



**SPACE SHUTTLE PROGRAM**  
**Space Shuttle Systems Engineering and Integration Office**  
NASA Johnson Space Center, Houston, Texas



# **STS-120**

## **SSP Flight Readiness Review**

**MS/Don Noah**  
**October 9, 2007**

**Pre-decisional. Internal Use Only.**



## Agenda

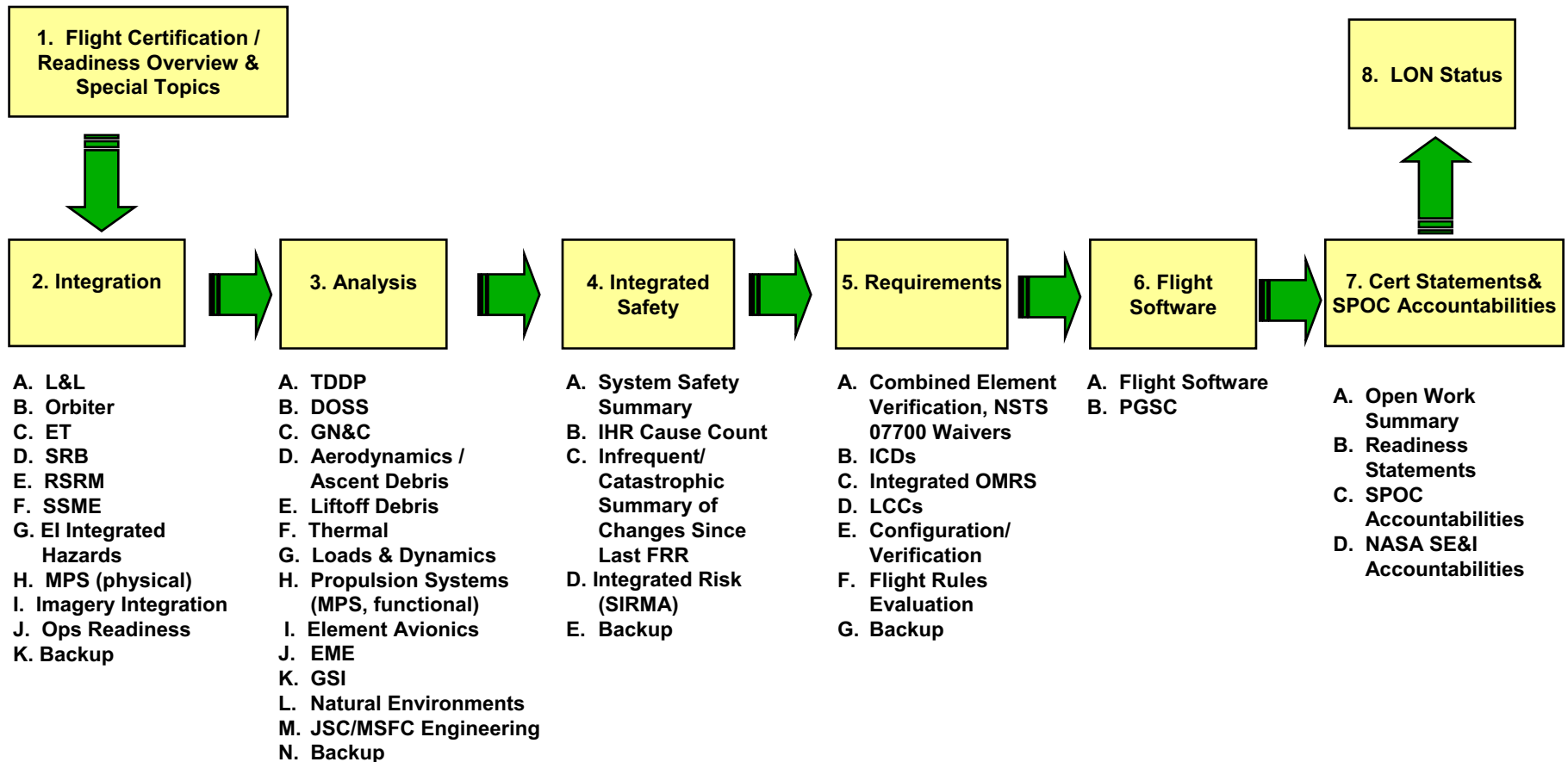
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- **Systems Engineering & Integration**
  - SE&I FRR Roadmap
  - Flight Preparation Readiness
  - Debris Radar
  - Integrated Debris Risk Assessment
  - Flight Software Readiness
  - Payload and General Support Computer Readiness
  - Integrated Hazard Report Changes Summary
  - Integrated In-flight Anomalies (IFAs)
  - Non-Standard Open Work Summary
  - Launch On Need (LON)
  - CoFR Endorsement



# SE&I FRR Roadmap

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## Flight Preparation Readiness

Presenter	MS/Don Noah	
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- **All standard Systems Engineering and Integration flight preparation activities have been completed or are planned. Non-standard open work will be addressed**
  - System requirements verification
  - Design requirements and induced environment updates; verification of element incorporation
  - Integrated vehicle performance evaluation
  - Real-time mission support preparation and certification of personnel as applicable
  - Review and disposition of waivers, deviations, and exceptions
  - Updates to Integrated Hazards baseline
  - Flight Software verification/Payload and General Support Computer (PGSC) Readiness
  - Review of element requirements changes and verifications for integration impacts

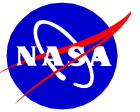


## Debris Radar

Presenter	MS/Don Noah	
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- **STS-118:** Excellent track quality for X1, X4 radars throughout ascent (C-bd unavailable due to site construction)
- X-bd only mission useful for developing X-bd systems
- **STS-120 NDR Configuration:**
  - 1 MCR C-band radar, under Radome
  - 2 NASA X-band radars
    - NASA #1 on SRB vessel *Liberty Star*
    - NASA #2 on *Runnymede-Class* ARMY LCU
- Ascent team training continues for new members
- Orbit team training complete
- NDR Readiness will be reviewed again 10/3/07





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# STS-120 FRR Charts

## Debris Special Topics

James Peters, MS2  
Systems Engineering & Integration Office  
Space Shuttle Program Office  
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<b>Debris Risk Assessment Process Flight-to-Flight</b>		Presenter <b>MS2/Jim Peters</b>	
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# STS-120



# STS-118



Standard Debris Risk Assessment Template

Document the debris releases and vehicle damage  
**(Post Flight Reports)**

Assess what we observed vs. what we expected  
**(NSTS60559 & Flight History)**

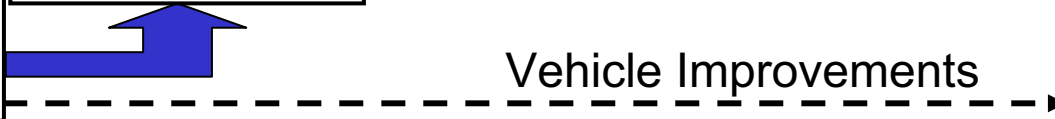
Utilize flight observations and test results to update the release, transport and impact models  
**(Model Updates)**

Update the risk results based on updated model changes and analysis  
**(Results Summary)**

Update the risk acceptance and flight rationale based on updated risk analysis  
**(IDBR-01 Updates)**

Debris Risk reduction from debris source elimination, redesign and mitigation

Vehicle Improvements





## STS-118 Debris Summary

Presenter MS2/Jim Peters

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- The “rebound/mixed” debris impact observed on STS-118 illustrates that “uncharacterized debris events” are possible
- 5 STS-118 Debris IIFAs
  - STS-118-I-002: LO2 Feedline Bracket Loss
  - STS-118-I-003: ET Foam Acreage Loss
  - STS-118-I-004: Partial Tyvek Cover Release
  - STS-118-I-005: Rope-like objects flapping near aft LSRB & RSRB nozzle
  - STS-118-I-001: Liftoff Debris – Closed based on mitigations and controls
- Orbiter TPS damage
  - The amount of Orbiter TPS damage >1” was larger than the previous 5 flights
  - The TPS damage in terms of volume loss exceeded the new control limit established since RTF
    - Consistent with LO2 Feedline bracket “mixed” impact



