttle Programs is also critical to ensure that ISS CSCS capability and rescue vehicle turnaround timeline synchronization occurs. Requirements needed to develop CSCS concepts across the Shuttle and ISS Programs are not yet mature.

<u>Future</u>

The Operations Panel will continue to review development of the CSCS concept.

Status

Plan – In development
Implementation – Not yet begun
Outstanding RFIs - None. RFIs are currently being drafted
Overall Status – Open

Integrated Vehicle Assessment

The set of actions from the CAIB report considered by this sub-panel includes:

3.2-1 External Tank Debris Shedding
3.3-2 Orbiter Hardening
6.4-1 Thermal Protection System Inspection and Repair
3.4-1 Ground-Based Imagery
3.4-2 High-Resolution Images of External Tank
3.4-3 High-Resolution Images of Orbiter
6.3-1 Mission Management Team Improvements

In addition to these unclassified actions, two members of this sub-panel will review the operational aspects of NASA's response to CAIB recommendation to modify the Memorandum of Agreement with the National Imagery and Mapping Agency (6.3-2).

RTF TG Interpretation

Related CAIB recommendations should be integrated.

NASA Implementation Plan (January 30,2004, Volume 1, Revision 1.2)

Plans for this integration are not specifically included in the current NASA Implementation Plan.

Assessment

NASA's Systems Engineering and Integration Office (SEIO) recognized the need to develop a plan to collect and integrate all the available information from these new cameras and sensors to support the Mission Management Team (MMT). In December, they produced a very preliminary draft of an operations concept for this integration and shared it with the members of this sub-panel. Shortly thereafter, SEIO established a Systems Engineering Office for Imagery Coordination and assigned it the responsibility for producing the integration plan, building on this initial preliminary draft operations concept.

The sub-panel met with representatives from SEIO, including the Office for Imagery Coordination, the Space Shuttle Program Office, and other NASA representatives at a meeting at the Johnson Space Center on February 20, 2004. At this meeting, the participants reviewed the charter of this sub-panel so that all participants would understand its scope and focus. The group then had a rich discussion of the challenges associated with integrating imagery and sensor information into a coherent picture that could support real-time decision-making. At the end of this meeting, NASA agreed to produce a revised operations concept, building on the first draft, and to provide their revision to the sub-panel prior to the plenary meeting that occurred April 13-16, 2004.

The revised operations concept was provided on April 4 and the sub-panel met with the authors on April 12, 2004. At that meeting, NASA briefed the sub-panel on its revised operations concept and its overall approach to the project.

Based on the latest version of the operations concept and the discussions of April 12, 2004, it is clear to the sub-panel that the Office of Imagery Coordination has made significant progress on this integration task in a relatively short period of time. The authors of the operations concept stressed that they expect the operations concept to be a living document that evolves as more information becomes available about the systems NASA will fly on STS-114, the capabilities of those systems, and the workings of the MMT and the information it needs to make decisions.

While this operations concept is still evolving, and will for some time, it is clear that it identifies the possible imagery and sensor data sources available to produce external damage data for the Orbiter. Through that process, they have identified those sensors that are critical for certain phases of the assessment process beginning with launch through to on-orbit inspection. One of the systems this analysis revealed as key to the on-orbit inspection process is the Orbiter Boom Sensor System.

Also included in the operations concept is an integrated timeline for data availability for STS-114. This includes all the cameras and sensors currently planned for use and the time the data will be collected during flight. It does not yet include the time it will take to relay that information to the ground. Once the data is received on the ground, the operations concept identifies the organizations involved in processing that data. Finally, and very significantly, the operations concept proposes a path for the processed data to flow to the MMT.

As a next step, the operations concept development process should consider the decisions this information will support and determine if the timelines, format, and content of the products will provide a sufficient basis for these decisions from a more “top down” perspective.

Future

The Office of Imagery Integration intends to revise the operations concept based on feedback from various components of NASA. Once a revised operations concept is produced, they will provide it to the sub-panel and an opportunity will be provided to review it and discuss it with the authors.

Soon, NASA intends to include this integration operations concept in their planned MMT simulations. The sub-panel feels that this is a critical step in the evolution of the concept and intends to observe these simulations. The sub-panel further believes it would be desirable to conduct smaller, focused simulations specifically designed to test the concept. As NASA conducts theses experiments, it will make revisions based on the lessons learned from the simulation experience. The sub-panel will observe these events and continue to monitor the evolution of the operations concept until a final version is produced before return to flight.

Status

Plan – In Progress
Implementation – Awaiting plan
Outstanding RFIs – None
Overall Status - Open

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Appendix A - Return to Flight Task Group Charter

ESTABLISHMENT AND AUTHORITY

The NASA Administrator, having determined that it is in the public interest in connection with performance of the Agency duties under the law, and with the concurrence of the General Services Administration, establishes the NASA Return to Flight Task Group, pursuant to the Federal Advisory Committee Act (FACA), 5 U.S.C. App. §§ 1 et seq.

PURPOSE AND DUTIES

1. The Task Group will perform an independent assessment of NASA's actions to implement the recommendations of the Columbia Accident Investigation Board (CAIB), as they relate to the safety and operational readiness of the next flight. As necessary to its activities, the Task Group will consult with former members of the CAIB.
2. While the Task Group will not attempt to assess the adequacy of the CAIB recommendations, it will report on the progress of NASA's response to meet the intent.
3. The Task Group may make other such observations on safety or operational readiness, as it believes appropriate.
4. The Task Group will draw on the expertise of its members and other sources to provide its assessment to the Administrator. The Task Group will hold meetings and make site visits as necessary to accomplish its fact-finding. The Task Group will be provided information necessary to perform its advisory functions, including activities of both the Agency and its contractors.
5. The Task Group will function solely as an advisory body and will comply fully with the provisions of the FACA.

ORGANIZATION

The Task Group is authorized to establish panels in areas related to its work. The panels will report findings and recommendations to the Task Group.

MEMBERSHIP

1. In order to reflect a balance of views, the Task Group will consist of non-NASA employees and one NASA non-voting, ex officio member, the Deputy Associate Administrator for Safety and Mission Assurance. In addition, there may be associate members selected for Task Group panels. The Task Group may also request appointment of consultants to support specific tasks. Members of the Task Group and panels will be chosen from among industry, academia, and Government with recognized knowledge and expertise in fields relevant to safety and space flight.

2. The Task Group members and the co-chairs of the Task Group will be appointed by the

Administrator. At the request of the Task Group, associate members and consultants will be appointed by the Associate Deputy Administrator (Technical Programs).

ADMINISTRATIVE PROVISIONS

1. The Task Group will formally report is results to NASA on a continuing basis at appropriate intervals, including a final written report.
2. The Task Group will meet as often as required to complete its duties and will conduct at least two public meetings. Meetings will be open to the public, except when the General Counsel and the Agency Committee Management Officer determine that the meeting or a portion of it will be closed pursuant to the Government in the Sunshine Act or that the meeting is not covered by FACA. Panel meetings will be held as required.
3. The Executive Secretary will be appointed by the Administrator and will serve as the Designated Federal Officer.
4. The Office of Space Flight will provide technical and staff support through the Task Group on International Space Station Operational Readiness. The Office of Space Flight will provide operating funds for the Task Group and panels. The estimated operating costs total approximately $2 million, including 17.5 work years for staff support.
5. Members of the Task Group are entitled to be compensated for their services at the rate equivalent to a GS 15, step 10. Members of the Task Group will also be allowed per diem and travel expenses as authorized by 5 U.S.C. § 5701 et seq.

DURATION

The Task Group will terminate two years from the date of this charter, unless terminated earlier or renewed by the NASA Administrator.

