Return to Flight Task Group

Plenary and Public Meeting

June 6-8, 2005
Houston, Texas

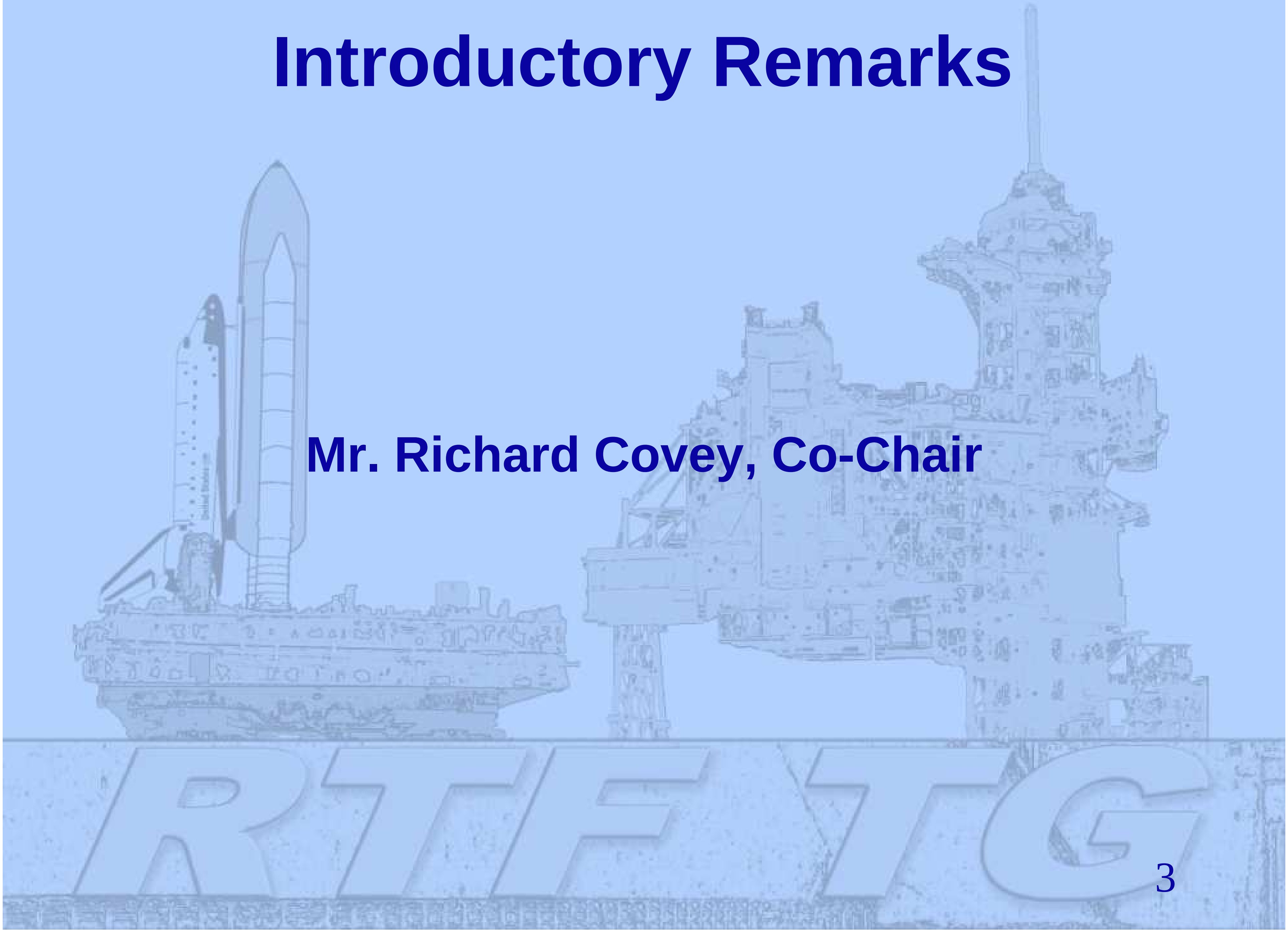
Public Meeting Agenda

June 8, 2005

Webster Civic Center, Webster Texas

- **0800 – 0805** **Administrative Remarks:**
  Mr. Vincent Watkins – Executive Secretary
- **0805 – 0810** **Introductory Remarks:**
  Mr. Richard Covey – Co-Chair
- **0810 – 1010** **Management Panel Fact-Finding Status**
  Dr. Dan Crippen
- **1010 – 1120** **Operations Panel Fact-Finding Status**
  Mr. James Adamson
- **1120 – 1140** **Technical Panel Fact-Finding Status**
  Mr. Joseph Cuzzupoli
- **1140 – 1150** **Action Item Summary and Closing Remarks**
  Mr. Richard Covey – Co-Chair

Introductory Remarks



Mr. Richard Covey, Co-Chair

Management Panel Fact-Finding Status

Dr. Dan Crippen, Lead

Management Panel
CAIB Recommendations

6.3-2 NASA/NIMA MOA
Closed December 2004

6.2-1 Scheduling and Resources

6.3-1 MMT Improvements

9.1-1 Organization

7.5-1 Independent Technical Authority

7.5-2 S&MA Organization

7.5-3 Shuttle Integration Office Reorganization

Management Panel
Acceptance Recommendation

R6.2-1 Consistency with Resources

Maj. Gen. Bill Anders

6.2-1 – Consistency with Resources

CAIB Recommendation

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.

