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THIS LEADING-EDGE KNOWLEDGE IS BROUGHT TO YOU BY
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2011 Executive Edge Workshop A: Creating and Leading Change

Presented by:

Peter Panetta, NASA Headquarters

John Casper, NASA Johnson Space Center

Steve Poulos, NASA Johnson Space Center

Scott Johnson, NASA Johnson Space Center

Moderated by:

Doug Pontsler, Owens Corning

Rich Widdowson, Schneider Electric NA

Introduction

This workshop will focus on leadership, risk management, and the changes required in policy and governance structures to deliver a true high reliability organization focused on operational and safety excellence.

Workshop Leaders

Panelists:

Peter Panetta	Space Shuttle Flight Safety Manager, Office of Safety & Mission Assurance – NASA Headquarters
John Casper	Associate Manager, Space Shuttle Program – NASA Johnson Space Center
Steve Poulos	Deputy Director of Engineering – NASA Johnson Space Center
Scott Johnson	Space Shuttle Program, Chief Safety Officer – NASA Johnson Space Center

Moderators:

Doug Pontsler	VP, EHS – Owens Corning
Rich Widdowson	VP, Safety, Real Estate & Environment – Schneider Electric North America

Workshop Agenda

Item	Time	Description	Responsible
1	5 min	Session Opening & Introductions	Moderator
2	30 min	Core Concept Presentation •Leadership Challenges •Actions Taken •Corrective action systems	NASA
3	60 min	Interactive Workshop •How does normalization of deviance exist in your organizations and what approaches can be used to combat it? •What are the leadership challenges in achieving HRO? •What corrective action and course adjustment systems have you found effective in enabling successful change?	NASA & WCT
4	20 min	Questions to Panel	All
5	5 min	Closing	

Space Shuttle Program

Return to Flight Leadership Challenges

John Casper Nov 2011

RTF Leadership Challenges

- **Return to flight ASAP to preserve ISS and complete assembly**
  - ISS in a vulnerable situation, totally reliant on Russian Progress (cargo) and Soyuz (crew)
  - Shuttle's large up-mass capability was needed to complete ISS assembly
  - Always being about "six months from flight" hurt the RTF planning

- **Convince the team to "Accept, Embrace and Comply" with the CAIB recommendations**
  - Counter to how Challenger recommendations were handled
  - Not everyone in NASA agreed with CAIB findings and recommendations
  - Independent Technical Authority diluted Program Manager's authority

- **Influence and change the culture in a positive way**
  - What really needed changing?
  - What values and attributes should we keep?
  - What do we want our culture to be?

Influence and Change the Culture in a Positive Way

- **What really needs changing?**
  - Engineering rigor, flight or test-based vs. analysis
  - "Staying hungry" to understand the vehicle when flight results don't meet expectations
  - Acceptance of dissent, differing or alternative opinions --- must bring data
  - Better integration of program elements and how they interact
  - Better risk analysis and prioritization across the program
  - Budget allocation process tied to top risk priorities

- **What values and attributes should we keep?**
  - "Can do" attitude, influenced by Mercury, Gemini and Apollo successes
  - Passion for and belief in the importance of human spaceflight
  - Dedication and desire to "do the right thing"

- **What do we want our culture to look like?**
  - Organization that learns from mistakes and grows in understanding
  - Understand risks, but not be risk averse
  - Strong engineering rigor and questioning attitude
  - Nimble decision-making based on facts and data