____ ________________________

Sean O'Keefe (signature on file at NASA Headquarters) Date
Administrator

Appendix B - RTF TG Membership

Co-Chairman of the Return to Flight Task Group

Lt. Gen. Tom Stafford USAF (Ret), Chairman, NASA Advisory Council Task Force on International Space Station Operational Readiness (Stafford Task Force), President, Stafford, Burke & Hecker Inc., Astronaut (Gemini 6A, Gemini 9A, Apollo 10, CDR of the Apollo-Soyuz Test Project)
Mr. Richard Covey, Vice President, Support Operations, Boeing Homeland Security and Services, Astronaut (STS-51I, STS-26, STS-38, and STS-61)

Task Group Members

Colonel Jim Adamson, U.S. Army (Ret.), CEO, Monarch Precision, LLC, Astronaut (STS-28 & 43)
Major General Bill Anders U.S. Air Force (Ret.), Retired Chair and CEO of General Dynamics Corporation, Astronaut (Apollo 8)
Dr. Walter Broadnax, President, Clark Atlanta University
Rear Admiral Walter Cantrell, U.S. Navy (Ret.), Consultant, Member Aerospace Safety Advisory Panel, Former Commander, Space and Naval Warfare Systems Command
Dr. Kathryn Clark, Vice President for Education, TIVY, Incorporated
Mr. Ben Cosgrove, Senior Vice President, Boeing Commercial Airplane Group (Retired)
Mr. Dan Crippen, Former Director of the Congressional Budget Office
Mr. Joe Cuzzupoli, Vice President and K-1 Program Manager, Kistler Aerospace Corporation
Dr. Charles Daniel, Engineering Consultant, Stafford –Anfimov Task Force
Dr. Richard Danzig, JD, Director of National Semiconductor Corporation and Human Genome Sciences, Senior Fellow, Center for Naval Analysis
Dr. Amy Donahue, Assistant Professor of Public Administration, University of Connecticut
General Ron Fogleman, U.S. Air Force (Ret.), President and COO of Durango Aerospace Incorporated
Ms. Christine A. Fox, Vice President and Director, Operations Evaluation Group, Center for Naval Analyses
Mr. Gary Geyer, Aerospace Consultant, Served for 26 years with the NRO
Colonel Susan J. Helms, U.S. Air Force, Division Chief, Space Superiority Division, Air Force Space Command, Astronaut (STS-54, STS-64, STS-78, STS-101, and ISS 2)
Mr. Richard Kohrs, Chief Engineer, Kistler Aerospace Corporation
Mrs. Susan Livingstone, Former Under Secretary of the Navy
Lieutenant General Forrest McCartney, USAF (Ret.), Aerospace Consultant, Member Aerospace Safety Advisory Panel, Former Director of Kennedy Space Center
Dr. Rosemary O'Leary, Professor of Public Administration, Syracuse University
Dr. Decatur Rogers, Dean, Tennessee State University College of Engineering, Technology and Computer Science
Mr. Sy Rubenstein, Aerospace Consultant, Former Rockwell International Director of Systems Engineering
Mr. Robert Sieck, Aerospace Consultant, Member Aerospace Safety Advisory Panel, Former Director of Shuttle Processing, Kennedy Space Center
Mr. Thomas N. Tate, Retired former Vice President of Legislative Affairs for the Aerospace Industries Association
Dr. Kathryn C. Thornton, Professor, University of Virginia School of Engineering & Applied Science, Astronaut (STS-33, STS-49, STS-61)
Mr. Bill Wegner, Consultant, Former Deputy Director to Admiral Rickover in Nuclear Navy Program

Task Group Support

Ex Officio Member: Mr. James Lloyd, Deputy Associate Administrator, Office of Safety & Mission Assurance, NASA Headquarters
Executive Secretary: Mr. David Lengyel, NASA Headquarters
Astronaut Representative: Col. Michael Bloomfield USAF

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Appendix C - Return to Flight Task Group Organization

CO-CHAIRMAN
Lt. Gen. Tom Stafford

ASTRONAUT REP
Col. Michael Bloomfield

CO-CHAIRMAN
Mr. Richard Covey

EXEC. SECRETARY
Mr. David Lengyel

MANAGEMENT PANEL
Dr. Dan Crippen

Maj. Gen. Bill Anders
Dr. Walter Broadnax
Hon. Richard Danzig
Gen. Ron Fogleman
Mr. Gary Geyer
Mrs. Susan Livingstone
Mr. Tom Tate
Mr. Bill Wegner

TECHNICAL PANEL
Mr. Joe Cuzzupoli

RADM Walt Cantrell
Mr. Ben Cosgrove
Dr. Chuck Daniel
Mr. Richard Kohrs
Dr. Decatur Rogers
Mr. Sy Rubenstein

OPERATIONS PANEL
Col. Jim Adamson

Dr. Kathy Clark
Dr. Amy Donahue
Ms. Christine Fox
Col. Susan Helms
Lt. Gen. Forrest McCartney
Dr. Rosemary O'Leary
Mr. Bob Sieck
Dr. Kathy Thornton

EDITORIAL SUB-PANEL

ADM Walt Cantrell
Dr. Daniel Crippen
Dr. Rosemary O'Leary

INTEGRATED VEHICLE ASSESSMENT SUB-PANEL

ADM Walt Cantrell
Dr. Kathryn Clark
Mr. Tom Diegelman
Ms. Christine Fox
Mr. Gary Geyer
Mrs. Susan Livingstone
Lt. Gen. Forrest McCartney
Mr. Robert Sieck
Dr. Kathryn Thornton

EX OFFICIO

Mr. James Lloyd

Appendix D - RTF TG Fact-Finding Activities

January

January 09, 2004	Technical Panel Telecon
January 09, 2004	Co-Chair/Panel Chair/Staff Telecon
January 13, 2004	Co-Chair/Panel Chair/Staff Telecon
January 15, 2004	Johnson Space Center, STS-114 Flight Techniques Panel.
January 20, 2004	Co-Chair/Panel Chair/Staff Telecon
January 22, 2004	Telecon with Mr. Steve Wallace (CAIB member) regarding R3.4-1 thru -3 and 6.4-1, Imagery and TPS Inspection/Repair. Operations Panel.
January 26, 2004	Telecon with Code Q/Bryan O'Connor regarding R9.1-1, Management Panel.
January 27, 2004	Co-Chair/Panel Chair/Staff Telecon
January 28-30, 2004	Kennedy Space Center, SEIO Summit II. Mr. Kohrs.
January 29, 2004	Subnominal Bond TIM, Mr. Cuzzupoli, Mr. Cosgrove.

February

February 03, 2004	Michoud Assembly Facility, RFI Mini-TIM, Mr. Cuzzupoli, Mr. Cosgrove.
February 03, 2004	Integrated Vehicle Assessment Sub-Panel Organizational Telecon. Ms. Fox, Lt.Gen. McCartney, Mr. Sieck, RADM Cantrell.
February 03, 2004	Co-Chair/Panel Chair/Staff Telecon
February 04, 2004	Johnson Space Center, DTO 848 PDR, Mr. Cuzzupoli, Mr. Cosgrove, Mr. Rubenstein, Dr. Clark.
February 02-05, 2004	Kennedy Space Center, Launch and Landing Imagery PRD Requirements Review. Mr. Sieck and LtGen. McCartney.
February 04, 2004	NASA Headquarters, ITEA Meeting. Mrs. Livingstone.
February 05, 2004	Johnson Space Center, STS-114 Joint Operations Panel #9 Telecon, Dr. Thornton.

February 05, 2004	Technical Panel Telecon
February 06, 2004	Kennedy Space Center, Solid Rocket Booster Thermal Protection System Mini-TIM. Dr. Daniel, LtGen. McCartney.
February 09, 2004	Management Panel Telecon
February 10, 2004	Johnson Space Center, Imagery TIM, Dr. Sieck and Lt.Gen. McCartney.
February 10, 2004	Co-Chair/Panel Chair/Staff Telecon
February 11, 2004	Johnson Space Center, 12A MMT simulation.
February 10, 2004	Telecon with JSC MER personnel regarding SIMS Database. Mr. Sieck and Lt.Gen. McCartney.
February 12-13, 2004	Debris Summit II Summit at the Johnson Space Center
February 17-18, 2004	SLEP II Summit at Galveston, TX, RADM Cantrell.
February 19, 2004	Johnson Space Center, SFLC Meeting, Mr. Covey and RADM Cantrell.
February 18-19, 2004	Johnson Space Center, NASA/NIMA MOA Meeting, Mr. Geyer and Dr. Donahue.
February 20, 2004	Johnson Space Center, Integrated Vehicle Assessment Sub-Panel Meeting.
February 20, 2004	Co-Chair/Panel Chair/Staff Telecon
February 23, 2004	Management Panel Telecon
February 24-25, 2004	NASA Headquarters, Management Panel Meetings.
February 27, 2004	Co-Chair/Panel Chair/Staff Telecon

March

March 08, 2004	Management Panel Telecon
March 11, 2004	Kennedy Space Center, FOD and Digital Closeout Imagery. Lt.Gen. McCartney, Mr. Sieck, and Dr. Thornton.
March 16, 2004	Co-Chair/Panel Chair/Staff Telecon
March 22, 2004	Management Panel Telecon
March 23, 2004	Co-Chair/Panel Chair/Staff Telecon
March 23-24, 2004	Johnson Space Center, OBSS Status Meeting, Mr. Bruckman.
March 30, 2004	Co-Chair/Panel Chair/Staff Telecon
March 30, 2004	Johnson Space Center, STS-114 Joint Operations Panel #12 Telecon, Dr. Thornton.
March 31, 2004	Sandia Labs, Albuquerque, NM. OBSS Status Meeting, Mr. Bruckman.

