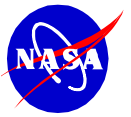




SPACE SHUTTLE PROGRAM
Space Shuttle Systems Engineering and Integration Office
NASA Johnson Space Center, Houston, Texas



STS-122

SSP Flight Readiness Review

MS/Don Noah
November 13, 2007

Pre-decisional. Internal Use Only.



Agenda

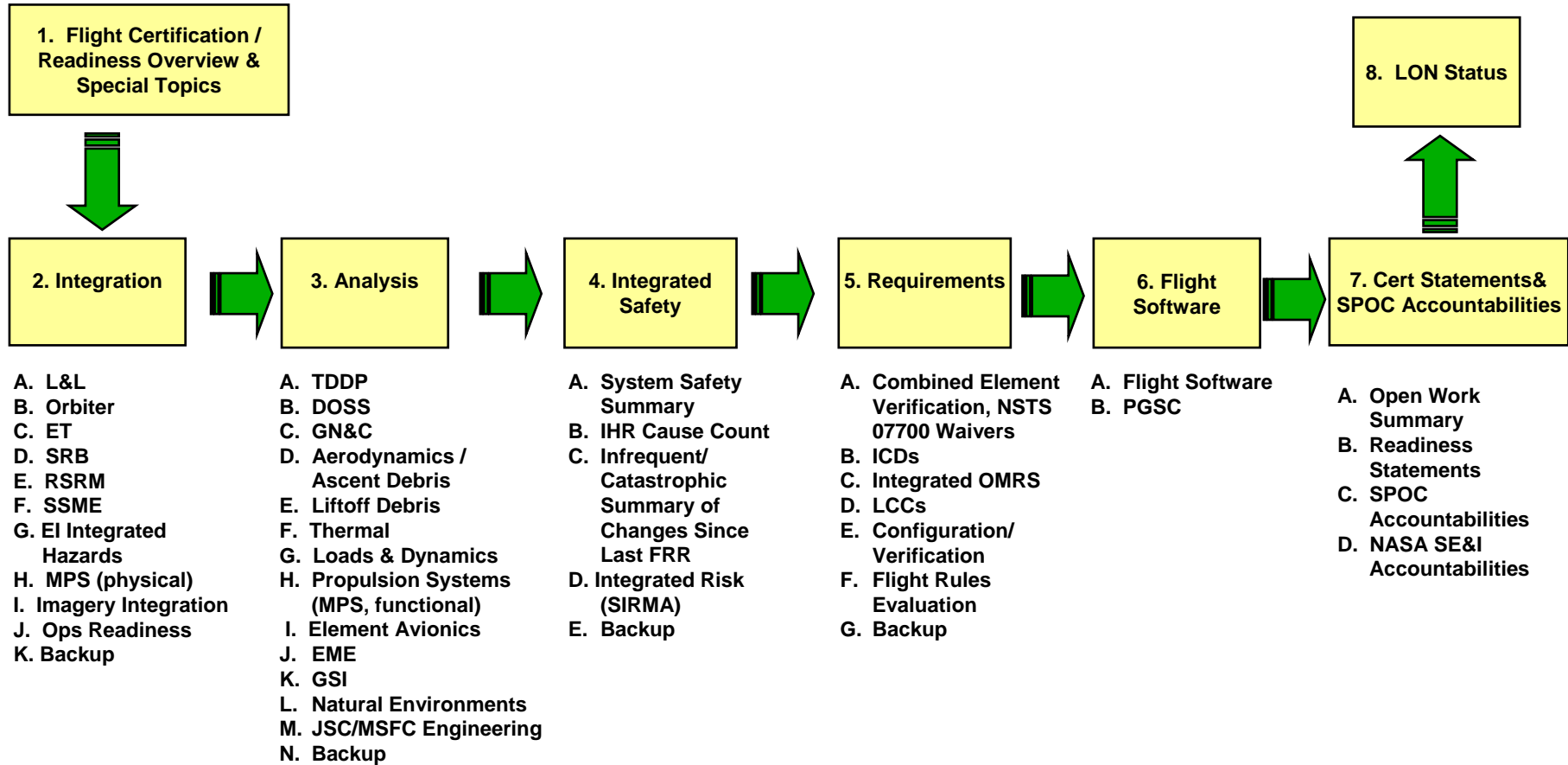
Presenter	MS/Don Noah	
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- **Systems Engineering & Integration**
 - **SE&I FRR Roadmap**
 - **Flight Preparation Readiness**
 - **Debris Radar**
 - **Integrated Debris Risk Assessment**
 - **STS-118 Main Injector LOX Dome Contamination**
 - **Flight 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

Presenter	MS/Don Noah	
Date	11/13/07	Page 3





Flight Preparation Readiness

Presenter	MS/Don Noah	
Date	11/13/07	Page 4

- **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 Configuration

- **STS-120:** Excellent track quality for X3, X4 radars throughout ASTT
- C-bd, although planned for support, remained unavailable due to relocation issues
- **STS-122 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
- First operational SRB tracking, following ASTT, by both X-bd radars
- Ascent team training continues
- Orbit team training complete
- NDR Readiness will be reviewed again 11/14/07