6.2-1 – Consistency with Resources

RTF TG Interpretation

CAIB explicitly recognized the legitimacy of using 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. In the case of Columbia, CAIB discovered schedule pressure on the Shuttle was created by the schedule for construction of the International Space Station (ISS). Indeed, the February 2004 scheduled completion of Node 2 of ISS was being touted as a measure of NASA's ability to maintain a schedule.

CAIB further observed budget constraints inherently intensify conflicts between schedule and safety. The meaning of the first sentence of the CAIB recommendation is clear: adjust the schedule to fit available resources.

6.2-1 – Consistency with Resources

NASA Implementation

- More routinely assess schedule risks and incorporate more margin into the schedule and manifest to accommodate changes.
- Shuttle Processing and USA Ground Operations Management will use the Equivalent Flow Model to plan resources.
- Developed Manifest Assessment System for Shuttle launch schedules.
- Accountability for ISS and SSP moved from JSC to Deputy Associate Administrator for ISS/SSP's along with authority to establish requirements and direct program milestones and assign resources, contract awards, and contract fees.
- Quarterly Program Management Reviews established to assess program and project technical, schedule, and cost performance against an established baseline.

6.2-1 – Consistency with Resources

<u>Panel Assessment</u>

- **Resource Constraints.**
  - **Not an apparent factor in NASA's RTF response.**
  - **Issue will likely pressure future programs (e.g., remainder of SSP/STS and President's Vision).**
- **In retrospect, expanding RTF technical challenges, coupled with aggressive scheduling, possibly precluded more appropriate and time consuming approaches to RTF.**
- **NASA must address size and skill mix of future workforce.**
- **There will always be pressure for under budgeting and overly aggressive scheduling that must be recognized and mitigated by senior leadership.**

6.2-1 – Consistency with Resources

RTF TG Recommendation

- **Accept NASA Implementation of CAIB 6.2-1**

Management Panel Acceptance Recommendation

R6.3-1 Mission Management Team Improvements

Mrs. Susan Livingstone

6.3-1 – MMT Improvements

CAIB Recommendation

"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."

6.3-1 – MMT Improvements

RTF TG Interpretation

MMT activities during the flight of Columbia (STS-107) were strongly criticized by the CAIB. 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 needed to exercise these many new sources of data and information.

6.3-1 – MMT Improvements

NASA Implementation

NASA formed a team in 2003 to address the recommendation. Changes have been made to NSTS 07700 and other documents redefining MMT training requirements, processes, organization, and roles and responsibilities. Corrective actions have focused on both individual and team effectiveness. A formal MMT Training Plan has been established to certify MMT members and provide annual requalification. Numerous training sessions have been conducted to include 13 MMT simulations. Evaluation and lessons learned processes are in place and need to mature. Documentation of new MMT requirements is progressing well, to include TPS Assessment OIP and MMT-IMMT interfaces. MMT logistics support has been significantly improved.

6.3-1 – MMT Improvements

RTF TG Fact Finding and Assessment

Fact Finding:

- RTF TG trips, meetings, reports
- RTF TG additional closure criteria and documentation recommendations (11/04)
- Final NASA 6.3-1 closure package (submitted 3/7/05) – Updates prior to RTF

Assessment:

- NASA implementation meets CAIB intent
- STS-114 launch delay has resulted in continual MMT improvement

6.3-1 – MMT Improvements

RTF TG Recommendation

- **Accept NASA Implementation of CAIB 6.3-1**

Management Panel
Acceptance Recommendation

9.1-1 Detailed Plan for Organizational Change

Dr. Dan Crippen

9.1-1 Detailed Plan for Organizational Change

CAIB Recommendation

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.

7.5-1 Independent Technical Engineering Authority

CAIB Recommendation

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 systems.
- Conduct integrated hazard analysis.
- Decide what is and is not an anomalous event.
- Independently verify launch readiness.
- Approve the provisions of the certification 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.

7.5-1 Independent Technical Engineering Authority

RTF TG Interpretation

Many of CAIB's SSP organization observations are reflected in this recommendation. CAIB observed critical technical requirements are routinely waived and concluded 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:

F7.4-2 Safety and Mission Assurance organizations supporting the Shuttle Program are largely dependent upon the Program for funding, which hampers their status as independent advisors.

F7.4-4 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.

F7.4-12 The dependence of Safety, Reliability & Quality Assurance personnel on Shuttle Program support limits their ability to oversee operations and communicate potential problems throughout the organization.