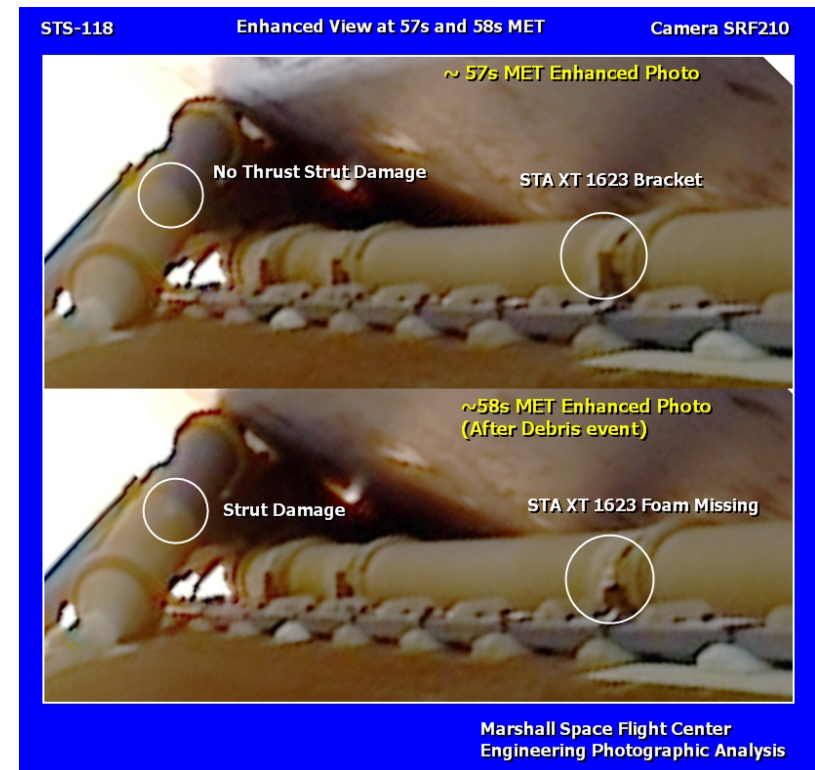


## STS-118-I-002: LO2 Feedline Bracket Loss

Presenter MS2/Jim Peters

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- 60559 Source ID: ET-COMP5-010-01-A:
- 60559 Mass: 0.037 lbm
- Est. mass: 0.023 lbm (Foam only estimate). Possible ice/SLA liberation (imagery inconclusive)
- Location: Xt1623 on Outboard LO2 Feedline Bracket
- Time of release: 58 seconds
- Cause: Mechanically induced cracking (due to cracked SLA & ice bridging) leading to liberation by aeroshear. Mass of loss is inconsistent with observed Orbiter tile damage when compared against current foam/tile testing (Mixed debris event)
- Mitigation/Closure Plan: LO2 Feedline Bracket Yoke modification (Removal of SLA) being performed on ET-120 and subs.

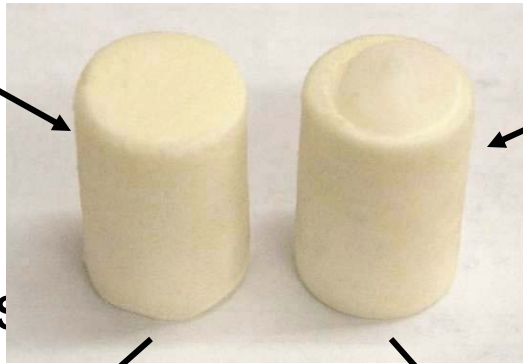




Investigation of STS-118 Damage: "Mixed" Debris Impact Demonstration Test		Presenter MS2/Jim Peters	
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• **BX-265 Foam Only**

- 0.001 lbm cylinder
  - 0.89" OD x 1.3" length
- $V_{\text{impact}} = 1160 \text{ fps}$
- 40° impact angle
- Aged tile target

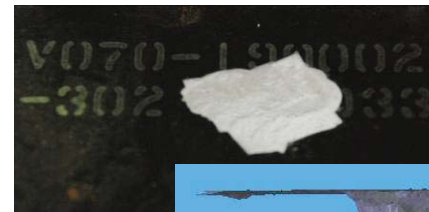


**Damage depth = 0.125"**

Damage volume = 0.06 in<sup>3</sup>

• **BX Foam & Ice Combo**

- 0.001 lbm foam
  - 0.89" OD x 1.3" length
- 0.001 lbm ice
  - 0.125" thick ice on cylinder end
- $V_{\text{impact}} = 860 \text{ fps}$ 
  - Ice end impacted first
- 40° impact angle
- Aged tile target



**Damage depth = 0.54"**

Damage volume = 0.23 in<sup>3</sup>



## LO2 Feedline Bracket Flight Rationale

Presenter MS2/Jim Peters

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- LO2 Feedline Bracket (Cause AM) Flight Rationale and Risk Classification:
  - Closure of IIFA STS-118-I-002 is based on the understanding of the failure mechanisms and bracket design modifications, which remove the top 5 inches of BX & SLA and replaces them with sprayed BX to the current OML
    - This eliminates the possibility of cracked SLA contributing to the failure mechanism as well as the possibility of a “mixed” foam/SLA debris event
  - The outboard upper monoballs were modified by trimming out a diverter on the forward side of the closeouts, to reduce ice from forming in the gap between the monoballs and the yokes
    - This minimizes the potential for ice buildup and the possibility of ice bridging, which mitigates the failure mode
  - Minimal gap within OML specifications between the feedline and bracket to reduce ice growth
  - The tanking time was reduced to minimize the potential of ice bridging and ice solidification
  - The Cause AM risk level classification is considered “Remote/Catastrophic” based on the strength of the design modification to eliminate the cracked SLA failure mode and “mixed” foam/SLA debris as well as the reduction of the ice bridging and ice growth from the condensate diverter.



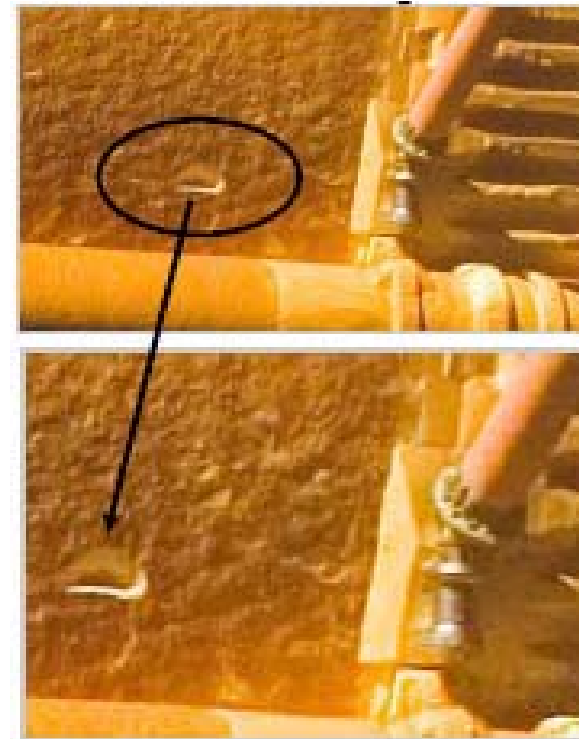
## STS-118-I-003: ET Foam Acreage Loss

Presenter MS2/Jim Peters

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- 60559 Source ID: ET-LH2T-002-02-A
- 60559 Mass:
  - 0.004 lbm <135 sec.
  - 0.015 lbm >135 sec.
- Est. mass: 0.031 lbm
- Location: Xt1163 on the LH2 Acreage aft of +Y Bipod fitting closeout
- Time of release: ~151 seconds
- Cause: Cryopumping - due to process-induced TPS damage
- Mitigation/Closure Plan:
  - A series of additional visual and tactile inspections of the ET Hardware
  - Low risk due to cryopumping release time with release occurring past ASTT