Organizational Changes

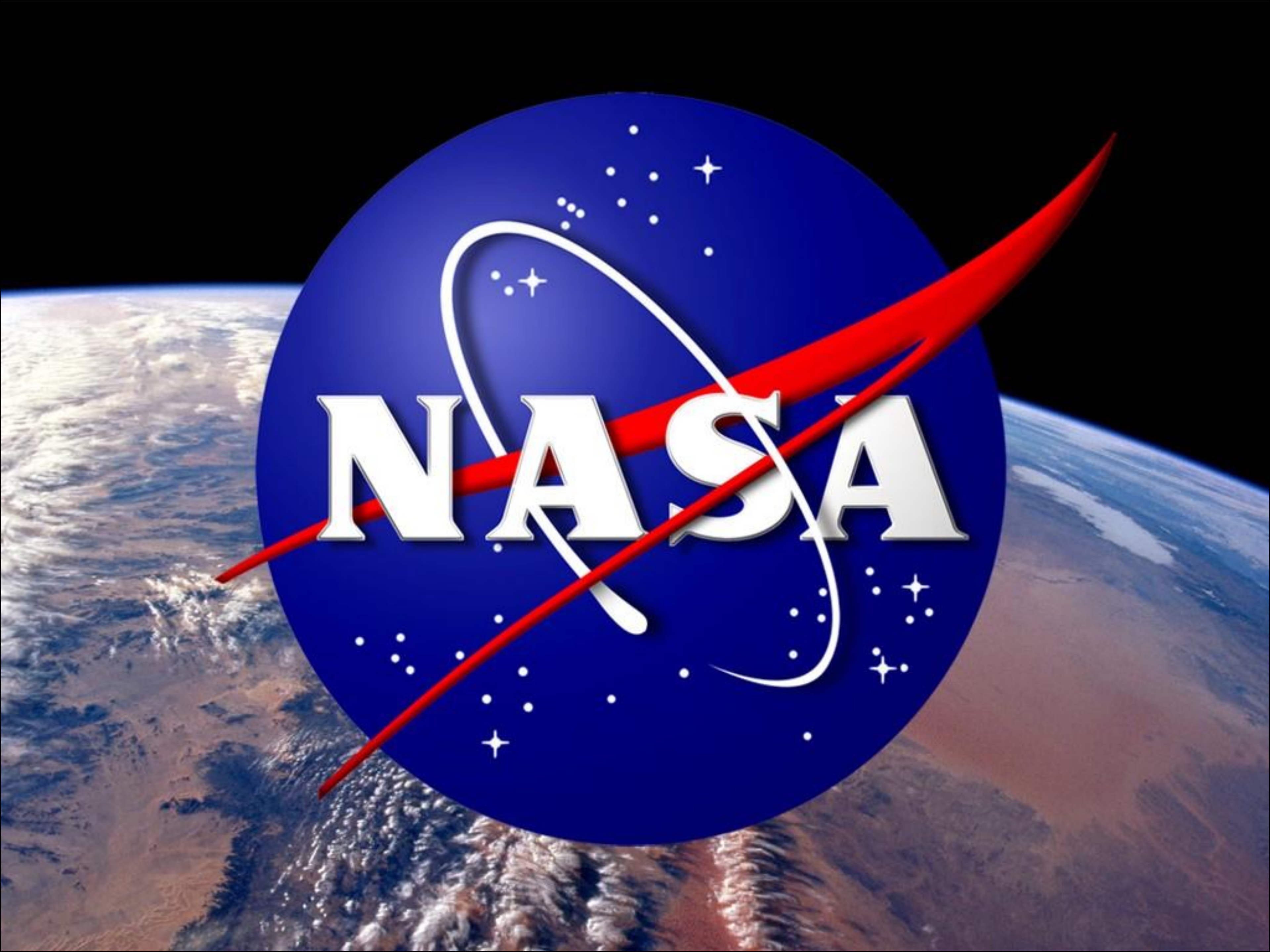
- Systems Engineering and Integration Office
  - Established new office with systems engineering emphasis
  - Authority and accountability for integration of all program elements
  - Reports directly to Program Manager
- Mission Management Team (MMT) – Instituted member training, established certification criteria, began simulations, defined meeting times, documented board members clarified responsibility and authority of MMT
- Independent Technical Authority – Establishes, monitors, and approves technical requirements, processes, products and policy
- Safety and Mission Assurance – Provides leadership, direction, functional oversight, assessment and coordination for the safety, quality and mission assurance disciplines across the Agency

A Few Lessons Learned

- **Tie the budget process to your top risk review**
  - Why do a top risk review? Check a box? Lay awake at night?
  - Answer: to ensure that people and money are deployed in right places
  - Budget review/ reductions should tie back to mission success & safety
  - Budget reviews shouldn’t make arbitrary cuts w/o knowledge of risk

- **Risk acceptance should consider probability of failure**
  - Things that COULD happen can drive enormous costs and workload
  - Price is paid in lost opportunity costs (resources could be better used)

- **Importance of a Systems Engineering & Integration organization**
  - Projects can’t “self-integrate” effectively: Need a technical referee and someone to challenge the project on budget and schedule
  - Problems should be fully integrated before going to the top-level control board
  - Top-level control board should make strategic decisions, not be a data discovery board