7.5-1 Independent Technical Engineering Authority

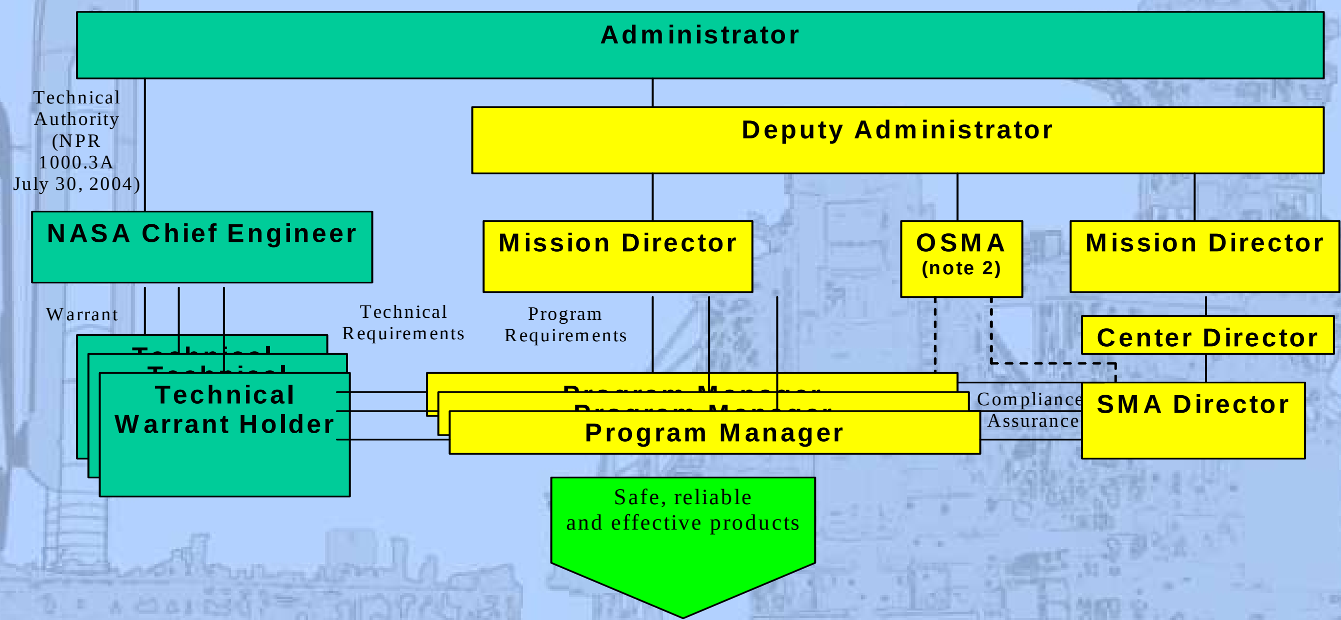
NASA Implementation

NASA is implementing an ITA which has the responsibility, authority and accountability to establish, monitor and approve technical requirements, products and safety. The NASA Chief Engineer, as the ITA, will govern and be accountable for technical decisions that affect safe and reliable operations and will use a warrant system to further delegate this technical authority. The Technical Warrant Holders (TWH's) will be proven subject matter experts with mature judgment who will operate with a technical authority budget that is independent from Program budgets and authority.

In the role of ITA, the NASA Chief Engineer also is charged with developing a technical conscience throughout the engineering community, that is, personal responsibility to provide safe technical products coupled with an awareness of avenues available to raise and resolve technical concerns.

7.5-1 Independent Technical Engineering Authority

Technical Authority Flow



Notes: 1) Technical Authority flow for the NASA Chief Health and Medical Officer, as the NASA Technical Authority for all health and medical requirements, is similar to that of the Chief Engineer.
2) The NASA Chief Safety and Mission Assurance Officer, as head of the OSMA, is accountable to the Deputy Administrator for providing leadership, policy direction, functional oversight, assessment and coordination for all Safety Assurance and Mission Assurance processes and products.

Figure 12 – Technical Authority Flow (NASA)

7.5-1 Independent Technical Engineering Authority

NASA Implementation (continued)

The five key principles which govern the ITA are:

1. Must reside in an individual, not an organization;
2. Is clear and unambiguous regarding authority, responsibility, and accountability;
3. Is independent of Program Management;
4. Is executed using credible personnel, technical requirements, and decision-making tools; and
5. Makes and influences technical decisions through prestige, visibility, and the strength of technical requirements and evaluations.

7.5-1 Independent Technical Engineering Authority

NASA Implementation (continued)

The NASA Engineering and Safety Center (NESC) was conceived by the Administrator before finalization of the CAIB report, was chartered in the fall of 2003 and formally opened its doors on November 1, 2003. Initially, NESC reported to the Office of Safety and Mission Assurance SMA) at Headquarters but was subsequently reassigned to the Chief Engineer. NESC will provide support to the Chief Engineer to perform ITA activities as well as house a number of warrant holders.

7.5-1 Independent Technical Engineering Authority

Panel Assessment

- Construct fully consistent with CAIB's recommendation.
- Some details of implementation have yet to be worked out, especially roles and responsibilities of ITA relative to SMA and SEIO.
- While a number of Technical Warrant Holders (TWH's) have been designated, not all will be in place before RTF.
- While the Task Group has not imposed it as a condition for completion of our assessment, we expect the ITA to issue a report on the status of waivers prior to RTF.

7.5-2 Safety and Mission Assurance Organization

CAIB Recommendation

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.