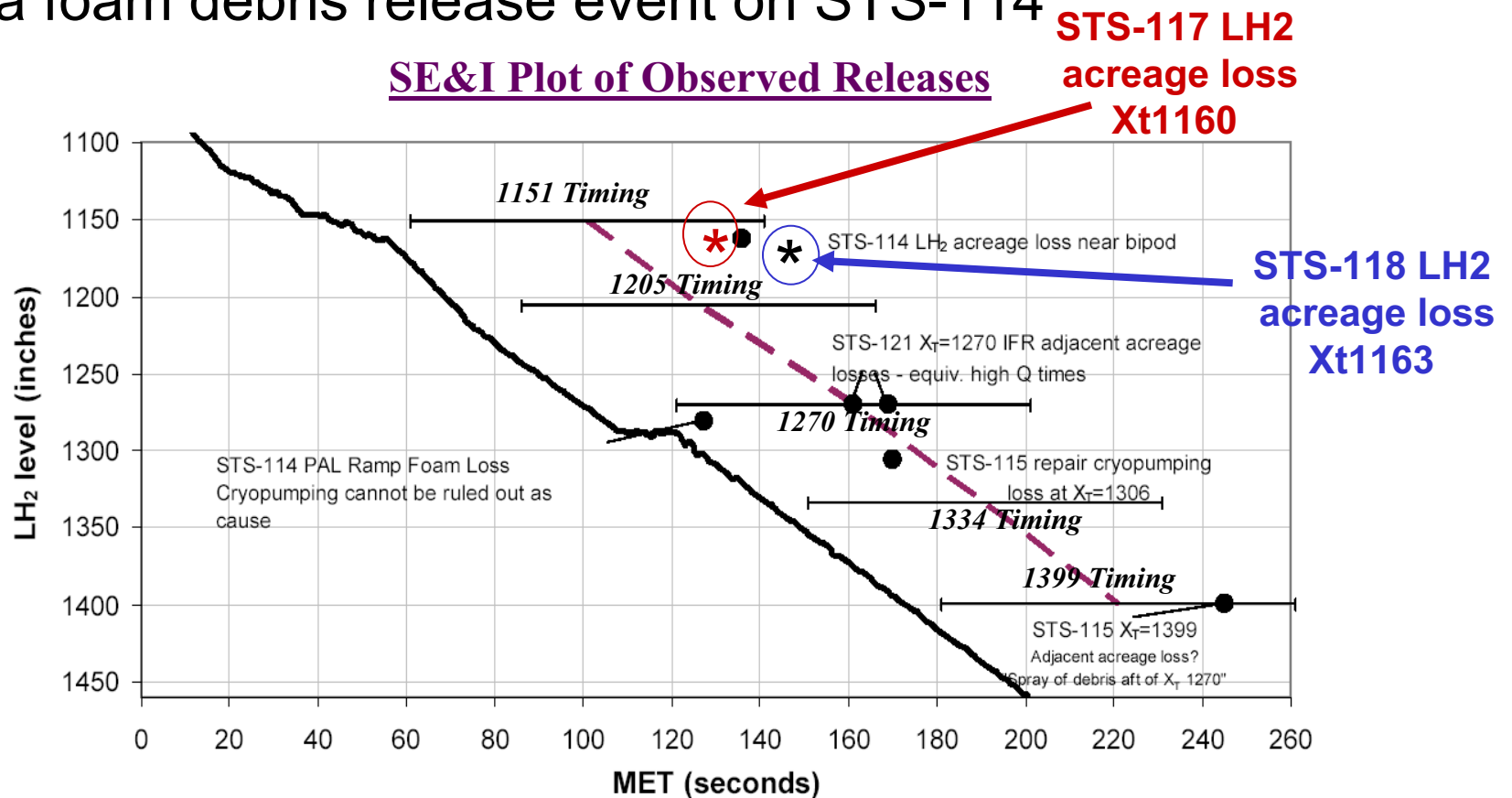




<b>Select Foam Debris Releases (Cryopumping Release Timing)</b>		Presenter MS2/Jim Peters	
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- The STS-117 & STS-118 LH2 Acreage losses were similar to a foam debris release event on STS-114

SE&I Plot of Observed Releases





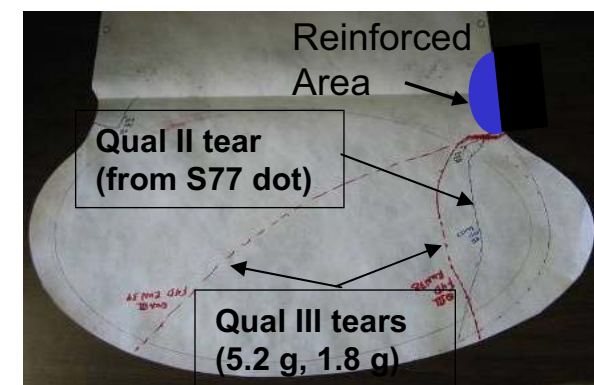
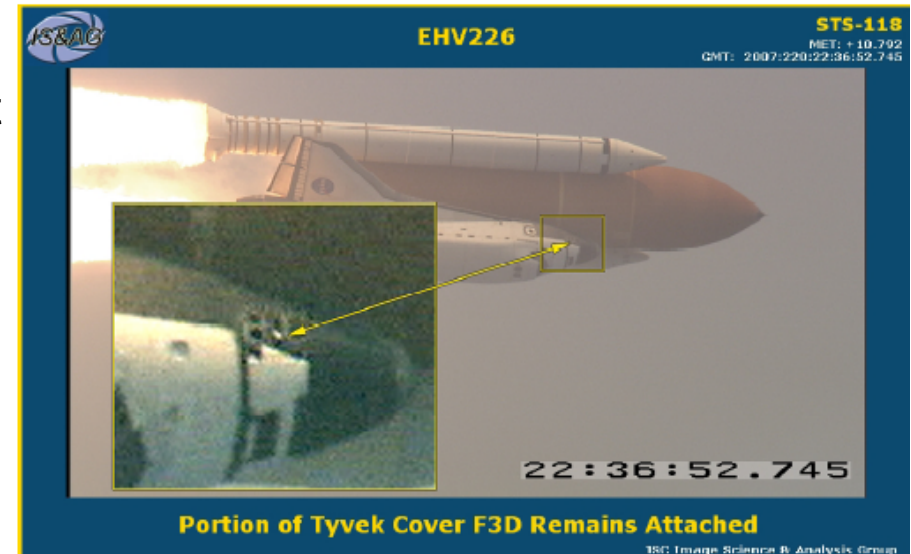
## STS-118-I-004: Partial Tyvek Cover Release

Presenter MS2/Jim Peters

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- 60559 Source ID: ORB-UFWD-147-00-LA
- Observation: Tyvek cover F3D tears into two pieces at ~ 4.39 seconds. The remnant releases at ~16 seconds MET. The Tyvek remnant is noted falling aft along Orbiter fuselage over port OMS pod and does not appear to contact the vehicle.
- Location: Forward RCS F3D
- Mass: ~0.004 lbm for partial piece
- Time of release: ~16 seconds for second
- Cause: Tearing at stress concentration
- Mitigation/Closure Plan: Perform DTA to determine residual risk of partial release. Orbiter to conduct Window, Tile and RCC impact testing as well as implement design change to eliminate failure mechanism. Design change scheduled for STS-123.
  - Impacts to windows are cleared via Impact Testing and DTA showing no impacts >M0.4
  - Impacts to RCC, Tile and OMS pod may have residual risk
  - Orbiter to produce bounding estimate on time of release