NASA

National Safety Council Congress

NASA Recovery from Columbia Tragedy

November 1, 2011

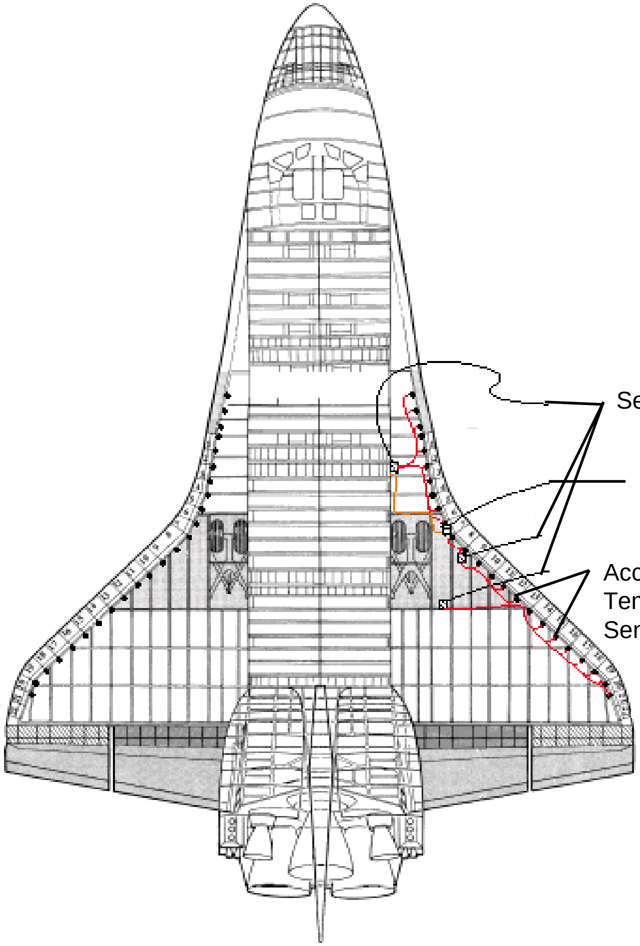
Steve Poulos
Deputy Director, Engineering
Johnson Space Center

Leadership Challenges Post-Columbia

- **Accept, Comply, Embrace**
  - The Agency's response to the Columbia Accident Investigation Board Report, although likely the correct political stance, created an extremely challenging environment
    - Stafford-Covey Return-to-Flight Task Force held the Program and Projects accountable to the literal word for each recommendation
- Although the Orbiter was not associated with the physical cause of the accident, 70% of the recommendations affected the Orbiter Project
- Launch date was always 6 months away
  - Minimum schedule developed in July 2003 indicated 24 months to develop all of the required systems
- Required culture change, and the implementation of "Technical Authority", drove numerous discussions/decisions to higher level control boards
- Detect, inspect, and repair were the technical challenges to return-to-flight


STS-134 Endeavour
Endeavour
RodOstoski.com

Wing Leading Edge Sensors (Impact Detection System)