7.5-2 Safety and Mission Assurance Organization

RTF TG Interpretation

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

Among the CAIB findings supporting this recommendation are:

- **F7.4-1 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 Roger's Commission recommendation.**
- **F7.4-2 Safety and Mission Assurance organizations supporting the Shuttle Program are largely dependent upon the Program for funding, which hampers their status as independent advisors.**
- **F7.4-12 The dependence of Safety, Reliability & Quality Assurance personnel on Shuttle Program support limits their ability to oversee operations and communicate potential problems throughout the organization.**

7.5-2 Safety and Mission Assurance Organization

NASA Implementation

- Independent safety organizations reporting directly to the Center Directors have been established at all Space Flight Centers.
- Chief SMA Officer (Headquarters position) has concurrent authority over selection, relief, and performance evaluation for key safety personnel at the Centers, lead SMA managers for major programs including Space Shuttle and ISS, and Directors of the Independent Verification and Validation Center; and is a voting member of the Institutional Council (Headquarters committee allocating overhead funding).
- Chief SMA Officer provides an annual formal “functional performance evaluation” on Center Directors and Center SMA personnel to their Headquarters Center Executive.
- Center Directors and their SMA Directors will have “suspension authority” applying to any program, project, or operation conducted at that Center or under the Center’s oversight, whether or not that Center has programmatic responsibility.

7.5-2 Safety and Mission Assurance Organization

NASA Implementation (continued)

- Headquarters Office of SMA is developing an enhanced process for review and assessment and a capability for performing more in depth compliance audits with requirements critical for safety and mission success.
  - In response to CAIB's concern over lack of mainstream system safety engineering, the audit plan will include an assessment of the adequacy of system safety engineering in audited projects and/or line engineering organizations.
  - In response to CAIB's concern regarding poor safety visibility, SMA has staffed a full-time experienced System Safety Manager as the NASA's dedicated senior system safety engineering policy expert.
  - Additional auditing will help overcome lack of direct line reporting.

7.5-2 Safety and Mission Assurance Organization

Panel Assessment

- Although CAIB recommended NASA Headquarters Office of SMA "…should have direct line authority over the entire Space Shuttle Program safety organization...", NASA determined it is preferable to Center Directors in the line of authority so they retain some responsibility for safety.
- Rather than comply with this recommendation, NASA has strengthened the role headquarters plays in employment and evaluation of safety personnel, and removed decisions for funding safety activities from the Shuttle Program.

7.5-3 Space Shuttle Integration Office Reorganization

CAIB Recommendation

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

7.5-3 Space Shuttle Integration Office Reorganization

RTF TG Interpretation

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 Project thought it was up to those responsible for the tank to stop the shedding and the Tank Project assumed the shedding 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 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.

7.5-3 Space Shuttle Integration Office Reorganization

NASA Implementation

The Space Shuttle Program (SSP) has established the Space Shuttle Systems Engineering & Integration Office (SEIO):

- **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 Kennedy Space Center (KSC) Launch and Landing Project].**
- **Responsible for:**
  - **Systems engineering and integration of flight performance of all Space Shuttle project elements.**
  - **All System Integration Plans and Master Verification Plans, as well as the Space Shuttle Flight Software organization.**
- **Reports directly to the SSP Manager (Space Shuttle Vehicle Engineering Office became the Orbiter Project Office and its charter has been amended to show SEIO is now responsible for integrating all flight elements.**

Reorganized and revitalized Integration Control Board (ICB):

- **Orbiter changes that affect multiple elements must now go through the ICB.**
- **Orbiter changes for return to flight affecting multiple elements not previously reviewed and approve by the ICB, will be routed from the Program Requirements Control Board back through the ICB.**

7.5-3 Space Shuttle Integration Office Reorganization

NASA Implementation (continued)

All SSP functions at Marshall Space Flight Center, KSC, and Johnson Space Center coordinated through and receive technical direction from SEIO.

SEIO responsible for all the Design Certification Reviews (DCR's) conducted before return to flight.

Draft Systems Engineering Management Plan (version 4) completed.

7.5-3 Space Shuttle Integration Office Reorganization

Panel Assessment

- NASA and the Shuttle Program greatly enhanced the reach and responsibilities of SEIO within the program.
- Additional resources and personnel were added and new processes instituted.
- Integration function was improved and coordination between program elements is more common.
- Weaknesses remain in systems engineering function and processes.
- Task Group and other outside observers have faulted NASA for inadequate documentation.
- SEIO's management of the DCR/DVR process for RTF has been inconsistent.
- Development of analytical models has not adhered to normal process and rigor.

9.1-1 Detailed Plan for Organizational Change

Panel Assessment

- CAIB required only a plan to implement the 7.5 series of recommendations before RTF.
- With the passage of time, however, the NASA Administrator announced his desire to have elements of R9.1-1 implemented, at least for the Shuttle Program, before RTF.
- NASA's implementation thus far of R7.5-1 (ITA) is consistent with CAIB's intent.
- NASA strengthened OSMA role in safety personnel selection and removed funding decision from SSP but chose not to fully comply with CAIB's intent on R7.5-2 (SMA) in order to ensure Center Directors' safety responsibility.
- While the integration function of R7.5-3 (SEIO) has been enhanced, weaknesses remain in the systems engineering function and processes.
- Increased involvement by NASA leadership required to enhance the validity of these organizational changes, particularly systems engineering and integration.