April

April 01, 2004	Kennedy Space Center, External Tank Monthly Review, Mr. Cuzzupoli, Mr. Kohrs, Dr. Daniel, Mr. Rubenstein
April 02, 2004	Kennedy Space Center, Two-Person Closeout, Orbiter Hardening, and RCC NDI Briefings, Mr. Cuzzupoli, Mr. Kohrs, Dr. Daniel, Mr. Rubenstein
April 02, 2004	Kennedy Space Center, Pre-Launch MMT Simulation, Mrs. Livingstone
April 05, 2004	Management Panel Telecon
April 06, 2004	Co-Chair/Panel Chair/Staff Telecon
April 09, 2004	Two-Person Closeout, Orbiter Hardening, and RCC NDI Dry Run Briefings, Mr. Cuzzupoli, Mr. Cosgrove, Mr. Kohrs, Dr. Daniel, Mr. Rubenstein

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Appendix E - RFI Status Matrix

*sorted by CAIB recommendation

Number	Title	CAIB Rec.	Description	OPEN / CLOSED
Tech-039	**GMIP's Independent Assessment**	SSP-1	RTF TG Technical Panel requests a copy of the NASA Independent Assessment Report on GMIP's.	**CLOSED**
Ops-016	**ISS Consumable, Sparing and Configuration for 2-Member Crew**	SSP-3	Provide current and projected consumables (water, propellant, CO2 removal capability, food and other crew provisioning) for current 2-member crew with projected needs on Russian assets (e.g. Soyuz rotations, crew rotations, Progress missions, etc.) for extended on-orbit maintenance of ISS without Shuttle availability. Also provide data on critical ORU sparing to maintain minimum acceptable habitability and mechanisms for providing that sparing without Shuttle.	**CLOSED**
Ops-017	**Contingency Shuttle Crew Support Data and Supporting Analysis**	SSP-3	Provide minimum ISS system requirements, consumables, etc. to maintain crew of 6-10 for contingency support of the Shuttle crew. Provide plans for use of Soyuz to bring down partial crew and length of time remaining crew can survive on ISS. Provide plans and timeframes for sending additional Soyuz and/or Shuttle rescue missions to retrieve remaining crew members. Provide forward work to verify feasibility of this concept and reliance on Russian segment and assets.	**CLOSED**
Ops-018	**ISS Safe Haven and ISS Extended Duration Orbiter Study Results**	SSP-3	Provide study results from ISS Program led analysis of the ISS as a safe haven to provide larger on-orbit crew size with limited Soyuz return capability. Also provide study results from ISS Program led analysis of use of EDO Shuttle missions to provide a larger crew for utilization. Both study results should discuss ISS minimum system capability, consumables projections, number of crew supported as a function of time, and reliance on Russian segment and other assets	**CLOSED**
Ops-058	**ISS ECLS Systems Training Manuals**	SSP-3	Provide: 1) Russian manuals (in english):a. Vozdukh b. BMPc. Electron d. ACY (toilet) e. CRBK (Water supply system) 2) US manuals: a. CDRA b. CCAA 3) Also provide an overview of the ability to supply O2/N2 from the ISS airlock to ISS ambient atmosphere - namely, whether it's possible and if so, a comparison between O2 used for 1 ISS EVA and what that same O2 amount would provide for ISS Safe Haven duration extension. 4) Is there a manual/overview on the US-provided water bags (CWC) that are used to supply water to the Electron, etc?	**CLOSED**

Tech-031	**SSME Controller Software Independent Verification and Validation (I V V), Other no Rec.**	SSP-13	Request clarification of the Space Shuttle Program Policy for IVV and descried the IVV process for the SSME controller software. Background: The Technical Panel Lead discussed SSME controller software IVV with Rocketdyne's Chief engineer. The Chief Engineer describe a process that indicated that the IVV of the Rocketdyne development software was also performed by Rocketdyne. Normal practice for IVV is to use an independent IVV contractor.	**CLOSED**
Tech-052	**RSRM TPS Application Assurance**	SSP-13	TPS application and assurance for SRB Nose Cap, Frustrum, Forward Skirt and Aft Skirt. RSRM TPS application and assurance. Failure mechanisms for TPS (what factors would cause liberations of debris). SRB and RSRM debris source identification provided to Level II.	**OPEN**
Tech-053	**Tile/SIP Peel Strength**	SSP-13	Provide rational or technical approach to OV 105 Tile/SIP Peel Strength issue for OV103 and OV104 orbiters.	**OPEN**
Tech-004	**Wind Tunnel Testing on External Tank**	3.2-1	Per our discussion, I would like to understand what wind tunnel cases are being run for the ET bi-pod and PAL ramp. I understand that these are ET only configurations. I am interested in MACH numbers, angle of attack, beta angle, etc. I am also interested in what CFD analysis or planned mated vehicle tests are planned to understand the effects of any changes. I am concerned that the changes to the ET may affect the system unless we understand the mated aero effects.	**CLOSED**
Tech-007	**Additional Instrumentation for vehicles ET FOAM (R3.2.1)**	3.2-1	What additional instrumentation will be added to the vehicles to obtain engineering data to verify pre-flight predictions, primarily concerning RCC and tank debris. Also, please provide the PRCB status addressing adding instrumentation to record impacts to the RCC leading edge and data availability near real-time to the ground and the program's position on implementation.	**CLOSED**
Tech-008	**Additional Instrumentation for ET for Pre-Launch and Launch (R3.2.1)**	3.2-1	The technical team is interested in what additional instrumentation is planned to be added to the External Tank (ET) to measure the environments during pre-launch and launch. The removal of the bipod ramps, and potentially the removal of the PAL ramps, and the uncertainty of the internal intertank environment of the LH tank interface creates the justification to add instrumentation to obtain engineering data and to facilitate the verification process.	**OPEN**
Tech-009	**Ascent Profile**	3.2-1	Would like to see a typical ascent profile that shows alpha, beta thrust bucket, propellant consumption, altitude and velocity.	**CLOSED**
Tech-010	**ET Finite Element Model (FEM)**	3.2-1	Provide results from FEM analysis on ET. Identify the model, assumptions, data targeted, uncertainty, how data was used, load(s), etc.	**CLOSED**

Tech-045	**Nominal Ascent Data**	3.2-1	Reference Tech 009: ascent profile data was provided for a nominal mission in Tech-009. Request nominal ascent data for the ET LH2, L02 ulage temperatures and ambient ourside air temps from T-20 seconds to Meco. The measurements of interest T41T1755A (L02 Ulage temp); T41T1705A (LH2 Ulage temp)	**CLOSED**
Tech-047	**Combined Loads**	3.2-1	Request that ET Office explain how they combine design environments to generate combined loads for stress analysis, in particular, with respect to bi-pod redesign.	**OPEN**
Tech-048	**Combined Loads Design Environments**	3.2-1	Request Level 2 Systems engineering and Integration to describe how level 2 ensures that design environments are properly combined into combined loads for use by the Projects.	**OPEN**
Tech-049	**3.2-1 TPS Verification Validation and Certification**	3.2-1	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review. NASA stated that in-flight vibration and flexure loads did not contribute to foam loss. Request the data be provided supporting this statement. Please indicate dynamic response frequency and induced loads.	**OPEN**
Tech-051	**3.2-1 TPS Verification Validation and Certification – Integrated Plan for TPS Verification**	3.2-1	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review: Request NASA provide an integrated plan for the TPS verification, validation and certification activity.	**OPEN**
Tech-054	**3.2-1 Bellows Debris Elimination**	3.2-1	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review: Request NASA provide the venting analysis of the bellows/gasket to assure the gasket will not degrade the design venting requirements and will not separate and become a debris source	**OPEN**
Tech-055	**3.2-1 INTERTANK/LH2 Flange Enhancement**	3.2-1	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review: Request NASA provide analysis showing that fastener leakage could not be a contributing cause of foam loss in other areas, including the bi-pod area on STS-107. The analysis will support root cause determination.	**OPEN**