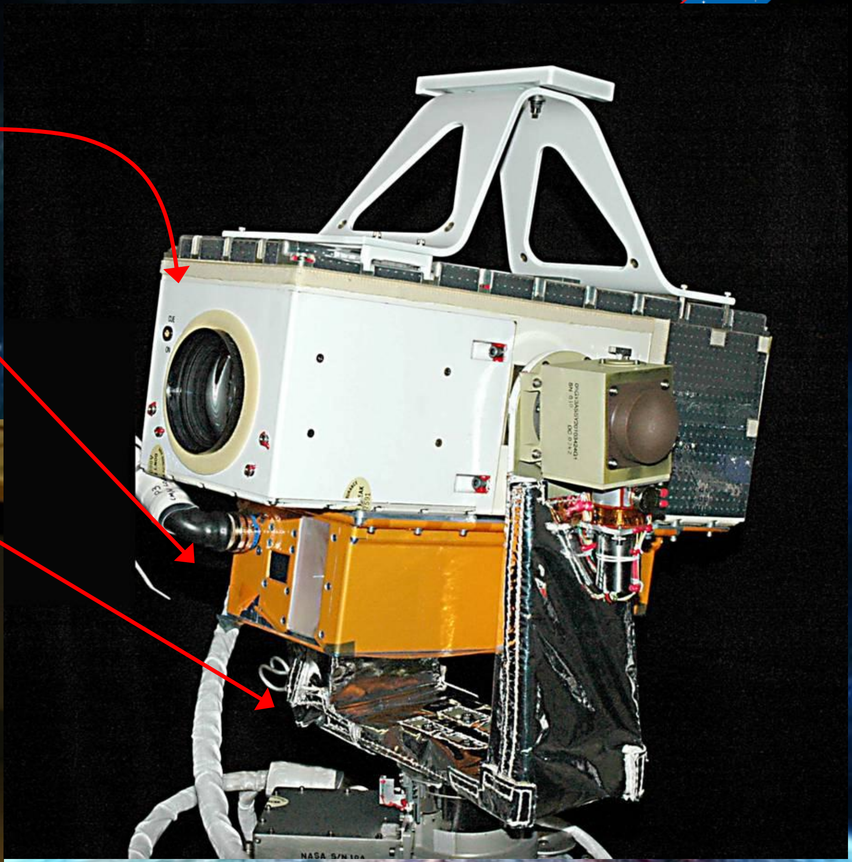


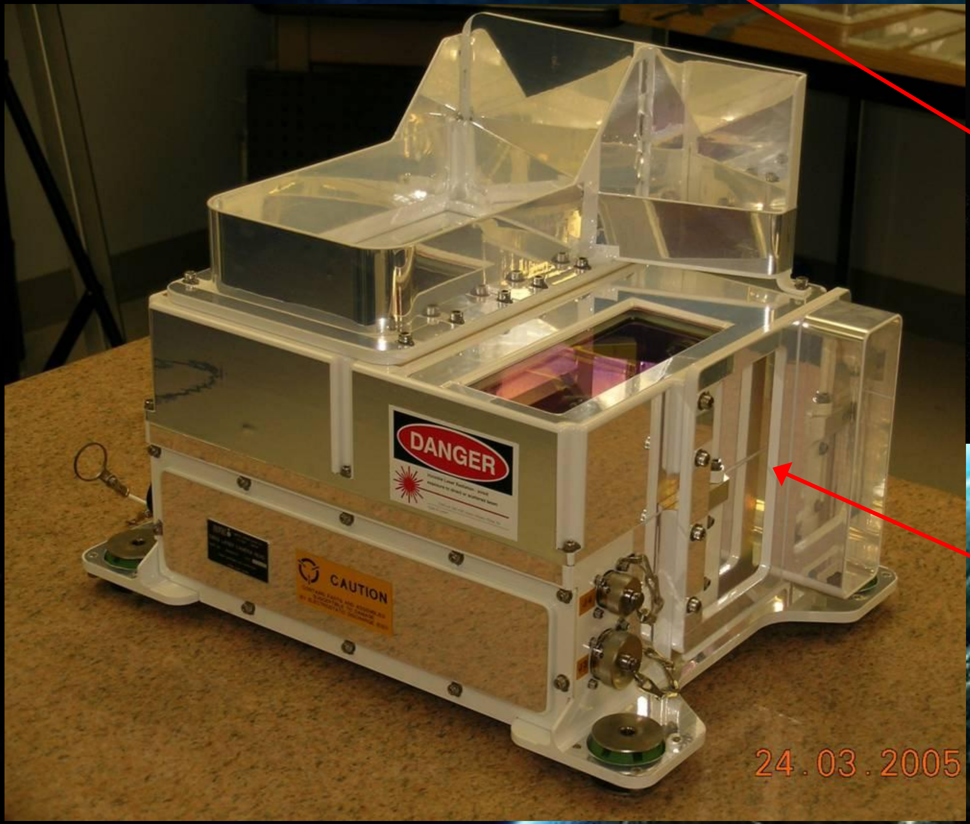
The OBSS was used to inspect the Thermal Protection System, TPS, prior to the Orbiter being docked to the International Space Station. It was also used for inspection and mapping of suspect areas of the TPS while docked.

S114E6310

Orbiter Boom Sensor System Sensor Packages

Sensor Package 1
- Intensified TV Camera
- LDRI – Laser Dynamic Range Imager
- PTU – Pan-Tilt Unit





Sensor Package 2 Assembly
LCS – Laser Camera System

NOAX Reinforced Carbon-Carbon Repair

Frontside Post-Test View of 0.007 inch Slot at 2800F & 100 psf

Frontside Post-Test View of 0.015 inch Slot at 2800F & 100 psf

Frontside Post-Test View of 0.007 inch Slot at 3000F & 148 psf

Frontside Post-Test View of 0.015 Slot at 3000F & 148 psf

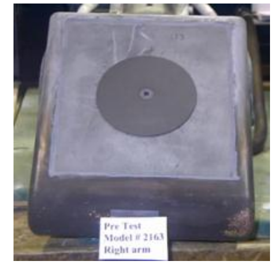
RCC Plug Repair Arc Jet Test Results

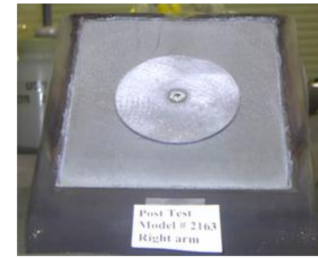
Pretest | Post test

MCM700-coated C/SiC 0.010" gap with no sealant

Max Plug Temp: 3108 ° F

Repair survived 1000 second entry profile with no material degradation





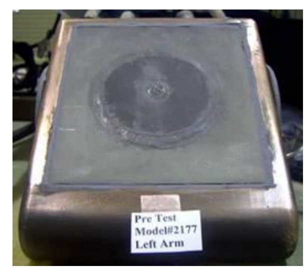
MCM700-coated C/SiC 0.020" gap with no sealant