9.1-1 Detailed Plan for Organizational Change

RTF TG Recommendation

- **Accept NASA Implementation of CAIB 9.1-1**

Operations Panel
Fact-Finding Status

Col. James Adamson, Lead

Operations Panel
CAIB Recommendations

3.4-1 **Ground-Based Imagery**
Conditionally Closed December 2004

3.4-2 **High-Resolution Imagery of External Tank (ET)**
Closed December 2004

3.4-3 **High-Resolution Imagery of Orbiter**

4.2-5 **KSC Foreign Object Debris (FOD)**
Closed December 2004

6.4-1 **Thermal Protection System (TPS) Inspection and Repair**

10.3-1 **Digitize Close Out Imagery**
Closed December 2004

SSP-3 **Contingency Shuttle Crew Support (CSCS)**

Operations Panel

R3.4-1 Ground-Based Imagery

Mr. Bob Sieck

3.4-1 Ground-Based Imagery

CAIB Recommendation

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 for additional views of the Shuttle during ascent.

3.4-1 Ground-Based Imagery

Background

- Ground Camera Sites
  - Ten new sites and two high altitude aircraft have been added/activated
  - HDTV has been added for quick look analysis to most sites
  - Training, use in simulations and other range operations ongoing
  - Site preparation essentially complete for STS-114

3.4-1 Ground-Based Imagery

Background

- **Recommendation was Conditionally Closed in December, 2004**
- **Open items were identified in RFIs Ops-070 and Ops-071**
  - **Documentation of camera technical requirements**
  - **Documentation of required camera sites**
  - **Documentation of responsible organization(s) for camera sites launch preparation – status reporting and certification of readiness**

3.4-1 Ground-Based Imagery

Panel Assessment

- **Documentation of launch requirements complete**
  - **Kennedy Space Center Program Requirements Document (PRD) selected to contain all ground camera requirements**
    - An assessment of which camera assets provide what views was included in the PRD which may be used to determine the impact of a camera asset failing during the launch countdown
  - **Launch procedure contains reporting protocol**
  - **Launch Commit Criteria approved for Pad Camera Power System**

3.4-1 Ground-Based Imagery

Recommendation

- **Assessment is complete and NASA has met the intent of CAIB Recommendation 3.4-1**

3.4-1 Ground-Based Imagery

Observations

- The approach to documenting the requirements provides launch management awareness of the status of these assets; however, it does not require a Launch Commit Criteria waiver to proceed with less than three useful views.
- The Shuttle should be treated as a developmental vehicle with its performance measured for all missions. Ground imagery has proven to be a useful tool for assessing the performance of the Space Shuttle during launch and ascent. Since a substantial amount of funds were expended to improve the ground-based imagery, NASA should retain these assets for the duration of the Space Shuttle Program.

Operations Panel

R3.4-3 On-Orbit Imagery

Mr. Robert Sieck

3.4-3 On-Orbit Imagery

CAIB Recommendation

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.

3.4-3 On-Orbit Imagery

NASA Implementation

- Primary method for imaging the wing leading edge will be via the Orbiter Boom Sensor System (OBSS)
- Primary method for imaging the underside of the Orbiter is photography from ISS prior to docking
- The capabilities were defined within the context of CAIB Recommendation 6.4-1
- To provide supplemental engineering ascent data to identify potential debris sources, NASA will fly
  - ET Camera, mounted on Liquid Oxygen (LOX) Feedline Fairing to view the underside of the Orbiter from the forward ET attach point
    - Data available real-time
  - Cameras mounted on each Forward SRB segment to view ET intertank areas
    - Data available after SRB recovery

3.4-3 On-Orbit Imagery

NASA Implementation

- There are two sensor packages on the OBSS that will be used to image the orbiter on-orbit
  - Sensor Package 1 (Laser Dynamic Range Imager (LDRI)) will accomplish wing leading edge lower surface and apex imagery
  - Sensor Package 2 (Laser Camera System (LCS)) was added as an improved resource to capture imagery of the nosecap
- LDRI and LCS have produced high resolution imagery under laboratory conditions (0.25 in. holes, 0.015 in. cracks and 0.125 in. holes, 0.25 in. coating loss, respectively)
  - May not be that good on-orbit
- Operational methods planned for STS-114 will optimize scan rates, viewing angle and lighting to the greatest extent practical
- Imagery of the underside of the orbiter will be accomplished with photography from ISS using an R-bar pitch maneuver (RPM) during approach to docking
  - Focused inspection of the orbiter can be accomplished within system limitations using LDRI or LCS as required

3.4-3 On-Orbit Imagery

Panel Assessment

- Forward Work
  - Analysis of Dynamic LDRI cable clearance with orbiter radiator and CMG payload
  - System Acceptance review for Sensor Package 1
  - Waivers to program documents are still being reviewed

3.4-3 On-Orbit Imagery

Recommendation

- Assessment is complete and NASA has met the intent of CAIB Recommendation 3.4-3
  - With the provision that forward work be completed, the intent of this recommendation has been met

3.4-3 On-Orbit Imagery

Observations

- Certified resolution does not meet critical damage size criteria

Operations Panel

SSP-3

Contingency Shuttle Crew Support

Col. Susan Helms

Dr. Amy Donahue

SSP-3 – Contingency Shuttle Crew Support

Raising the Bar Corrective Action

“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 effected.”