Tech-056	**3.2-1 NDI Techniques**	3.2-1	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review: Request NASA provide a narrative description (white paper) of the two NDI techniques being used for the foam inspection. Please indicate the acceptance criteria for NDI.	**OPEN**
Tech-057	**Physics of ET Foam Failure**	3.2-1	At the last Tech Panel meeting at MAF, presentations covered the failure mechanisms associated with foam liberation. The presentations explained the “how”, but not the “why” of failure at voids. The root cause, “why”, (or the physics of failure), of the breakdown at voids is needed to assess corrective action. Request a presentation giving MAF’s understanding of the “why” (or the physics of failure) of breakdown of ET foam at voids.	**OPEN**
Tech-001	**R3.3-1 Rationale for Retaining OV104 Nose Cap Rather than Testing**	3.3-1	Provide the rationale for retaining the OV104 nose cap in place rather than performing the tests being performed on the OV103/OV105 nose caps.	**CLOSED**
Tech-046	**Impact Test Data**	3.3-1	The Technical Panel would like an assessment of the tests and periodic (twice/ monthly) basis. In particular a summary of the: 1) Number of Tests conducted by kinetic energy 2) Impacts on establishing the design allowable 3) Impact on the repair requirements.	**OPEN**
Tech-002	**R3.3-2 Tile Improvements for First Flight**	3.3-2	What are the tile improvements for the first flight? If the improvements were selected to reduce risk please explain the rationale or testing underway to demonstrate why the changes are not required.	**CLOSED**
Tech-003	**R3.3-2 Tile Improvements Testing**	3.3-2	What testing (schedule and type) will be done to demonstrate the tile repair prior to first usage?	**CLOSED**
Tech-005	**R3.3-2 Testing Information on RCC and tile Testing**	3.3-2	Provide an integrated schedule of testing to support R.3.3-2,…"a program designed to increase the orbiters ability to sustain minor debris damage by measures such as improved impact resistant RCC and acreage tiles." Please explain the approach to demonstrate the margin between the ET shedding a and the Orbiter damage tolerance. Provide information for the RCC and tile testing.	**CLOSED**
Ops-070	**3.4-1: Requirements Documentation and System Performance Specifications**	3.4-1	1.Supply all documents containing the NASA requirements associated with ground based imagery, including the system performance and maintenance requirements documentation. 2.Supply all documentation describing the process / plan for the KSC and Range launch readiness certification of the ground imagery assets.	**OPEN**

Ops-071	**3.4-1: Launch Commit Criteria for revised and upgraded imagery assets**	3.4-1	1.Supply documentation of the Launch Commit Criteria for launch weather, and the relationship with the improved ground imagery assets (including airborne /ship based if and where applicable). 2.This documentation should include the decision process / Launch Commit Criteria for unavailability or inoperable assets, and associated safety of flight risk assessment	**OPEN**
Ops-072	**3.4-1: Integrated Schedule for the completion and the RTF TG review of Ground Imagery**	3.4-1	Schedule for all work / products / documentation / briefings for ground imagery requirements and implementation plans – including any work which will be accomplished after RTF. Schedule must be presented in sufficient time to allow the TG to assess the appropriateness of the improvements made pre and post RTF (STS-114)	**OPEN**
Ops-073	**3.4-2: Imagery Downlink – Completion of the flight Milestone for the Umbilical Well Camera Pt.1**	3.4-2	Documentation or verification of the completion of the qualification milestone (test, documentation, etc) for flight for the Umbilical Well Camera for RTF (STS-114).	**OPEN**
Ops-074	**3.4-2: Imagery Downlink – Completion of the flight Milestone for the Umbilical Well Camera Pt. 2**	3.4-2	1.Review of the procedures, and documentation for:(a)Check out of all cameras systems (b)Test, calibration and readiness of camera systems (c)Review of the Training prospectus for the Crew (hand held camera)and the ground operations personnel 2. Review of the Launch Commit Criteria against findings from Item #1 above.	**OPEN**
Ops-075	**3.4-2: Imagery Downlink – Completion of the flight Milestone for the Umbilical Well Camera Pt. 3**	3.4-2	1.Review of Total Data Handling process from Shuttle vehicle orbit insertion, to evaluation on the ground, of the images collected by the camera systems. 2.Review of the resolution, if possible by sample data, to assure the images will provide the desired decision information	**OPEN**
Ops-076	**3.4-2: Downlinked Imagery from previous Missions for ET, ET Umbilical, and Handheld camera**	3.4-2	A summary of the previous shuttle missions performance of the ET Film Cameras in the ET Umbilical Cavity and the Handheld Camera – specifically the reliability of these systems, the quality of the resolution, the performance against specifications, and the anticipated deltas associated with any changes made for the post RTF imagery	**OPEN**
Ops-068	**3.4-3: On-vehicle Imagery – Camera system Qualification / Certification (for Return to Flight)**	3.4-3	1.Review of the Check Out procedures to assure operational status of the on-board cameras. 2.Review of Launch Commit Criteria against the operational status of the on-board cameras	**OPEN**
Ops-069	**3.4-3: On-vehicle Imagery – Camera system Qualification / Certification (for continuing flights)**	3.4-3	1.Review of the qualification / certification data for the total suite of the cameras on-board the Vehicle. 2.Review of the Check out procedures to assure operational status of the cameras.	**OPEN**
Tech-011	**SRB Bolt Catcher Finite Element Model**	4.2-1	Provide the results from the FEM used to analyze the SRB bolt catcher assembly. Identify model, assumptions, loads, uncertainty, data targeted, etc.	**CLOSED**

Tech-084	**4.2-1 Request for Data Packages in Support from CDR on the SRB Bolt Catcher**	4.2-1	The SRB Project is requested to provide the following information: 1. Data packages from the delta-CDR on the SRB Bolt Catcher and the associated NSI. 2. RIDs and dispositions from this delta CDR.	**OPEN**
Tech-022	**Wiring Inspection and Repair (R4.2-2)**	4.2-2	What wiring inspection and repair will not be performed on OV-104 prior to return to flight. Provide rationale.	**CLOSED**
Tech-050	**4.2-3 Two Person Closeout**	4.2-3	The Tech Panel held a review of the ET return to flight activity at MAF on 05, Dec. 2003. These requests were made to provide additional information to the panel. This item was discussed at the review: Request NASA provide copies of the implementation plan as objective evidence for closure of the CAIB recommendation.	**CLOSED**
Ops-066	**4.2-5: Foreign Object Debris (FOD) Processes – New Work Processes**	4.2-5	Plans and schedules for education of the workforce in the use of the new procedures and work instructions, focused on the impacts of the new definition of FOD. Confirmation of the education initiative via training sessions and meetings with the workforce, via metrics, and participation records.	**OPEN**
Ops-067	**4.2-5: Foreign Object Debris (FOD) Processes – New Definition and Standards review**	4.2-5	Review applicable standards, references, and information, to develop a new definition of FOD with the intent of: 1.Consistency against FOD standards, particularly relevant industry and DOD standards. 2. Benchmark DOD and industry facilities that perform similar processing activities 3.Consistent with the standards and practices, develop a new set of metrics, with the intent of establishing and sustaining a more robust FOD control program	**OPEN**
Ops-081	**4.2-5: Foreign Object Debris Processes – Audits and Interviews**	4.2-5	1.Review of the improvements made under all the RFI's in this NASA Implementation Plan section, concluding in an audit. The results will be recorded as an RTF TG finding. 2.Conduct random interviews with the workforce after the closure of all RFI's, action items, and the audit is completed. The results will be documented for comparison with training records.	**OPEN**
Man-026	**Budget Impact on Scheduling and Resources 6.2-1**	6.2-1	1. Debrief of FY04 budget process. 2. Notional budget allocation process. 3. Changes in budget allocation process resulting from Columbia mishap. 4. How Level 2 tools are used to fulfill Level 1 requirements. 5. Copy of benchmarking. 6. Present results of Organization/Fault tree analysis conducted by SSPO at Dec. plenary.	**OPEN**
Man-025	**MMT Training Plan And Schedule RE CAIB 6.3-1**	6.3-1	1. NSTS 0700 Volume VIII with changes pertaining to MMT annotated. 2. Schedule for MMT exercises and drills. 3. Simulation control group organization plan. 4. Outline of individual and team training for scheduled exercise. 5. MMT POC and read-ahead materials for RTF TG December plenary	**CLOSED**