Max Plug Temp: 3138 ° F

Repair survived 1000 second entry profile with no material degradation

MCM700-coated C/SiC 0.020" gap sealed with Uncured-NOAX

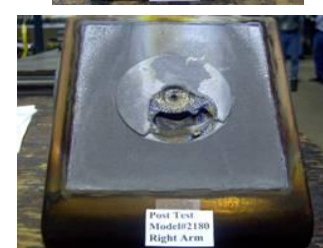
Repair survived 1000 second entry profile with no material degradation. NOAX pyrolyzed at forward edge of plug



MCM700-Coated C/SiC 0.038" gap with no sealant

Edge temps exceeded 4000 ° F at 2800 ° F set point

Sample removed 45 sec. into 2800 ° F set point due to excessive oxidation of plug



Cure-in-Place Ablator Tile Repair

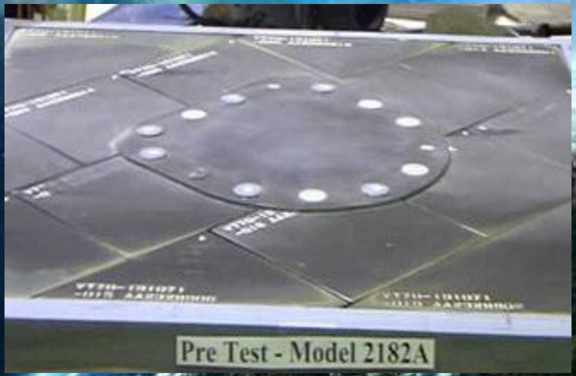
Overlay Tile Repair

Missing Tile Damage

Radiant Heat Protection

Overlay over Damage

Auger Installation



Pre Arc Jet

Post Arc Jet

Scott Johnson
Space Shuttle Program Chief Safety Officer
National Aeronautics and Space Administration

Agenda

I. Return to Flight Roadmap & the Hazard Reduction Precedence Sequence

II. NASA Governance Model – Engineering and Safety Technical Authority Influence on Return to Flight

III. The Role of PRA in the SSP Return to Flight Risk Reduction Effort

IV. Staying Hungry – Space Shuttle Risk Management in the post Columbia Era

RTF Roadmap & the Hazard Reduction Precedence Sequence

Roadmap for Risk Acceptance

Proposed Requirements

Identified debris sources shall not liberate debris in excess of limits established by orbiter damage tolerance and transport models. (NSTS 07700, Vol 10)

The system shall provide the capability to identify critical damage above thresholds established by orbiter damage tolerance assessment through the use of detection and inspection hardware.

The system shall provide the recovery capabilities for damage above thresholds established by orbiter damage tolerance assessment.

Roadmap

Primary Hazard Control

I
Elimination of Critical Debris

Warning Devices

II
Impact Detection During Ascent

III
On-Orbit Debris Impact/Damage Detection

Special Procedures

IV
On-Orbit TPS Repair (Tile & RCC)

V
Crew Rescue

Uncertainties

- Combined environments effects on design changes
- Process/material characterization (statistically based)
  - Limited NDE capabilities
  - Critical debris size/mass
    - Transport analyses
    - Damage tolerance

- Detection capability of cameras and sensors (% coverage, resolution)
- Camera reliability (parts selection, redundancy, analysis vs. test)

- Ability to detect critical flaws (capabilities vs. requirements)
- Reliability of inspection and sensing methods (parts selection, redundancy, analysis vs. test)
- Risk of Collateral damage (OBSS, RMS or crew contact with orbiter)

- Tile repair capabilities/certification
- RCC repair capabilities/availability
- Risk of collateral damage (OBSS, RMS or crew contact with orbiter)

- Processing time for rescue vehicle
- ISS life support capability
- Risk to ISS during undocking damaged orbiter
- Risk to public
- Risk to crew(s)