SSP-3 – Contingency Shuttle Crew Support

RTF TG Rationale for Assessing SSP-3

- CSCS was not required by CAIB for RTF.
- Section 9.1 of the CAIB report lists the exploration of "all options for survival, such as provisions for…safe havens" as one of several measures for safe flight.
- Section 6.4 of the CAIB report considers the possibility of rescuing a crew with another shuttle.
- NASA decided to consider CSCS as a residual risk mitigator.
- NASA has committed to making a rescue shuttle available within an estimated CSCS duration for STS-114 and STS-121.

SSP-3 – Contingency Shuttle Crew Support

NASA Implementation Plan for SSP-3

- Pursue as an emergency contingency capability.
- Evaluate current Shuttle and ISS support capabilities for crew rescue during a CSCS situation.
- Evaluate ISS fault tolerance requirements during the CSCS duration.
- Assess consumables management.
- Manifest additional logistics for more robust capability.

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment Conditions

- **In order for the Return to Flight Task Group to consider NASA's SSP-3 action closed, NASA should provide clear evidence of the following:**
  1. **Explanation of the role CSCS plays in NASA's risk management framework**
  2. **A dynamic, robust analytic process for estimating available CSCS duration**
  3. **A viable plan for launching a rescue shuttle, including undocking and de-orbiting a damaged shuttle**
  4. **Appropriate integration of CSCS into the launch decision process and relevant documents**
  5. **Appropriate consideration of CSCS in MMT decision process**

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment

- **Condition 1: Explanation of the role CSCS plays in NASA's risk management framework**
  - Addressed in RFI's Ops-111
  - Viable but limited emergency capability
  - Contingency plan of last resort
  - Non-certified
  - Lack of redundancy; zero fault tolerant
  - Not a primary control for the hazard of debris shedding
  - Additional mitigation of residual risk
  - All Shuttle reserves and ISS consumables may be depleted
  - Only applicable to STS TPS anomaly; other system failures not considered
  - Final CSCS decision will be made at the agency level

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment

- **Condition 2: A dynamic, robust analytic process for estimating available CSCS duration.**
  - Addressed in RFI's Ops-108, 109, 111, 112, 016, 017, 018
  - ISS assessed maintaining up to 7 additional people aboard ISS
  - Analysis assumes availability and active management of all Shuttle and ISS resources, but conservative estimates of system viability
  - Assumes that ISS consumables may be run to zero
  - Update to CSCS duration assessment is in work to reflect a July 2005 launch; revised assumptions are being incorporated
  - Duration fluctuates based on ISS system/consumable status
  - Duration may be extended through power-downs, resource-saving measures, additional supplies/spares
  - O2 has been limiting consumable; heavily dependent on CDRA

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment

- **Condition 3: A viable plan for launching a rescue shuttle, including undocking and de-orbiting a damaged shuttle**
  - Addressed in RFI's Ops-105, 110
  - For STS-114 and 121, SSP must be able to launch a rescue mission within ISS engineering estimate of CSCS duration
  - Rescue shuttle would be crewed by 4 and return with the stranded orbiter crew in addition
  - If ISS de-crewing necessary, ISS crew would return via Soyuz
  - Current processing estimate for STS-300 is approximately one month with work acceleration (schedule pressure - increased risk)
  - Since only 1 orbiter can dock to ISS, undock and safe deorbit procedures have been developed and simulated

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment

- Condition 4: Integration of CSCS into the launch process and relevant documents
  - Addressed in RFI's Ops-104, 105, 113
  - CSCS processes are documented in SSP-ISSP MOA
  - Programs jointly analyze and report capabilities at the L-6 months, L-3months, L-1 month, and L-2 week FRR.
  - Updates to the estimate will be provided at the L-2 and L-1 Day MMT, L-9 hour pre-tanking meeting, and final go/no-go for launch poll during the T-9 minute hold
  - No LCC's will be written to automatically abort a launch for late ISS failures which might create a gap in CSCS capability
  - The MMT will assess the impact of any reported failures, and decide whether to continue or scrub the launch

SSP-3 – Contingency Shuttle Crew Support

Panel Assessment

- **Condition 5: Appropriate consideration of CSCS in MMT decision process**
  - **Addressed in RFI's Ops-104, 106, 107**
  - **CSCS implementation would result in serious consequences**
  - **CSCS decision requires commensurate risk to crew survival**
  - **MMT will implement CSCS only upon clear evidence that TPS will not support acceptable reentry**
  - **CSCS recommendation will require assessment of repeating failures that stranded the primary orbiter**
  - **Final CSCS decision will be made at the agency level**
  - **NASA reports that simulations have specifically exercised the decision making process for CSCS (9/04; 11/04; 3/05; 5/05)**

SSP-3 – Contingency Shuttle Crew Support

SSP-3 RFI Status

RFI	Title	Status
016	ISS Consumables, Sparing, Config.	Closed
017	CSCS Data and Supporting Analysis	Closed
018	Safe Haven/Extended Duration Studies	Closed
104	Decision Process/LCC for CSCS & LON	Closed
105	Program and Operations Requirements	Closed
106	CSCS Simulation Plan	Closed
107	MMT Evaluation Process Demonstration	Closed
108	Impacts on ISS Stowage and Habitability	Closed
109	Inter-Program Coordination	Closed
110	CSCS and Undock/Deorbit Procedures	Closed
111	Assessments of Risk and Assumptions	Closed
112	Crew reports with Environment Comments	Closed
113	Role of International Partners	Closed