**Qualification Test Failures  
at Stress Concentration Point  
Consistent with STS-118 Failure**



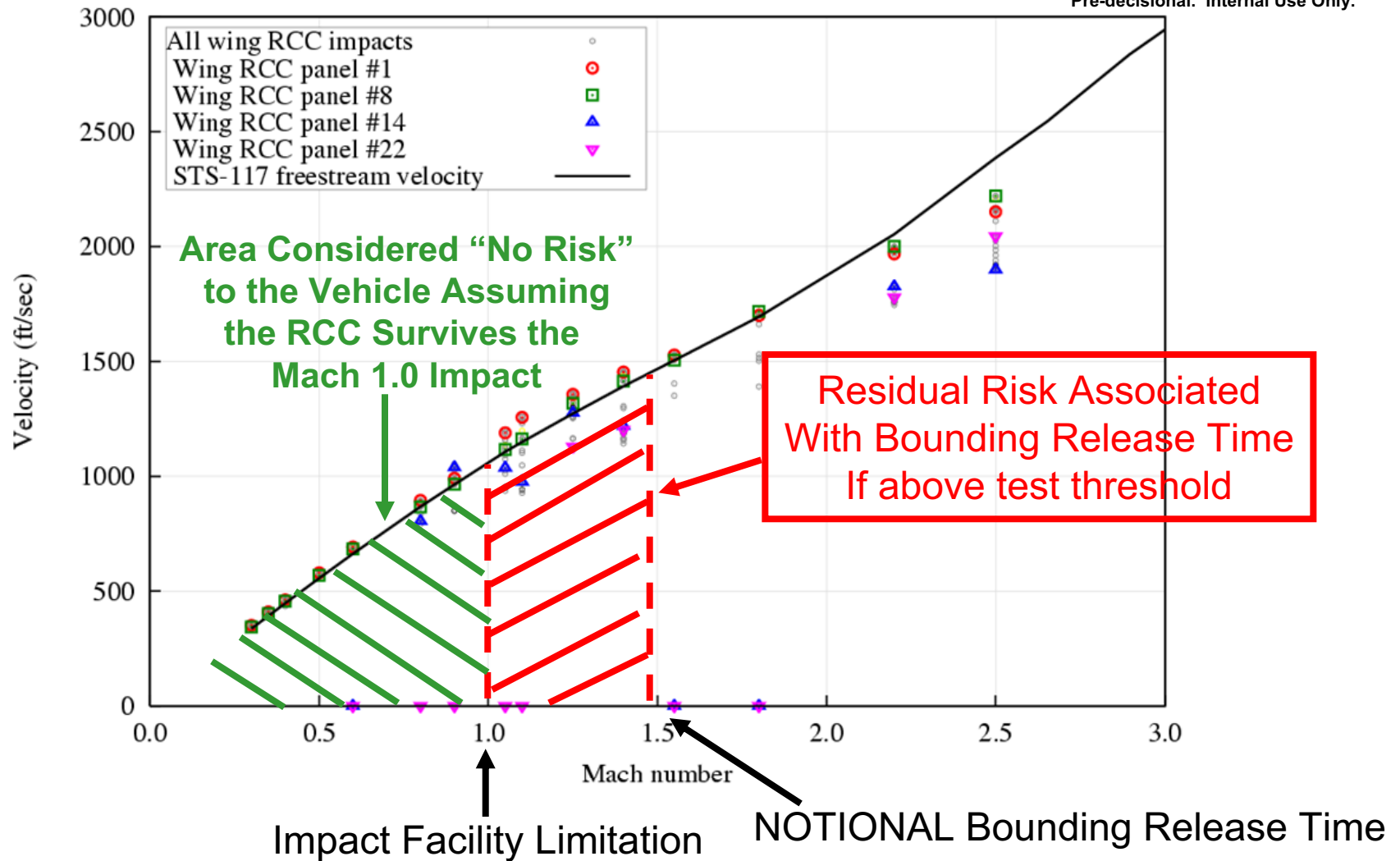
# DTA Example: Wing RCC Panel Impacts

Presenter MS2/Jim Peters

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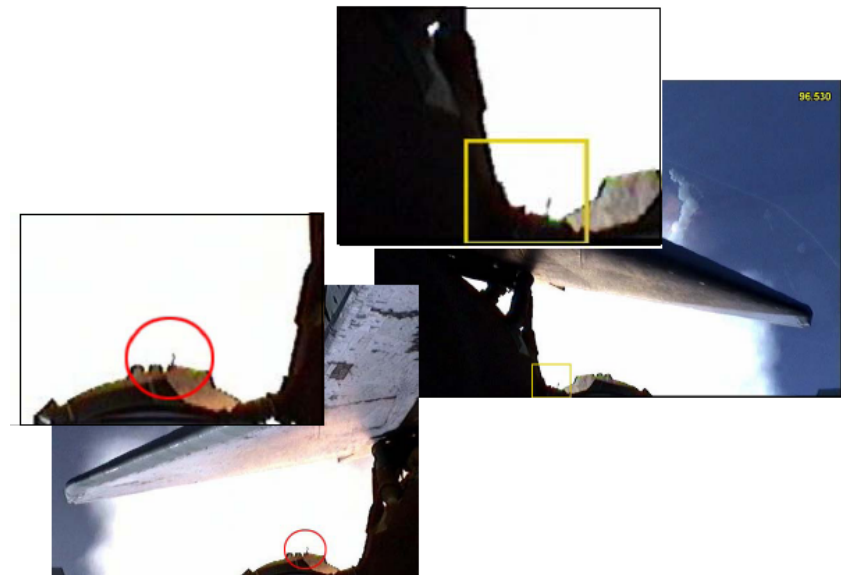
## STS-118-I-005: Rope-like objects flapping near aft LSRB & RSRB nozzle

Presenter MS2/Jim Peters

Date Oct. 9, 2007

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- Viton from the Thermal Curtain
- Est. Size: Approximate size of this object is 9.50" +/- 1.0" assuming the debris object is in the same image plane as the scale object
- Location: Rope-like objects flapping near aft LSRB and RSRB nozzles.
- Time of release: 96-101 seconds
- Cause: Elements reviewed list of possibilities before concluding the source as Viton from the Thermal Curtain.
- Mitigation/Closure Plan:
  - DTA shows no transport to the vehicle
  - Thermal Curtain Viton material is classified as expected debris and assessed as not threat to the SSV with masses up to 0.1 lbm (CR # S063545G)







<b>STS-120 IDBR-01 Risk Matrix</b>		Presenter <b>MS2/Jim Peters</b>
<b>Proposed Updates Pending PRCB Approval</b>		Date <b>Oct. 9, 2007</b>   Page <b>17</b>

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

<b>L I K E L I H O O D</b>	<b>PROBABLE</b>			
	<b>INFREQUENT</b>			6 (*11)
	<b>REMOTE</b>			23(*17)
	<b>IMPROBABLE</b>			6 (*7)
		<b>MARGINAL</b>	<b>CRITICAL</b>	<b>CATASTROPHIC</b>
		<b>SEVERITY</b>		

4 Causes lowered to Remote  
1 cause removed from Infrequent due to Open Work Closure:  
 •SRB BTA around the aft BSM nozzle and housing (AH) removed due to closure of Open Works

4 causes moved from Infrequent to Remote:  
 •LH2 IFR Adjacent Acreage (L)  
 •LH2 IFR Body (K)  
 •LH2 Acreage (H)  
 •Ceramic Inserts and FRSI Plugs (AE)  
 •Putty Repair (AK)  
 •Gap Filler (D)

2 causes added to Remote:  
 •BTA around the aft BSM (AL)  
 •LO2 Feedline Bracket (AP)