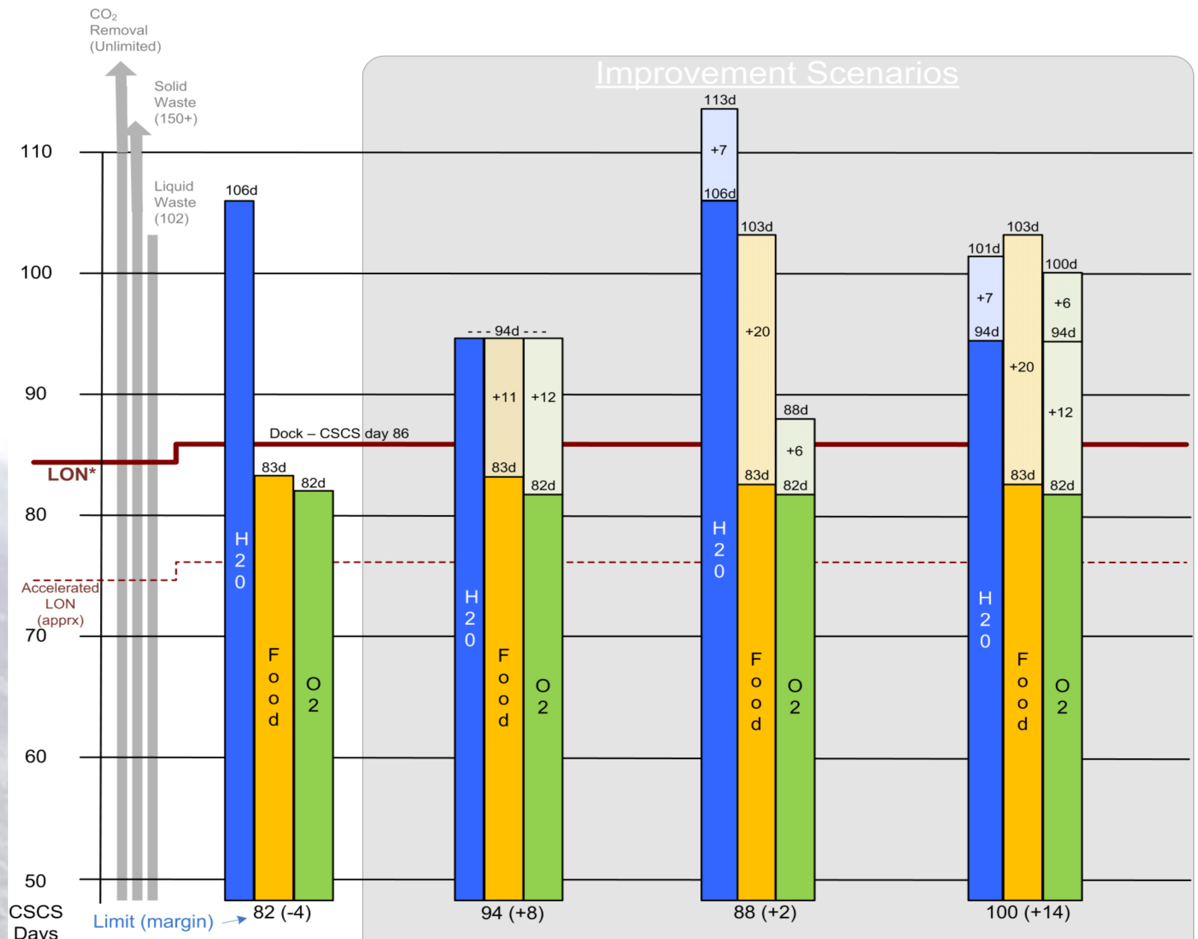
TOP Shuttle PRA Risks

Rank	% of Total	Cumulative Total	Probability (1/n)	Description
1	37.3	37.3	5.1E-03 (1:200)	Micrometeoroid and Orbital Debris (MMOD) strikes Orbiter on orbit leading to LOCV on orbit or entry
2	12.1	49.4	1.7E-03 (1:600)	Ascent debris strikes Orbiter Thermal Protection System (TPS) leading to LOCV on orbit or entry
3	12.0	61.4	1.6E-03 (1:610)	Space Shuttle Main Engine (SSME)-induced SSME catastrophic failure
4	6.0	67.3	8.2E-04 (1:1200)	Crew error during entry
5	4.8	72.1	6.5E-04 (1:1500)	Reusable Solid Rocket Motor (RSRM)-induced RSRM catastrophic failure
6	1.6	73.8	2.3E-04 (1:4400)	Orbiter flight software error results in catastrophic failure during ascent
7	1.3	75.1	1.8E-04 (1:5600)	Ammonia Boiler System (ABS) isolation valve leaks on Orbit overcooling the H20 loops and crew is unable to prevent rupture of the interchanger resulting in Loss of All Cooling
8	1.2	76.3	1.7E-04 (1:5900)	Solid Rocket Booster (SRB) APU shaft seal fracture
9	1.1	77.4	1.5E-04 (1:6500)	SRB booster separation motor debris strikes Orbiter windows
10	1.0	78.4	1.3E-04 (1:7600)	Flow Control Valve (FCV) poppet failure causes rupture in the GH2 re-pressurization line