Man-030	**Lessons Learned from First MMT Simulations, R6.3-1**	6.3-1	1. Report on lessons learned from first MMT simulation. 2. Quick look results from second MMT simulation.	**CLOSED**
Man-042	**MMT Additional Lessons Learned, Outside Evaluation Reports, and Other CAIB Rec. Exercise, R6.3-1**	6.3-1	1. Report on Lessons Learned from second MMT simulation. 2. Provide Parker and Van Eynde evaluations of first and second MMT simulations. 3. List aspects of other CAIB RTF recommendations exercised in MMT simulations. 4. List aspects of CAIB non-RTF recommendations exercised in MMT simulations	**OPEN**
Man-028	**NASA/NIMA MOA Plans and Documentation R6.3-2**	6.3-2	1. Master schedule for development, coordination, publication and implementation (to include simulation and test)2. MOA (classified)3. Clearance list/process description4. Description of NASA STRATCOM/Interface5. Presentation of plan to Incorporate STRATCOM ground based assets6. Standard operating procedures7. Training plan8. Integrated simulation/evaluation results	**OPEN**
Ops-015	**TPS Inspection/Repair Media Day Demo and KC-135 Test Video and Transcripts**	6.4-1	Provide videos and transcripts for the following: 1. Tile and RCC inspection and repair explanations and EVA tool/techniques demonstrations provided by JSC in Building 32 on either September 17 or 18, 2003 for Media Day. 2. Video tapes of KC-135 tests from 1979-1981 and some representative videos from more recent test in 2003 for tile repair techniques and material testing. These videos should illustrate basic tools, techniques and materials that were studied.	**CLOSED**
Ops-019	**TPS Repair/Inspection Points of Contact and Concept of Operations**	6.4-1	Provide contact information for the Program manager, operations lead, technical lead, and integrator (Program or otherwise; person who is insuring various parallel path items are coming together) for TPS repair/inspection techniques, testing, training and verification. Provide a summary of the concept of operations for any and all TPS repair/inspection techniques under evaluation and provide methodology for certifying for flight.	**CLOSED**
Ops-020	**TPS Repair/Inspection Test Reports (part 1)**	6.4-1	Provide copies of all test reports for any methods of TPS repair/inspection techniques and application processes under evaluation with any applicable crew consensus reports.	**CLOSED**
Ops-021	**TPS Repair/Inspection Test Reports for future tests - Part 2**	6.4-1	Provide copies of all test reports for any methods of TPS repair/inspection techniques and application processes under evaluation with any applicable crew consensus reports for future planned tests.	**OPEN**
Ops-038	**Sensor/Optics Product Integration for Real-Time Ops Mission Support**	6.4-1	1. Diagram and describe the integrated technical and operations effort to satisfy: (a) Imaging the Orbiter during ascent from the KSC/Canaveral ground sites; (b) Imaging the Orbiter from external tank/SRB-mounted cameras; (c) Imaging the external tank from wheel-well cameras and crew hand-held cameras; (d) Imaging the Thermal Protection System (TPS) using boom-mounted laser; and (e) Imaging the TPS using ground/space-based assets. 2. Diagram and describe how the products from items 1a-1e above will be integrated to support real-time operations decisions.	**OPEN**

Ops-059	**TPS Inspection/Repair Procedures and Flight Products**	6.4-1	1) Current list of EVA procedures and flight products related to the Shuttle TPS repair.2) SRMS RCC wing leading edge survey procedures. 3) Option-1 (Shuttle attached to ISS PMA-2 with SRMS) robotic procedures for Shuttle tile repair while attached to ISS.4) ODF procedures for imagery during Shuttle pitch maneuver for tile survey during ISS approach.5) Current and continuing flight plans for STS-114, particularly the EVA TPS repair DTO.	**OPEN**
Ops-060	**Tile Repair Stabilization Point**	6.4-1	1) Provide a list of the tile areas that can not support a 5psi generic work restraint or stabilization point for the tile repair EVA. 2) Provide workarounds planned for repair in areas that can not support an astronaut restraint or stabilization point.	**OPEN**
Ops-061	**Observe Crew Training Sessions for RPM and Wing Leading Edge Inspection**	6.4-1	Description: Task Group Members wish to observe a crew training session for: 1)the shuttle R-bar pitch maneuver and tile photographic inspection during Orbiter approach to ISS.2) the SRMS inspection of the wing leading edge for RCC damage.	**OPEN**
Ops-062	**Observe Human Thermal Vacuum Tests (Cold Case and Hot Case)**	6.4-1	Task Group members wish to observe the HTV tests (Cold case primarily but possibly Hot case) for tile repair testing	**OPEN**
Ops-063	**Complete History of Tile Damage**	6.4-1	Provide: A complete history of damage that the shuttle has sustained and landed with	**OPEN**
Ops-064	**Observe a suited Tile Repair NBL training run**	6.4-1	A task group member wishes to observe a crew EVA tile repair training session in the NBL.	**OPEN**
Ops-065	**Critical Damage to RCC Definition**	6.4-1	Define the RCC upper and lower critical damage limits (and the methodology for determining those limits) that can be patched and still survive re-entry, including the significant RCC failure modes and the behavior of each during entry (e.g., pass through holes versus delaminations versus cracks, etc.).	**OPEN**
Tech-006	**TPS Repair Testing Reports Including Astronaut Crew Consensus Report**	6.4-1	Pre "Press Day" Inspection and Demos of Tile and RCC repair tools. Informal Q&A and follow-up discussions. Glove Box demonstration for selected TG members. TG fact finding & planning session.	**N/A**
Tech-012	**Tile Repair Materials**	6.4-1	1. Provide material specifications for 511 materials. 2. Provide material specification on silicon material.	**CLOSED**
Tech-013	**Environment Testing of Tile Repair Materials**	6.4-1	Provide briefing to Tech Panel describing the combined environments testing on the tile repair material, i.e. vacuum, temperature, loads, etc.	**CLOSED**
Tech-014	**Briefing - Tile Repair Materials Procedure**	6.4-1	Provide briefing to Tech Panel explaining how tile repair material and procedures will account for and control material expansion protecting for 1/4" step.	**CLOSED**
Tech-023	**Pull Test on High Temperature Tiles (R6.4-1)**	6.4-1	Are there any plans to perform either a sampling or a 100% pull test on high temperature tiles/TPS prior to return to light. Provide rationale.	**CLOSED**