SSP-3 – Contingency Shuttle Crew Support

Summary

Assessment Condition	RTF TG Fact-finding	Ops Panel Assessment
Risk framework	Complete	Intent fulfilled
Engineering analysis	Complete	Intent fulfilled
Rescue shuttle	Complete	Intent fulfilled
Launch process	Complete	Intent fulfilled
MMT decision process	Complete	Intent fulfilled

SSP-3 – Contingency Shuttle Crew Support

Recommendation

- **Assessment is complete.**

Observation

- **NASA set a Raising the Bar goal for themselves and exceeded it by a significant margin.**

Operations Panel

R6.4-1 TPS Inspection and Repair

Dr. Kathryn Clark

Dr. Charles Daniel

Dr. Kathryn Thornton

6.4-1 TPS On-Orbit Inspection and Repair

CAIB Recommendation

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 when near to or docked at the International Space Station.

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

Accomplish an on-orbit TPS 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 ISS mission fails to achieve the correct orbit, fails to dock successfully, or is damaged during or after undocking.

6.4-1 – TPS On-Orbit Inspection and Repair

RTF TG Interpretation

- CAIB Recommendation 6.4-1 consists of four separate provisions. Although the entire recommendation is labeled Return to Flight, the second and fourth provisions do not apply to STS-114. These provisions are not being considered by NASA or the Task Group.
  - If a non-ISS mission, such as HST Service Mission 4, is added to the flight manifest, the ASAP should review this recommendation.
- NASA must define any damage to tile and RCC that poses an unacceptable hazard to the Orbiter and crew during entry, and be able to detect the location and extent of such damage.
- Each of the repair options in the suite of options that constitutes the repair capability must be sufficiently tested and vetted so that NASA would implement it in an emergency situation with confidence that it would behave as expected

6.4-1 – TPS On-Orbit Inspection and Repair

Panel Status Assessment

- RTF Task Group interpretation of CAIB intent with respect to Recommendation 6.4-1 is divided
- RTF Task Group has revised interpretation to accommodate the majority view; that view will be documented in the upcoming assessment to NASA's response and in our final report
    - Discussion focused on verification and confidence in the expected performance, and whether it constitutes a repair capability versus a 'better than nothing' contingency repair option
- Additional time is required to completely assess the data submitted by NASA for TG consideration
    - The TG will be able to complete and report their assessment at the next plenary/public meeting
- No additional data are expected to be provided by NASA that would modify this assessment

6.4-1 – TPS On-Orbit Inspection and Repair

Recommendation

- Remain open for further assessment

Technical Panel
Fact-Finding Status

Mr. Joe Cuzzupoli, Lead

Technical Panel
CAIB Recommendations

3.2-1 External Tank (ET) Debris Shedding

3.3-1 Reinforced Carbon Carbon (RCC) Structural Integrity
Closed February 2005

3.3-2 Orbiter Hardening

4.2-1 Solid Rocket Booster Bolt Catchers
Closed December 2004

4.2-3 Two Person Closeout
Closed December 2004

6.4-1 Thermal Protection System (TPS) Inspection and Repair

Technical Panel

3.2-1 – External Tank (ET) Debris Shedding

(Status)