STS-114 RESULTS
(5^{th} 1:100, Mean 1:73, 95^{th} 1:52)

Crew Rescue Analysis

STS-126 CSCS / LON Overview



Std CSCS Groundrules	**On-Orbit Adjustments**	**31P Adjustments**	**On-Orbit+31P Adjustments**
Limiting Factor(s) Primary – O_2 Secondary – Food Includes: 10-Crew Shuttle Resources SFOG-2 (119)	Mitigation Factors O_2 – OGS Operation Food – rationing can extend food to the 96 day O2 and H_2O limit H_2O – reduced to support OGS ops	O_2 – 6 STS crew-days H_2O – 7.5d Food – 20.5d at nominal 1 ration/crew/day Limiting factor – O_2 Note: Adjustment includes contribution for O_2 and air.	Limiting Factor(s) Primary – O_2 Secondary – H_2O Note: Combines 31P resources with On-Orbit adjustments, but eliminates food rationing.

31P – Launch 11/26/2008 (Day 12)

Oxygen

31P adds 28 kg O2 + 21 kg air = 32.41 kg O2

7 crew, no exercise = 4.3526 kg/day
32.41 kg O2 / 4.3526 kg/day = **7.4 days**

7 crew, nominal = 5.8422 kg/day
32.41 kg O2 / 5.8422 kg/day = **5.5 days**

Note: Assumes the Elektron is providing O2 for the 3 ISS crew members.

Water

Manifested = 210 L
Usage Rate = (2.8 L/crew-day * 10 crew) = 28 L/day
31P adds = 7.5 days for just crew use.

Note: Using H2O for O2 generation will decrease this time.

Food Rations

Manifested = 205* rations
Usage rate = (1 ration/crew-day * 10 crew) = 10 rations/day
31P adds = 20.5 days

Note: Rationing can extend time.

For additional discussion:

Operational
- Early ISS crew return in Soyuz
- Use STS-125 as rescue vehicle
- 31P manifesting changes if CSCS declared prior to 31P launch
- 32P resources – Launches 2/10/2009

Oxygen
- SFOG-3 on-orbit inventory (78)
- Elektron in 50 Amp mode (supports 5 crew members)
- EMU Secondary Oxygen Supplies and main tanks
- Russian Orlan O2 tanks
- US & RS Portable Breathing Apparatuses (PBAs)

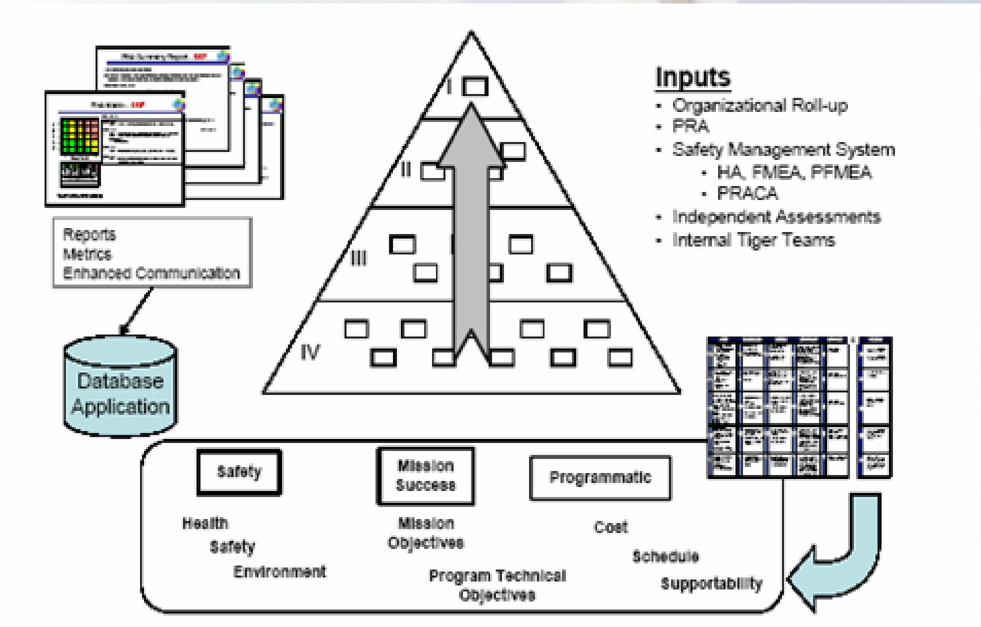
Water
- Condensate water pooled on pressure shells
- Medical saline IVs for hydration