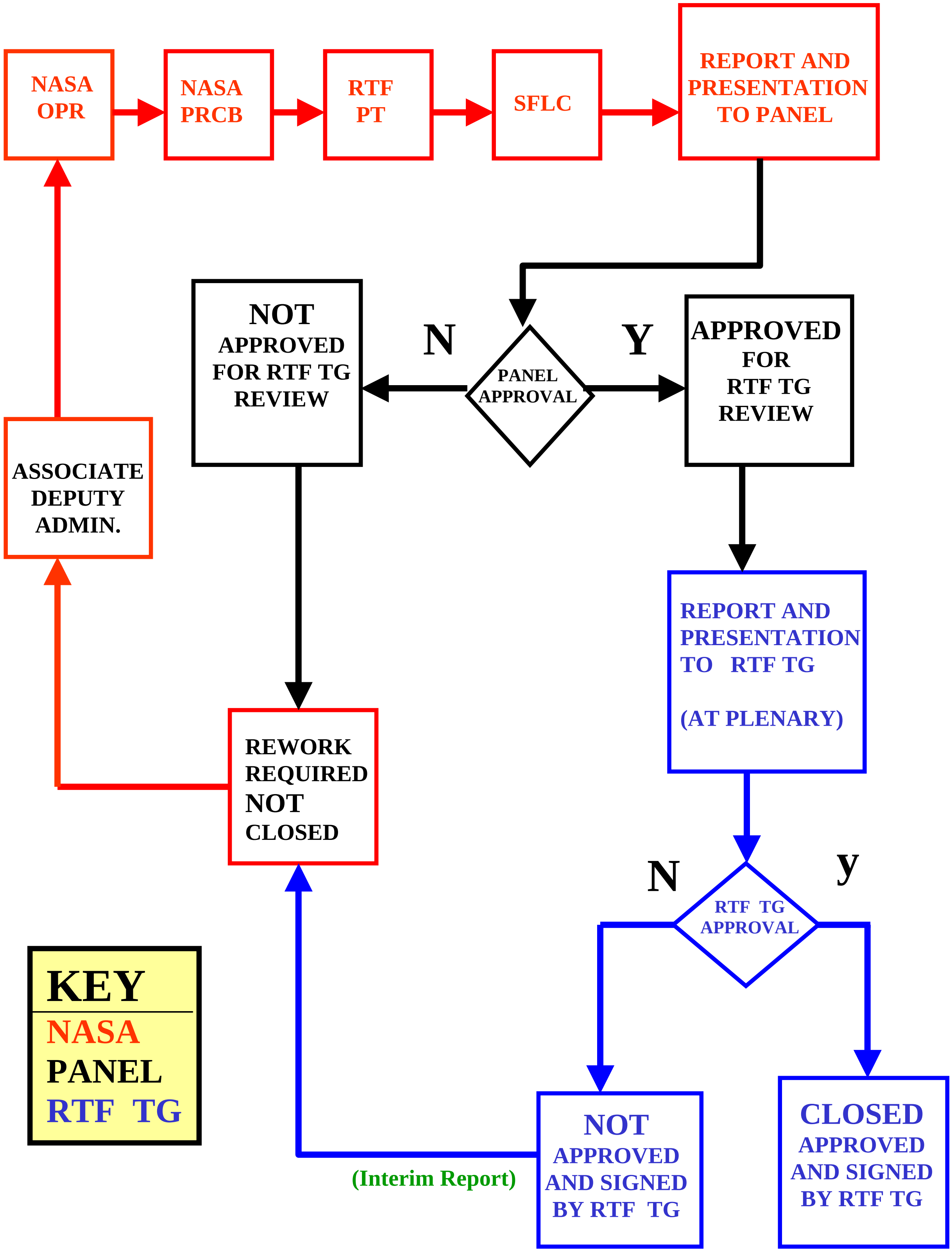
Tech-041	**Conduct an "Integrated Imagery/Sensor Inspection" Workshop**	6.4-1	1) Ground-Based Sensors Status 2) ET/SRB Sensors Status 3) OBSS Status 4) Umbillical Well Camera Status 5) Hand-Held Camera Status 6) Inspection Requirements, Standards, Criteria 7) Integrated Risk Assessment 8) NASA/NIMA Operational Approach 9) Resolution Requirements 10) Inspection Timeline & Decision Making Process (MMT) 11) Collection/Integration of Sensor Products/Data 12) Real-Time Ops Procedures 13) Training (crew, Controller, MMT) 14) DTO's 15) Contract(s) Structure 16) Integration with Other Instrumentation 17) Revision to NSTS Requirements Documents 18) Budget 19) Integrated Schedule/Critical Path/Key Milestones 20) Role of SEIO 21) Integration of Inspection with EVA Repair 22) Non-Advocate Review Plans This workshop should include outside experts in Optics, Laser, Software Integration, and Classified Data Gathering/Integration from Government, Industry, and/or Academia. Detailed minutes should be kept.	**CLOSED**
Man-044	**Changes to NASA and SSP Waiver Processes, R7.5-1 and R7.5-2**	7.5-1	If the Space Shuttle External Tank (ET) sheds foam and requires waiver(s) before flight, describe:1. Waiver(s) required. 2. Process flow. 3. Who, by billet, decides at each level in the process flow? 4. Who, by billet, is ultimately responsible for granting waiver(s)? 5. Who, by billet, has veto authority? 6. How are cognizant organizations funded? -Describe processes as they existed at the time of the Columbia mishap and as envisioned in Option 1A presented by NASA's Code Q to members of the RTF TG on 10 December 2003.	**OPEN**
Man-083	**7.5-2 NNBE Application to Code Q Review and Assessment Division Processes**	7.5-2	Update evolution of the OSMA/QV (Review & Assessment Division - established in December 03) to strengthen NASA SMA independent assessment and review capability including:1.Infusion of SUBSAFE-like audit and review processes into NASA culture. 2. Update current NNBE activities, progress reports and efforts to establish a Safety-Critical Decision Making - Training Initiative at NASA (evolved from NNBE Report Volume I and CAIB discussion in Chapter 7).3. Discuss efforts to establish a strengthened independent OSMA SSP-PAR process within the context of an overarching restructured OSMA safety-critical program and pre-operations review process	**OPEN**
Man-029	**Space Shuttle Systems Engineering Office (MS) Reorganization plans, resources, and documents, R7.5-3 (rolls into R9.1-1)**	7.5-3	1. MS reorganization milestones and master schedule 2. MS meeting and workshop schedules, agendas and presentation materials 3. MS organization and process documents (e.g., white papers, memoranda, etc.) 4. Presentation of MS reorganization budget and resources	**OPEN**

Man-027	**Human Resources, Organization and Culture 6.2-1 and 9.1-1**	9.1-1	1. Presentation of NASA's Strategic Human Capitalization Plan. 2. Presentation of Succession Plan. 3. How NASA has gathered feedback from the workforce regarding moral, views on culture, etc. 4. Presentation of NASA's plan to balance civil service and contractor workforce. 5. Presentation of NASA's Conflict Management Plan. 6. Impact of NESC stand up on line organizations. 7. Forward plan for civil service workforce structure (e.g., percentage of increase and decrease per skill and grade, increase and decrease of temporary and permanent positions). 8. Code F and NAWAT interfaces and functional relationships.	**OPEN**
Man-032	**CAIB Agency Wide Action Team (CAWAT) Status, R6.2-1 and 9.1-1**	9.1-1	1. Brief CAWAT's current status. 2. CAWAT Master Schedule. 3. CAWAT benchmarking/milestones 4. Address CAWAT's conceptual approach to enable NASA's compliance with CAIB recommendation, particularly R6.2-1 and R9.1-1.	**OPEN**
Man-033	**Detailed Organization Plan, R9.1-1**	9.1-1	1. Status of Organization Plan. 2. Brief of notional approach. 3. Presentation of metrics, milestones, and Master Schedule. 4. Rationale for separating R7.5-3 from R9.1-1, R7.5-1, and R7.5-2 in Implementation Plan. 5. Rationale for assignment of overall responsibility for R9.1-1 implementation to a center individual vice HQ Code, particularly in light of Code Q responsibility for R7.2-1 and R7.5-2. 6. Schedule for periodic briefs to RTF TG Management Panel and presentation of options development, risk/benefit analyses, decisions, and progress.	**OPEN**
Man-034	**Organization Plan Interdisciplinary Assessment Team, R9.1-1**	9.1-1	1. Personnel assigned, parent organization(s), and team structure.2. Team charter and reporting chain.3. Meeting schedules, locations, agendas, and coordinator's contact information.4. Meeting minutes, presentation material, and supporting documentation.5. Team recommendation and dates of completion and final report.	**OPEN**