1 debris cause combined with another:  
 •RSRM Stiffener Ring Foam (AG) added to Cause AB, ETA Ring Foam (already classified Improbable)

\*The STS-118 risk numbers are in parentheses;  
 STS-120 risk numbers are to the left

- All debris hazards are assessed at the worst case severity



## Conclusions

Presenter MS2/Jim Peters

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- IDBR-01 Hazard Report approval pending 10/11/07 PRCB
  - IDBR-01 will remain “Open” until the Tyvek Open Work actions (OW-44 and OW-45) are closed, NLT L-2.
    - OW-44: SE&I to complete DTA Assessment of Partial Release for all Mach Numbers to account for unknown release time.
    - OW-45: Orbiter to complete DTA Impact Assessment and Impact testing of Tyvek Cover to Windows, RCC and Tile.
  - Flight Effectivity: STS-120 and STS-122



## STS-120 FLIGHT SOFTWARE READINESS

Presenter	MS/D. Stamper	
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- **PASS and BFS**
  - First flight of Operational Increment 32 (OI-32)
    - Standard capability release including changes for:
      - Enhanced crew safety and situational awareness
      - Improved Mated Control of ISS
      - Other enhancements for ground and flight operations and safety
- **MEDS**
  - First flight of OI-32 compatible Integrated Display Processor<sup>1</sup> (IDP) FSW (VI 5.00)
    - Standard capability enhancements to support OI-32
  - Seventh flight of OI-30/OI-32 Compatible MEDS Multi-function Display Unit Function<sup>2</sup> (MDUF) FSW (VI 5.00)
    - No changes for STS-120
- **MAGRS-3S**
  - Fifth flight of MAGRS-3S Link 613-9966-007 (Link-007) FSW
    - No changes for STS-120 (single string flight)



## **MAJOR NEW OI-32 CAPABILITIES PASS, BFS and MEDS**

Presenter	<b>MS/D. Stamper</b>	
Date	<b>10/09/07</b>	Page <b>20</b>

- **Enhanced crew situational awareness**
  - Added phase tailored PASS 6X Traj Displays
    - Creates first stage, second stage, and RTLS trajectory displays similar to BFS to replace the current PASS 6X Traj display.
    - Provides a PASS capability to assess trajectory performance throughout the ascent powered flight phases
  - Added BFS Head Up Display (HUD) Capability
    - Adds HUD functionality to BFS Flight Software for use post BFS engage during MM305 & MM603
    - Provides the crew with a runway overlay allowing rapid assessment and correction of navigation errors and insures consistency between PASS and BFS flight techniques
  - Enabled Alpha Mach Indicator (AMI) and Altitude Vertical Velocity Indicator (AVVI) for BFS Ascents
    - Allows BFS to display AMI and AVVI data on the MEDS A/E Primary Flight Display (PFD) during powered ascent to provide the same composite flight instrumentation data and information as PASS



## **MAJOR NEW OI-32 CAPABILITIES PASS, BFS and MEDS**

Presenter	<b>MS/D. Stamper</b>	
Date	<b>10/09/07</b>	Page <b>21</b>

- **Enhanced crew safety**
  - ISS Alarms
    - Improves a Shuttle crews ability to detect critical Shuttle faults while on ISS by facilitating ISS annunciation of the selected Shuttle Alarms
      - Shuttle capability to remain disabled pending availability of ISS compatible software (target 2008)
  - Reduce Risk of Aft Overpressure in Premature Shutdown Scenario
    - Separates SSME LH2 Pre-valve times to create separate closure times for pre-MECO (cut-off quickly) and post-MECO shutdown cases (open longer)
  - Automation of Single Engine OPS 1 Abort Procedures
    - Eliminates the need for manual throttle back and manual MECO procedures that are required to prevent catastrophic SSME shutdown during OPS1 single engine aborts
  - Reduce Risk of Combustion at ET Separation during Aborts
    - Removes an ignition hazard by deadfacing the SRB interface prior to ET Separation



## **MAJOR NEW OI-32 CAPABILITIES PASS, BFS and MEDS**

Presenter	<b>MS/D. STAMPER</b>	
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- **Improved GPS FSW Robustness**
  - Prevent a Loss of GPS Navigation in the event of an MTU Failure
    - Allow the incorporation of a time adjustment that will compensate for clock drift associated with the failure of an MTU
  - Add GPS Reference State Processor to BFS
    - Adds a new sub-function in Navigation to initialize and aid the GPS receivers thus eliminating unannounced transients in the BFS GPS aiding state and increasing stability in the BFS GPS Navigation system
- **Facilitate Ground Assessment of MEDS Display Quality**
  - New MEDS “White Cornering” Display
    - Adds a new maintenance display to provide more accurate and objective evaluation of “White Corner” intrusion on MDU Active Matrix Liquid Crystal Displays (AMLCDs)



## **MAJOR NEW OI-32 CAPABILITIES PASS, BFS and MEDS**

Presenter	<b>MS/D. Stamper</b>	
Date	<b>10/09/07</b>	Page <b>23</b>

- **Improved On-Orbit Flight Control to Extend Shuttle Ability to Control ISS Attitude**
  - Notch Filter Performance Improvement
    - Incorporates predicted acceleration due to RCS firings into existing DAP notch filter function to reduce filter lag and allow for more robust notch filter design
  - Reduced VRCS Pulsing During Shuttle Control
    - Changes control algorithm to reduce Vernier RCS pulsing during ISS control to prevent violation of a VRCS SODB pulsing limit
- **Improved Ability to Dock with ISS**
  - THC Command Response Improvement
    - Improves the likelihood of the software detecting a short THC input by increasing the effective processing rates for the THC software
  - Hot Stick Rate Estimate Improvement
    - Improves accuracy of attitude rate estimates associated with short PRCS translational pulses to eliminate risk of undesired firings near ISS



## VERIFICATION SUMMARY & STS-320

Presenter **MS/D. Stamper**

Date **10/09/07**

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- **Integrated Avionics Verification (IAV) complete**
  - A total of 103 test cases were performed in the Shuttle Avionics Integration Laboratory (SAIL) and analyzed in support of OI-32
  - A total of 19 cases were executed and analyzed in support of STS-120
    - Included testing of full flight system (PASS/BFS OI-32 and STS-120 changes; MEDS VI 5.00/5.00; MAGRS-3S Link 7; and SSME AHM S/W AD03/DA03)
- **STS-320**
  - **STS-320 is the Rescue Launch on Need (LON) flight for STS-120.**
    - STS-320 Base Mass Memory products were created for use on OV-104
    - Open Work (Post Call-up)
      - 1 BFS K-load change (N<sub>2</sub>O<sub>2</sub> flow rates)
      - Standard PASS and BFS GMEMs
      - Flight Specific Verification (SPF and SAIL)
  - **In the event of STS-320 call-up, a full STS-320 Software Readiness Review will be conducted.**
    - LON call-up need date is NLT 11/05/07 for FSWE to support a 12/02/07 LON launch





## **FSW READINESS SUMMARY**

Presenter	<b>MS/D. STAMPER</b>	
Date	<b>10/09/07</b>	Page <b>25</b>

- **SAIL facility will be in a condition of readiness for mission support**
- **Formal Software Readiness Review (SRR) was conducted on 09/20/07**
  - **No known constraints**
- **With the successful completion of scheduled open work, FSW is in a condition of readiness for flight**