* LON is 86 days from ULF2 launch. "CSCS days" begin at ULF2 dock (launch +2d), so LON is on CSCS day 84.

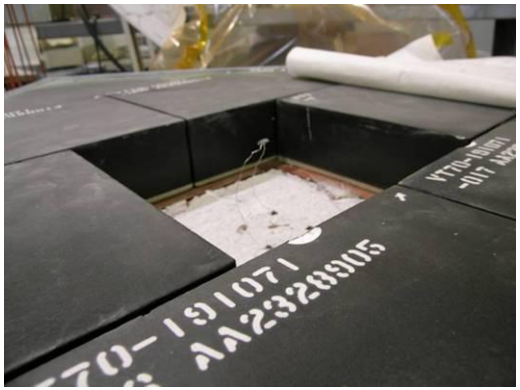
Shuttle Program Risk Management

- A program Risk Manager, and program RM Working Group was established to implement a CRM program and better integrate the various risk identification and assessment activities into a unified and integrated risk management process
  - Program RM focal points established in SSP organizations at JSC, KSC, MSFC to act as RM champions

- A program wide risk review process was established to ensure that risk communication was continuous, that progress was made in retiring risks, and that risk were proactively collected and acted on



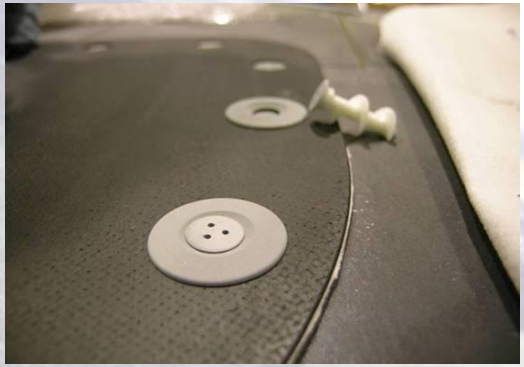
Overlay Tile Repair



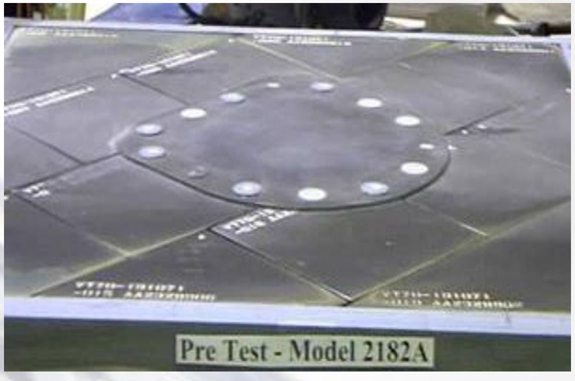
Missing Tile Damage

Radiant Heat Protection

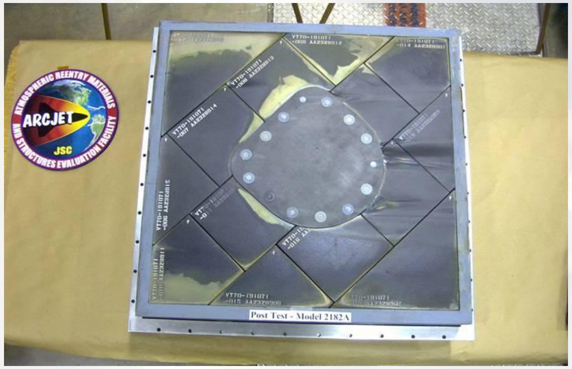
Overlay over Damage



Auger Installation



Pre Arc Jet



Post Arc Jet

What's Next?

Tuesday, November 1, Room 126A+B

3:30 – 5:30 p.m.

Executive Edge Track Workshop B

Sustaining Change:

a Hands-On Look at NASA's Journey

Pre-Registration Required for Workshops.

See Congress Registration Desk for Details.

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