Man-035	**ITEA and S&MA Concepts, R7.5-1, R7.5-2, and R9.1-1**	9.1-1	1. How does NASA define "independent" and "independently" as referred to in R7.5-1 and R7.5-2? 2. Notional approach to contractor technical expertise vis-à-vis "independence" criteria and anticipated contract modifications. 3. Notional concept separating technical authority from other programmatic functions (e.g., corollary to NAVSEA's warrants/veto authority). 4. Risk/benefit analysis of separating final technical and safety authority from line management. Address distinction between centralized safety line authority and "safety is everyone's responsibility." 5. NASA's plan to address "High Reliability Theory" versus "Normal Accident Theory" referred to in the CAIB Report.	**OPEN**
Man-036	**NASA HQ S&MA Line Authority, R7.5-2 and R9.1-1**	9.1-1	1. Present pre-mishap Shuttle safety responsibility and authority (specifying levels of final accountability), to include contractor roles. 2. Present annotated changes to number 1, above, delineating specific improvements and rationale for change. Include interfaces and functional relationships with NESC.	**OPEN**
Man-037	**ITEA and NESC Status, R7.5-1 and R9.1-1**	9.1-1	1. Brief status of 14 common themes and concerns delineated in September 2003 White Paper subsequent to NESC tour, as well as other concerns raised during briefings to Congress. 2. Brief current NESC staffing, personnel acquisition sources, and budget and funding source(s). 3. Provide NESC oversight matrix, organizational interfaces, and functional relationships. 4. Discuss lessons learned/observations from 27 October Submarine Safety Colloquium, including planned incorporation into NESC's organization and operational concepts. 5. Assessment of NESC's added value to a notional Columbia mishap scenario. 6. Is NESC NASA's response to R7.5-1? If not, present NASA's response to R7.5-1 as delineated in R9.1-1.	**CLOSED**
Man-043	**NASA JSC Workforce Stress Level Survey Results, R6.2-1 and R9.1-1**	9.1-1	1. Provide results from 2000 JSC Stress Survey and actions initiated to reduce identified stress levels. 2. Provide results from most recent JSC Stress Survey mentioned in JSC HR e-mail from JSC Center Director, dated 24 October 2003, and any additional actions contemplated to reduce identified stress levels.	**OPEN**
Man-085	**Space Shuttle Systems Engineering Office (MS) Organization, Staffing, and Schedule, R7.5-3 (rolls into R9.1-1)**	9.1-1	1.Identify MS Office organizational structure and list personnel supporting each. Also list contractor and peer groups supporting each office. 2.Provide staffing plans, which identify current and planned personnel needs organized by skill categories, for each of the SE&I organizations. 3. Provide list of Boards, Tech Panels, and Working Groups utilized to resolve SSP integration issues.	**OPEN**

Tech-024	**Vehicle Re-certification & Hardware Qualifications/Certification Limits**	9.2-1	CAIB recommendations 9.2-1 to conduct a vehicle re-certification. SSP action 13 also discusses NASA's plan for hardware to access whether the hardware is being operated within the qualification and certification limits. The Technical Panel would like a briefing describing details of the process and plan for implementing these two activities.	**OPEN**
Ops-077	**10.3-1 Closeout Photography**	10.3-1	1.Review the baseline the new definition of "closeout photography", and the applicability to the vehicle assembly / processing against defined work instructions, and new processes. 2. Review of the requirements, and design specifications for the SIMS software indexing changes that reflect the requested improvements stated in the implementation plan. Schedule for accomplishing these activities is to be supplied as the first deliverable item, and is due 2 weeks after acceptance of this action.	**OPEN**
Ops-078	**10.3-1: Close Out Photography Processes – Integration of JSC and MSFC Work Processes**	10.3-1	1.Review of requirements and work processes from JSC and MSFC. Document and / or resolve any discrepancies or conflicts affecting these work documents. 2. Provide sufficient evidence that the MMT / MER staff can access the SIMS database in a timely manner from all required locations.3.Define any process / tool improvements that will be accomplished after the RTF milestone has been passed. 4. Provide schedule for training of MER and MCC personnel on SIMS usage.	**OPEN**
Ops-079	**10.3-1: Close Out Photography Processes – Documentation and Schedule for Improvements**	10.3-1	1.Document the results of the KSC lead Photo Team evaluation of the KSC equipment, and develop an implementation plan, and schedule to effect the Team's recommendations before RTF. 2. Closed loop demonstration of the total photography system process to the RTF TG prior to RTF (STS-114). This demonstration would be considered a RTF TG finding.	**OPEN**
Ops-080	**10.3-1: Close Out Photography Processes – Physical Configuration Audit (PCA)**	10.3-1	Review of a typical KSC Problem Report and Maintenance Report package process to assure photos of as Built configuration vs. the Engineering Drawings is acceptable for flight. The metrics of this comparison would be considered an RTF TG finding	**OPEN**
Ops-082	**R10.3-1: MER Usage of SIMS Database for Access to Closeout Imagery**	10.3-1	This RFI documents a Fact Finding meeting being arranged between MER folks (MV6/D. Moyer and SX/D. Smith) and Ops Panel members to discuss MER usage of the SIMS database to access Shuttle closeout imagery. Past experience, issues with user interface and access and involvement in KSC efforts to enhance access capabilities will be discussed. Any other imagery databases planned for use by the MER will also be discussed.	**CLOSED**
NONE-040			NO # 40 RFI Omitted by mistake	**N/A**

Appendix F - Process for Review, Signature, and Closure



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Appendix G - Request for Information Process (RFI) Flow

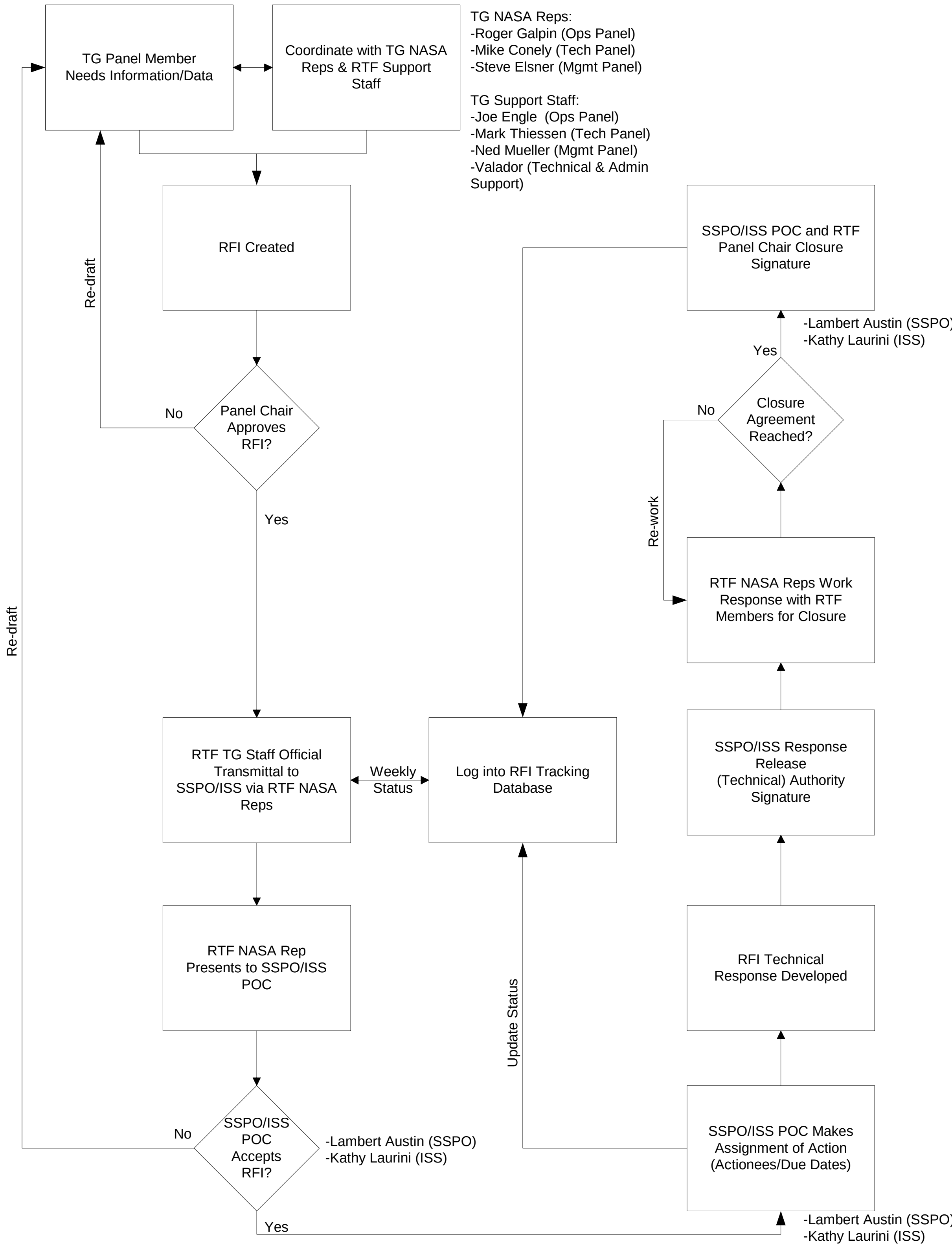
Figure 1 illustrates the process flow for RTF TG members to request information from NASA/contractors. This includes both the SSPO and ISS Office. When a TG member identifies a need for information, the NASA Panel representatives assigned to the RTF TG and the RTF TG Advisory Staff should be consulted about the request. In some cases, an official RFI might not need to be created, i.e., an existing event or meeting. However, once consultation is done and a request is still considered valid, an RFI will be created. Figure 2 illustrates the RFI form. Upon completion of the form, the RFI must be signed by the appropriate TG Panel Chairman and NASA Panel representative. At this point, the RFI is considered official and will be released to either the SSPO or ISS Office as appropriate. Concurrent with release to NASA, the RFI is logged into a tracking database maintained by RTF TG staff. The database will be used to keep track of the status of each RFI and maintain a centralized location for close out. RTF TG staff will coordinate with NASA Panel Representative and/or Points-of-Contact (POC) to track due dates, actionees, and status.