## **Payload and General Support Computer Readiness**

Presenter	<b>MS/D. Stamper</b>	
Date	<b>10/09/07</b>	Page <b>26</b>

- **STS-120 Will Be the Seventh Space Shuttle Flight of the IBM ThinkPad A31p PGSC and Associated 28V DC Power Supply (Emerald brick)**
  - **First flight of Windows XP Operating System**
  - **A31p Docking Station, and its compatible cards may not complete their certification in time to support this flight. (Cert ECD 10/17/07)**
  - **A 2<sup>nd</sup> 760 XD laptop; its Docking Station, with OCA Rev0 board installed; and appropriate cables have been requested to be added to STS-120.**
    - **Rationale: Provides backup support for downlinking Crit 1R Imagery Data**
    - **This 760 XD combination has successfully flown as a certified set on numerous past missions. Last flight this combination used was STS-118.**
- **Bench Review completed 09/20/07**
- **Open Work**
  - **Program Approval of new STS-120 PGSC Manifest Plan – ECD 10/09/07**
  - **Delta Bench Review Successful Completion – ECD 10/11/07**
  - **L-10 Late Update Disk - 10/14/2007**
- **With completion of above open work, PGSC's are ready to support STS-120.**



## Integrated Hazard Report Changes Summary

Presenter	MS/Don Noah	
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- Fourteen Integrated Hazard Reports updated since STS-118 FRR
  - \*IDBR-01 “External Debris Impact to SSV”
  - \*ICOM-01, “Adverse Effects Due to Intentional RF Environment”
  - IEME-01, “Adverse Electromagnetic Effects (EME)”
  - IFSI-01, “ET/SRB System Interface Failure”
  - IFSI-02, “ET/Orbiter System Interface Failure”
  - IFSI-03, “SSME/Orbiter System Interface Failure”
  - IFSI-04, “Outer Mold Line/Pad Configuration Error”
  - IFSW-02, “Erroneous Input to Flight Software Can Result in Loss of Vehicle Command and Control”
  - IMPS-03, “Improper IMPS configuration during SSME Operation”
  - IMPS-05, “Over pressurization of the Integrated MPS H2 System”
  - IMPS-06, “Under pressurization of the Integrated MPS H2 System”
  - IMPS-07, “Over pressurization of the Integrated MPS O2 System”
  - IMPS-08, “Under pressurization of the Integrated MPS O2 System”
  - ISPR-03, “ET Vent Arm System (ETVAS) Umbilical Malfunction”

\*Significant Change



## Integrated Hazard Report Changes Summary

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- IDBR-01 “Ascent Debris Impact to SSV”
  - Document the impacts associated with the STS-118 Integrated IFAs, including closure rationale and open work items
  - See Debris Presentation
- ICOM-01, “Adverse Effects Due to Intentional RF Environment”
  - Increased Risk of cause C, “Intentional RF Environment Fails to Conform to Design Requirements due to Procedural Errors” from Improbable/Catastrophic (Controlled) to Remote/Catastrophic (Accepted Risk)
    - Result of In-Flight Anomalies associated with Ku-band antenna masking



## STS-118 INTEGRATED IFAs

Presenter	MS/Don Noah	
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IIFA / MSFC PRACA Record	Integrated In Flight Anomaly Title	Integrated Hazard Report	STS-120 Closure Status
STS-118-I-001 I00100	Unexpected Debris/Expected Debris Exceeding Mass Allowable Prior to Pad Clearance (Liftoff Debris)	IDBR-01	CLOSED
STS-118-I-002 I00103	LO2 Feedline Bracket Loss	IDBR-01	CLOSED
STS-118-I-003 I00102	ET Foam Acreage Loss	IDBR-01	CLOSED
STS-118-I-004 I00104	F3D Partial Tyvek Cover Release	IDBR-01	OPEN
STS-118-I-005 I00101	Rope-like objects flapping near aft LSRB & RSRB nozzle	IDBR-01	CLOSED
STS-118-I-006 I00105	SSRMS Movement Prior to Shuttle Ku Mask	ICOM-01	CLOSED
STS-118-I-007 I00106	BFS loss of Class III alert from Spacehab	N/A	CLOSED



## STS-115 and -117 INTEGRATED IFAs

Presenter	MS/Don Noah	
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IIFA / MSFC PRACA Record	Integrated In Flight Anomaly Title	Integrated Hazard Report	STS-120 Closure Status
STS-115-I-004 I00068	LH2 low liquid level sensor #3 failed Wet	IMPS-03	CLOSED
STS-117-I-001 I00090	ET Foam LH2 Acreage Loss	IDBR-01	CLOSED
STS-117-I-005 I00094	Tile Piece From the Aft Fuselage Body Flap Interface Liberated During Liftoff/Ascent	IDBR-01	CLOSED
STS-117-I-007 I00096	FOD Found in Aft Compartment	IMEO-01	CLOSED
STS-117-I-010 I00099	Rope-Like Material Noted Moving in Umbilical Well Imagery	IDBR-01	CLOSED



## Non-Standard Open Work Summary

Presenter	MS/Don Noah	
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Open Work	Completion Date
<b>System Safety</b> <ul style="list-style-type: none"><li>- Approval of IHRs ICOM-01, IDBR-01</li><li>- Approval of Integrated IFA</li><li>- STS-118-I-004, F3D partial tyvek cover release</li></ul>	10/11/07 NLT L-2 days
<b>PGSC</b> <ul style="list-style-type: none"><li>- Manifest 760 PGSC &amp; OCA Cards in place of A31P</li><li>- Delta Bench Review Successful Completion</li></ul>	10/09/07 10/11/07



## LON Status

Presenter	MS/Don Noah	
Date	10/09/07	Page 32

- **STS-320 Mission Design & Support Requirements**
  - **STS-320 Flight Requirements Document, August 6, 2007**
    - **NSTS 17462-320, Rev. 4**
      - **The primary objective of the STS-320 crew rescue flight is to return a stranded STS-120 crew from the International Space Station (ISS) safely to earth as early as possible after the declared contingency**
      - **The SSP shall provide the capability to launch a rescue mission consistent with KSC vehicle processing capabilities and within the ISS consumables and systems limitations/operations (56 days, food limited)**
      - **The STS-320 launch (NET 12/2/07) is 40 calendar days from the planned launch of STS-120**
      - **STS-320 would utilize the STS-122 vehicle (OV-104) in the empty payload bay configuration (i.e., support structure only)**
      - **The crew compartment will be configured with additional seats to support the return of up to 11 crewmembers**
    - **First flight of OI-32 flight software on OV-104**





## LON Status

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- **System Integration's STS-320 Flight Products**
  - FRV required for first flight of OI-32 on OV-104 (Completed on 4/18/07)
  - Leverage STS-122 products where appropriate
  - Mission unique products will be assessed and developed by each technical discipline based on:
    - Data trending & anomaly resolutions from previous flights
    - Design constraints implemented for STS-122
    - Requirements documented in the STS-320 FRD and TDDP



## CoFR Endorsement

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The Space Shuttle Program, Systems Engineering and Integration Office's Flight Preparation Process Plan, documented in NSTS 08117, Requirements and Procedures for Certification of Flight Readiness have been satisfied. Required products and other responsibilities identified in NSTS 08117, paragraph 8.5.12 and Appendix M, have been or will be scheduled for completion. All technical functions and responsibilities are ready and the Systems Engineering and Integration Office is prepared to sign the Certificate of Flight Readiness for STS-120.