Mr. Richard Kohrs

3.2-1 – External Tank (ET) Debris Shedding

CAIB Recommendation

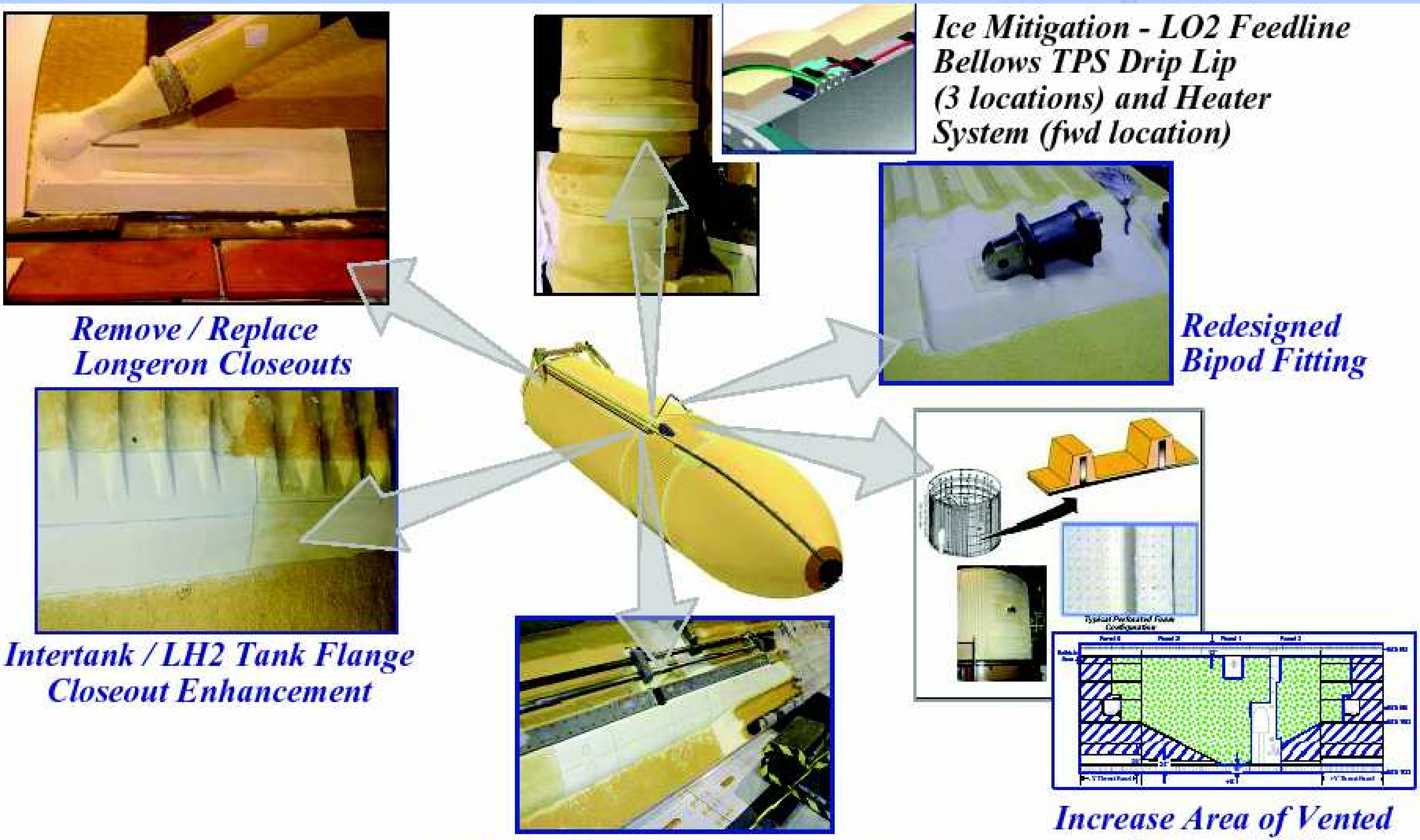
Initiate an aggressive program to eliminate all External Tank Thermal Protection System debris shedding at the source with particular emphasis on the region where the bipod struts attach to the External Tank.

3.2-1 – External Tank (ET) Debris Shedding

RTF TG Interpretation

Eliminate all sources of critical debris including 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.

3.2-1 – ET Design Changes for Debris Reduction



Ice Mitigation - LO2 Feedline Bellows TPS Drip Lip (3 locations) and Heater System (fwd location)

Remove / Replace Longeron Closeouts

Redesigned Bipod Fitting

Intertank / LH2 Tank Flange Closeout Enhancement

Increase Area of Vented Intertank TPS

Partial LH2 PAL Ramp Replacement (required to access underlying flange)

3.2-1 – External Tank (ET) Debris Shedding

- **Status**
  - SSP decided to swap the ET
    - New ET added heaters on forward bellows
    - New ET includes development flight instrumentation

3.2-1 – External Tank (ET) Debris Shedding

- **Open Items**
  - Monte Carlo Assessments of Debris Environment
    - Monte Carlo Assessments resolution at Debris Design Verification Review (DVR) June 24, 2005
  - Resolution of Forward Bellows Ice
    - Installation of bellows heater
      - DCR at MAF on June 20, 2005

3.2-1 – External Tank (ET) Debris Shedding

Summary Status

- **Status**
  - Awaiting closure of Monte Carlo assessment of debris environment at Debris DVR scheduled for June 24, 2005
    - Foam
    - Ice
  - Awaiting Bellows Heater DCR Board at MAF
- **Recommendation**
  - Keep Open

Technical Panel

3.3-2 – Orbiter Hardening

(Status)

Mr. Sy Rubenstein
Mr. Ben Cosgrove

3.3-2 – Orbiter Hardening

CAIB Recommendation

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

3.3-2 – Orbiter Hardening

RTF TG Interpretation

- Initiate a program to increase the Orbiter's ability to sustain minor debris damage. Select and implement changes required for Return to Flight. Define additional changes if required for the balance of the Shuttle program
- Develop a detail test, modeling and analysis program to determine the actual impact resistance of current materials and the effect of likely debris strikes.
- For the first Orbiter returning to flight, a high confidence estimate of the impact resistance of installed material and the effect of likely debris strikes should be known.

3.3-2 - Orbiter Hardening

Summary Status

- **Status**
  - 4 hardware changes installed and will be certified (6/22/05)
  - The tile and RCC impact test programs are complete.
  - Program has moved from the classical deterministic assessment used in certification to a statistical approach in order to better asses risk.
    - Over the course of the last month, various peer reviews of the models, Ice TIMs and Unexpected Debris review have been conducted.
    - Results expected at the 6/24 Design Verification Review
  - TPS Damage Analytical Tools
    - Program currently on schedule to meet 7/13 launch date
    - NESC has been performing extensive review of the models.
      - NESC's major concern has been the end-to-end evaluation of the tools. This will be completed prior to RTF
- **Recommendation**
  - Keep Open

Action Item Summary and Closing Remarks

Mr. Dick Covey – Co-Chair