A NASA POC has been identified for both the SSPO and ISS Offices. All RFI's submitted by the RTF TG will be coordinated through these NASA POC's. The NASA POC's will have the authority to accept or reject the RFI before passing onto the appropriate office. Rejection of an RFI will result in the NASA Panel Representatives reworking the RFI for acceptability. Once the NASA POC accepts the RFI, due dates and actionees are assigned. This information will be fed back to the RTF TG staff for update of the tracking database.

The appropriate actionee(s) will develop the response to an official RFI. A response will only be considered official when signed by an SSPO/ISS Office Release Response (Technical) Authority. At this point, the NASA Panel Representatives will coordinate the official response with the TG member requesting the information.   If the information is deemed acceptable, the NASA POC and the RTF TG Panel Chairman will sign the RFI form for official closure. The RFI form and associated response will then be uploaded to PBMA and the tracking database will be updated. RTF TG staff will also maintain a hard copy library of all RFI's and associated NASA responses.

Appendix G: Request for Information Process (RFI) Flow

Figure 1, RFI Flow



Appendix G: Request for Information Process (RFI) Flow

Date of Request: _____ **RTF Need Date:** _____ **Date Received:** _____	**Return To Flight (RTF)** **Task Group (TG)** **Action/Request for Information**	**Action No:** _____ **Reference No:** _____

Requestor: ____________ Phone: ____________ E-Mail: ____________

Title: ____________

Description:

Response Format: ☐ CD ☐ 3 ½" Disk ☐ Hard Copy ☐ E-Mail ☐ DVD ☐ Presented to: ____________ ☐ Other Explain: ____________ No. of Copies: ____________	**RTF TG Approval of Request:** TG Panel Chair: ____________ Date: ______ NASA Panel Rep: ____________ Date: ______
SSPO/ISS Acceptance: Name: ____________ Phone: ______ E-Mail: ____________	**Action/Data Type:** ☐ Action ☐ Data Request

SSPO/ISS Actionee(s):

Name: ____________ Phone: ______ E-Mail: ____________

Name: ____________ Phone: ______ E-Mail: ____________

Name: ____________ Phone: ______ E-Mail: ____________

Actionee Due Date: ______

SSPO/ISS Response:

SSPO/ISS Response Release (Technical) Authority:

Approval: ____________ Phone: ______ E-Mail: ____________

Closure:

SSPO/ISS: ____________ Date: ______

Signature

Accepted by TG: ____________ Date: ______

Signature

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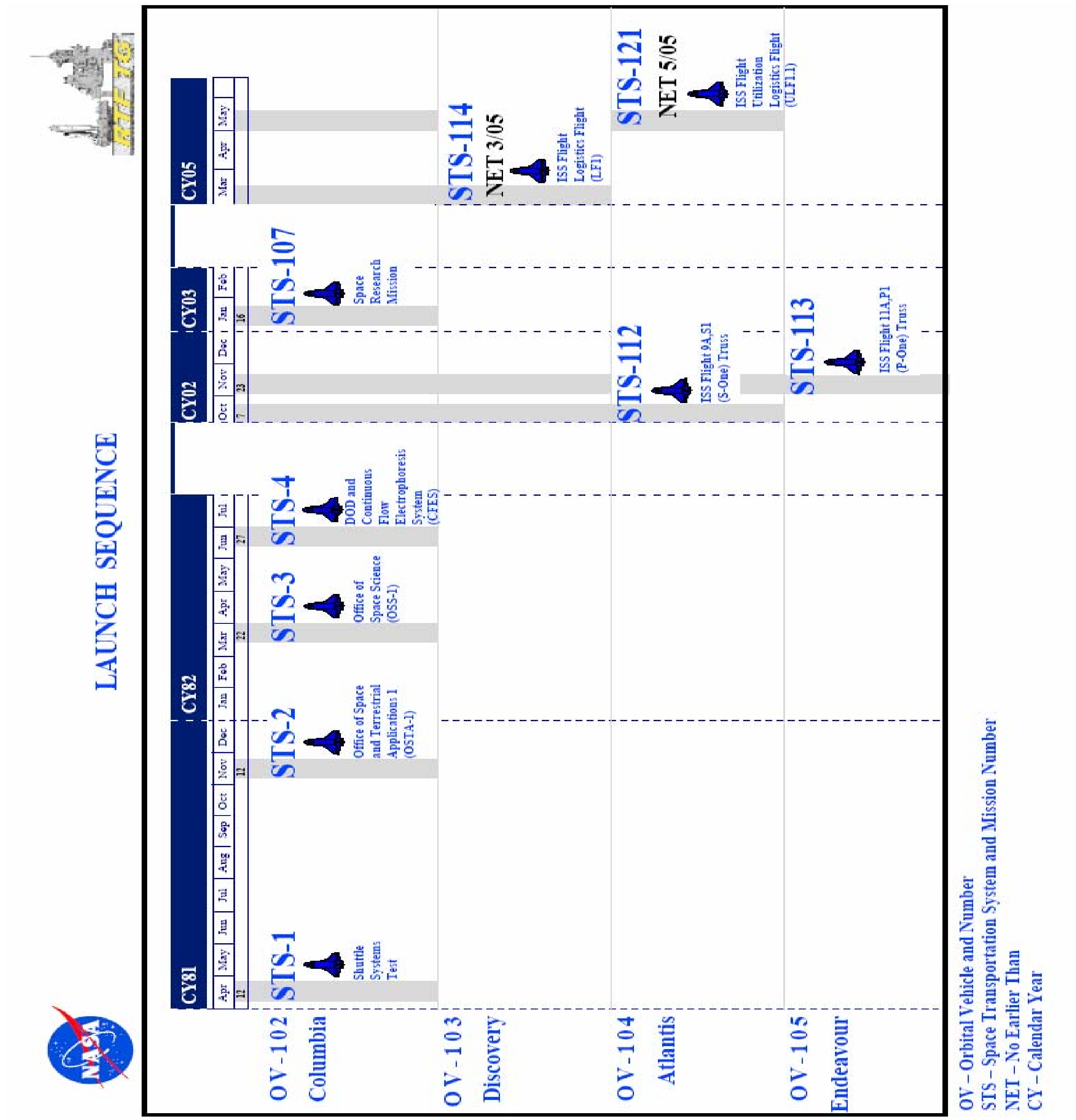
Appendix H – Shuttle Launch Flow - Historical



Appendix I - Acronyms

CAIB	Columbia Accident Investigation Board
CDR	Critical Design Review
ET	External Tank
ETA	External Tank Attachment
EVA	Extravehicular Activity
FACA	Federal Advisory Committee Act
FOD	Foreign Object Debris
FRCS	Forward Reaction Control System
IMMT	International Space Station Mission Management Team
ISS	International Space Station
ITEA	Independent Technical Engineering Authority
JSC	Johnson Space Center
KSC	Kennedy Space Center
L02/LOX	Liquid Oxygen
LH2	Liquid Hydrogen
MLGD	Main Landing Gear Door
MMT	Mission Management Team
MOU	Memorandum on Understanding
MPP	Manufacturing Process Procedures
MSFC	Marshall Space Flight Center
NASA	National Astronautics and Space Administration
NESC	NASA Engineering and Safety Center
NDE	Non-Destructive Evaluation
NDI	Non-Destructive Inspection
NIMA	National Imagery and Mapping Agency
NSI	NASA Standard Initiator
OSF	Office of Space Flight
RCC	Reinforced Carbon-Carbon
RFI	Request for Information
RTF TG	Return to Flight Task Group
S&MA	Office of Safety and Mission Assurance
SE&I	Systems Engineering and Integration
SFLC	Space Flight Leadership Council
SIMS	Still Image Management System
SRB	Solid Rocket Booster
SSPO	Space Shuttle Program Office
TPS	Thermal Protection System
USA	United Space Alliance
WLE	Wing Leading Edge

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