/s/ Donald S. Noah

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**Donald S. Noah**  
**Manager Systems Engineering and Integration Office**

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# DOLILU Load Indicator Implementation for STS-120

October 9 2007



1

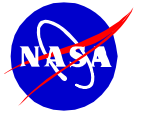


# STS-120 Load Indicator Plan

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- While performing updated roll maneuver certification project, an error was discovered in the load indicator calculation method for upper and lower ET/SRB aft attach struts
  - Error in the rigid body loads program was caused by incorrect load application point in algorithm resident since 1988
  - Effects four indicators used in DOLILU (P8, P9, P11, P12)
  - Analysis (1800 PE cert cases) shows max indicator value after correction is 65% of the redline (was 50%)
    - Other wind sensitive indicators would be violated prior to these indicators
- MOD Flight DOLILU team visual check will verify indicators are below 80% of redline (protect for error in rigid body loads program)
  - Redline reduction approved by Shuttle loads panel and SICB
- Incorporate updated code into automated checks in the next DOLILU block update (STS-123)
  - Implementation plan concurred on by the loads panel and SICB





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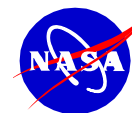
## Back-up charts



# Standard Open Work Summary

Presenter	MS/Don Noah	
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Open Work	Completion Date
<b>TDDP</b>	
- DOL TDDP	10/15/07
- RSRM L-3 day PMBT prediction update	10/20/07
<b>DOSS</b>	
- L-3 week test / TCDT	10/10/07
- L-7 day SIRB review	10/17/07
- L-2 verification test (incorporate L-8 day TDDP & L-3 day change notice)	10/21/07
<b>GN&amp;C</b>	
- Update FRV results to SIRB	10/17/07
- Normal prelaunch configuration & testing	10/19/07
<b>Loads &amp; Dynamics</b>	
- Normal prelaunch configuration and testing	10/19/07
<b>FSW</b>	
- STS-120 PRCB disposition of SCR 93181A patch	10/05/07
<b>PGSC</b>	
- L-10 Late Update Disk	10/14/07 -



# LH2 Risk Classification Summary

Presenter MS2/Jim Peters

Date Oct. 9, 2007 Page 37

Pre-decisional. Internal Use Only.

## 5/06 Status: Program Decides on Redesign

## 10/07 Status: Risk Summary from IDBR-01

Key Risk Level Factors	Rating	Comments
Risk Level (Body and Acreage)	<b>HIGH</b>	Risk level in low 100's
Uncertainty of understanding IFR Body Failures	<b>MEDIUM</b>	Single Debris cloud generated with worse case heating
Uncertainty of understanding Adjacent acreage Failure mode	<b>HIGH</b>	Cryopumping and Unknown failure mode considered
Uncertainty of PRA Modeling	<b>MEDIUM</b>	Model still under development
Flight Performance (observed losses)	<b>HIGH</b>	Expected body and acreage losses, single mass releases assumed
Uncertainty of Contols/Mitigation	<b>HIGH</b>	IFR redesign being pursued

Key Risk Level Factors	Rating	Comments
Risk Level (Body and Acreage)	<b>LOW</b>	Risk level <1/1,000
Uncertainty of understanding IFR Body Failures	<b>LOW</b>	Debris cloud generated for several IFRs with representative heating
Uncertainty of understanding Adjacent acreage Failure mode	<b>LOW</b>	Cryopumping based on detailed thermal analysis and flight data release time comparison
Uncertainty of PRA Modeling	<b>LOW</b>	Model predicts mass loss and release time, model Peer reviewed & under CMMDB control
Flight Performance (observed losses)	<b>MEDIUM</b>	$\Delta P$ Release rate is well below what model predicts, losses liberate in multiple pieces
Uncertainty of Controls/Mitigation	<b>MEDIUM</b>	Shear-pin cryo leak path being mitigated



<b>LH2 IFR Risk Summary (Current Design)</b>		Presenter <b>MS2/Jim Peters</b>
		Date <b>Oct. 9, 2007</b>   Page <b>38</b>

- The tables reflect the risk differences that resulted from the update to the foam on tile damage map
- The STS-117 FRR Void DeltaP Risk Results are based on the following Debris Clouds: Simulation of Ramps 1151, 1205, 1270, with 1270 Representative of Aft 13 Ramps

**LH2 IFR – Void DeltaP Failure Mode**

Target	Risk Index (STS-116 DVR) 11/15/06	Risk Index (STS-120 FRR) 10/09/07
RCC	1/10,000	<1/10,000
Tile	1/285	1/1,420
Special Tile	1/350	1/400
Tile Shear	Not Computed	No Risk
Overall	1/155	1/245

**Updated Foam on  
Tile Damage Map**

**LH2 IFR – Cryopumping Failure Mode**

Target	Risk Index (STS-116 DVR) 11/15/06	Risk Index (STS-120 FRR) 10/09/07
RCC	1/5,000	1/5,000
Tile	1/10,000	<1/10,000
Special Tile	1/10,000	<1/10,000
Tile Shear	Not Computed	1/10,000
Overall	1/3,300	1/3,000

**Updated Foam on  
Tile Damage Map**





# Risk Assessment Results for Foam

Presenter **MS2/Jim Peters**

Date **Oct. 9, 2007**

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Source – Failure Mode	Basis	Tile	Special Tile	Tile Shear	RCC	Overall (1-P <sub>F</sub> )
<b>LO<sub>2</sub> Acreage-Unknown</b>	Flight-Worst Time	1/5,000	1/1,110	1/10,000	1/10,000	1/900
<b>LO<sub>2</sub> I/F- ΔP</b>	Physics/Empirical	1/10,000	1/400	0	1/10,000	1/380
<b>LO<sub>2</sub> Flange-ΔP</b>	Physics/Empirical	1/5,000	1/830	0	1/10,000	1/710
<b>IT I/F- ΔP</b>	Physics/Empirical	1/2,000	1/1,250	0	1/10,000	1/770
<b>LH<sub>2</sub> Flange- ΔP, Cryo</b>	Physics/Empirical	1/10,000	1/10,000	0	1/10,000	1/10,000
<b>LH<sub>2</sub> General Acreage-Unknown</b>	Flight-Worst Time	1/1,000	1/3,330	0	1/10,000	1/770
<b>LH<sub>2</sub> IFR Acreage Adjacent-Cryopump</b>	Flight-Liquid Level	1/10,000	1/10,000	1/10,000	1/5,000	1/3,330
<b>LH<sub>2</sub> IFR- ΔP</b>	Physics/Empirical	1/1,420	1/400	0	1/10,000	1/245
<b>LH<sub>2</sub> 2 IFR-Aeroloads</b>	Flight-Max Q Centered	1/1,250	1/10,000	0	1/10,000	1/1,110
<b>Bipod Closeout – ΔP, Cryo</b>	Physics/Empirical	1/10,000	1/10,000	0	1/10,000	1/10,000
<b>Feedline Fairing/Supports</b>	Physics/Empirical	1/10,000	1/3,330	0	1/10,000	1/2,500
<b>Intertank Acreage-Unknown</b>	Flight					1.0
<b>IT / LH<sub>2</sub> Acreage-Popcorn</b>	Flight-Observation					1.0
<b>Aft Attach Hardware</b>	Max Expected					1.0

**Impacts to the Special Tiles are Driving the Overall and Integrated Foam Debris Risk**



## STS-120 CODE PATCHES

Presenter **MS/D. STAMPER**

Date **10/09/07**

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- **Two minor patches applied for OI-32 capabilities**
  - One PASS data patch is included on the STS-120 Comp Load
    - Updates altitude initialization parameter to eliminate a transient in the Ascent Trajectory Display predictor symbol upon transition to MM102 at SRB ignition.
    - OSB PRCB approval expected by 10/05/07
  - One BFS code patch is included on the STS-120 Base 2 Load
    - Improve accuracy of BFS HUD Deceleration, Altitude, and Altitude Rate Calculations
      - Corrects a Velocity Scaling input to the BFS HUD that is used to produce Deceleration, Altitude, and Altitude rate calculations.



<b>OTHER INTEGRATED HAZARD REPORT CHANGES SINCE STS-118</b>	Presenter <b>MS/Don Noah</b>
	Date <b>10/09/07</b> Page <b>41</b>

- **Flight effectivity extension only**
  - IEME-01, “Adverse Electromagnetic Effects (EME)”
  - IFSW-02, “Erroneous Input to Flight Software Can Result in Loss of Vehicle Command and Control”
- **Open Work, VTL, Editorial updates**
  - IFSI-01, “ET/SRB System Interface Failure”
    - Remains all-flights effectivity
  - IFSI-02, “ET/Orbiter System Interface Failure”
    - Added all-flights effectivity
  - IFSI-03, “SSME/Orbiter System Interface Failure”
    - Added all-flights effectivity
  - IFSI-04, “Outer Mold Line/Pad Configuration Error”
    - Added all-flights effectivity
  - IMPS-05, “Over pressurization of the Integrated MPS H2 System”
    - Added all-flights effectivity
  - IMPS-06, “Under pressurization of the Integrated MPS H2 System”
    - Added all-flights effectivity



<b>OTHER INTEGRATED HAZARD REPORT CHANGES SINCE STS-118 cont'd</b>	Presenter <b>MS/Don Noah</b>
	Date <b>10/09/07</b> Page <b>42</b>

- **IMPS-03, “Improper IMPS configuration during SSME Operation”**
  - Two-flight extension
  - Closed open work, added L&L OW for He bubbling
- **IMPS-07, “Over pressurization of the Integrated MPS O2 System”**
  - Added causes Y, Z (report remains controlled)
    - Overpressurization of the Integrated MPS O2 System during Pad Abort due to O2 ET Isolation during propellant flow
    - Excessive Integrated MPS O2 System Pressure during Ascent due to O2 Prevalve closure
  - Corrected errors, closed open work, editorial changes
  - Added all-flights effectivity
- **IMPS-08, “Under pressurization of the Integrated MPS O2 System”**
  - Added causes AB (report remains controlled)
    - Underpressurization of the Integrated MPS O2 System during Ascent due to O2 Prevalve Closure
  - Corrected errors, closed open work, editorial changes
  - Added all-flights effectivity



<b>OTHER INTEGRATED HAZARD REPORT CHANGES SINCE STS-118 cont'd</b>	Presenter <b>MS/Don Noah</b>
	Date <b>10/09/07</b> Page <b>43</b>

- **ISPR-03, “ET Vent Arm System (ETVAS) Umbilical Malfunction”**
  - Added controls, verifications, closed open work
  - IHR classification downgraded from Accepted Risk to Controlled
  - Added all-flights effectivity



# SPACE SHUTTLE PROGRAM

## Space Shuttle Systems Engineering and Integration Office

NASA Johnson Space Center, Houston, Texas




<b>INTEGRATED HAZARD RISK MATRIX</b>	Presenter <b>MS/Don Noah</b>	
	Date <b>10/09/07</b>	Page <b>44</b>

Likelihood

Probable			
Infrequent	2		17
Remote	2	4	138(*132)
Improbable	11 (*15)	13 (*14)	308 (*332)
	Marginal	Critical	Catastrophic

**Risk Summary**  
 21 of 38 IHR's are classified as Controlled Risk  
 17 of 38 IHR's are classified as Accepted Risk  
 \* Previous Flight

Pre-decisional. Internal use Only.

Hazard Report #	Integrated Hazard Titles	Controlled					Accepted Risk						probable-catastrophic		
		Controlled Risk	remote-marginal	improbable-marginal	improbable-critical	improbable-catastrophic	Accepted Risk	probable-marginal	infrequent-marginal	remote-critical	remote-catastrophic	probable-critical		infrequent-critical	infrequent-catastrophic
															
	<b>"Accepted Risk" Hazard Reports</b>														
IDBR-01	External Debris Impact to SSV*	6				6	29					23			6
ICOM-01	Adverse Effects due to Intentional RF Environment					2						1			
IEME-01	Adverse Electromagnetic Effects (EME)	1				1	21					21			
IEPD-01	Inability to Power Critical Functions	10			5	5	1			1					
IGNC-01	Ascent Trajectory Event Anomaly	13				13	1								1
IMEO-01	Hazardous Environment in the Aft Compartment	0					4					1			3
IMPS-01	Contamination in the Integrated MPS H2 System	0					2					2			
IMPS-02	Contamination in the Integrated MPS O2 System	0					1					1			
IMPS-03	Improper IMPS configuration during SSME Operation	10				10	3					2			1
IMPS-04	Off-Nominal Purges	11				11	1					1			
IMPS-09 <sup>2</sup>	Hazardous Environment due to H2 External to SSV	4				4	6					5			1
INEV-01	Exposure to Natural Environment Exceeds Capability of the Space Shuttle SSV Elements	17	1	1		15	52		1	1		49			1
ISPR-04	SRB Hold Down Post (HDP) System Malfunction	1				1	1					1			
ISPR-05	SRB Umbilical System Malfunction	3				3	2					2			
ITHM-01	Exposure to Thermal Environment Exceed Capability of SSV	15	1	5	2	7	3		1	1		1			
IVLD-01	Exposure to Induced Environments Exceed Structural Capability of SSV	38				38	26					1	25		
ILIT-01	Adverse Effects of Lightning	0					7					3			4
	<b>Accepted Risk Distribution Totals</b>	(see next page)					161	0	2	4	138	0	0	17	0

\*IDBR-01 numbers are preliminary

Pre-decisional. Internal Use Only.



INTEGRATED HAZARD RISK MATRIX	Presenter <b>MS/Don Noah</b>	
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	<u>"Controlled Risk" Hazard Reports</u>														
IARO-01	Aerodynamics Environment not per Specified Design	1			1	0									
IFSI-01	ET/SRB System Interface Failure	6			6	0									
IFSI-02	ET/Orbiter System Interface Failure	10			10	0									
IFSI-03	SSME/Orbiter System Interface Failure	16			16	0									
<b>IFSI-04</b>	<b>Outer Mold Line Configuration Error</b>	<b>14</b>			<b>14</b>	<b>0</b>									
IFSW-01	Flight Software Generic Problems can cause loss of vehicle command and control	1			1	0									
IFSW-02	Erroneous Inputs to Flight Software can cause loss of vehicle command and control	15			15										
IMEO-02	Malfunction of Integrated Hydraulic System (Systems 1, 2 and 3)	4			4	0									
IMEO-03	SSME Nozzle/OMS Pod/ Body Flap Interference	2			2	0									
<b>IMPS-05</b>	<b>Over pressurization of the Integrated MPS H2 System</b>	<b>7</b>			<b>7</b>	<b>0</b>									
<b>IMPS-06</b>	<b>Under pressurization of the Integrated MPS H2 System</b>	<b>7</b>			<b>7</b>	<b>0</b>									
<b>IMPS-07</b>	<b>Over pressurization of the Integrated MPS O2 System</b>	<b>7</b>			<b>7</b>	<b>0</b>									
<b>IMPS-08</b>	<b>Under pressurization of the Integrated MPS O2 System</b>	<b>7</b>			<b>7</b>	<b>0</b>									
IMPS-12 <sup>2</sup>	Excessive O2 from ET/Orbiter/SSME External to SSV	7			7	0									
IMPS-15	LO2 Geyser Event during Cryo Loading	8			8	0									
IMPS-16	Loss of MPS He System	4			4	0									
IMPS-17	Inadvertent SSME Shutdown	3			3	0									
IPYR-01	Pyrotechnic System Malfunction	11			11	0									
ISPR-02	ET Vent Arm System (ETVAS) Umbilical System Malfunction	14			14	0									
<b>ISPR-03</b>	<b>Tail Service Mast (TSM) T-0 Umbilical System Malfunction</b>			<b>5</b>	<b>6</b>	<b>29</b>									
IVLD-02	System Instability Results In Structural Failure of SSV	19			19	0									
	<b>Controlled Risk Distribution Totals</b>	<b>292</b>	<b>2</b>	<b>11</b>	<b>13</b>	<b>308</b>	<b>161</b>	<b>0</b>	<b>2</b>	<b>4</b>	<b>138</b>	<b>0</b>	<b>0</b>	<b>17</b>	<b>0</b>