	Presenter	MS2/Jim Peters	
	Date	Nov. 13, 2007	Page 6

STS-122 FRR Charts

Debris Overview

James Peters, MS2
Systems Engineering & Integration Office
Space Shuttle Program Office



STS-122 Debris Overview

Presenter MS2/Jim Peters

Date Nov. 13, 2007 Page 7

- STS-120 Debris Performance Summary
- STS-120 Debris IIFA Disposition Summary
- LO2 Feedline Bracket Risk Classification
- STS-122 Debris Risk Summary



STS-120 Debris Performance Summary		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 8

- 5 STS-120 Debris IIFAs:
 - STS-120-I-001: Umbilical Ice exceeded limits of NSTS08303 requiring a waiver
 - STS-120-I-002: Ground Umbilical Carrier Plate (GUCP) Ice and Foam loss
 - STS-120-I-003: LH2 Acverage Foam Losses aft of +Y/-Y Bipod
 - STS-120-I-004: Liftoff Debris
 - STS-120-I-005: Debris Release on Outboard side of LO2 Feedline at ~277 sec
- STS-120 Debris Observation Summary:
 - The modified LH2 and LO2 IFRs implemented on STS-120 performed very well with no observed losses
 - The Tyvek covers performed as expected with all releasing before 170 mph
 - Weather conditions (temp, humidity, wind and light rain) for STS-120 were conducive for heavy icing on the vehicle
 - No significant damage observed with the BRI-18 Tile around the Umbilical doors
 - No significant TPS or WLE damage was noted during OBSS inspection, RPM or Late Inspection
 - No focused inspections requested

Flight	STS-114	STS-121	STS-115	STS-116	STS-117	STS-118	STS-120
Total Bottom TPS Hits	125	86	104	124	247	160	247
Number >1"	17	10	5	16	15	22	12
Largest Length	4.5"	1.5"	2"	3"	1.7"	3.5"	2.5"

STS-120 IIFA Disposition Summary

Presenter MS2/Jim Peters

Date Nov. 13, 2007 Page 9

- STS-120-I-001: Umbilical Ice exceeded limits of NSTS08303
 - Required a Day of Launch waiver for visibly hard ice
 - STS-122 Goal:
 - The requirements in NSTS08303 will remain unchanged (no visible hard ice)
 - SE&I will complete and review Umbilical Ice PRA and Orbiter deterministic assessment for various shapes and masses to determine an allowable mass for hard ice
 - Results will be available should a DOL waiver be necessary
 - Post STS-122:
 - SE&I will update NSTS08303 with umbilical ice mass allowables based on PRA analysis and/or Orbiter deterministic analysis



**LH2 Umbilical Ice
on STS-120**



STS-120 IFA Disposition Summary

Presenter MS2/Jim Peters

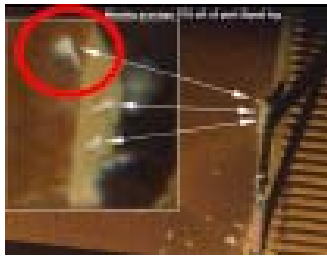
Date Nov. 13, 2007 Page 10

- STS-120-I-002: Ground Umbilical Carrier Plate (GUCP) Ice/Foam loss
 - “Ice Bridging” is considered unacceptable per NSTS08303
 - The Final Inspection Team did not observe “Ice Bridging” before launch
 - However, High Speed Imagery review did reveal “Ice Bridging”
 - Addition of Color Cameras to replace Blank & White under consideration
 - STS-122 Goal:
 - Requirements in NSTS08303 for GUCP Ice Bridging remain unchanged for STS-122
 - The GUCP is located at 120 degrees phi, which is outside the +/-110 degree phi for transport for either foam or ice and therefore not an Ascent debris threat due to no transport
 - These results have been reviewed and documented at the DIG
 - Post STS-122:
 - Update NSTS08303 to declare “ice bridging” acceptable for ascent and liftoff
 - Update IDBR-01 to state that there is residual Liftoff only risk from a specific set of ice conditions, winds and rebound that could have potential transport to the Orbiter



<h1>STS-120 IIFA Summary</h1>		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 11

- STS-120-I-003: LH2 Acreage Foam Losses aft of +Y/-Y Bipod (Location of losses on STS-120: Xt1139, Xt1146, Xt1150)
 - Trend noted in LH2 acreage foam losses in area aft of the Bipod
 - Cause identified as cryo-pumping
 - Mechanism for leak path introduction is induced damage during processing
 - Bounded in release time due to conditions required for Cryo pumping
 - “Zero” risk at time of release based on reconstructions (well past ASTT)
 - Low risk for these losses based on Focused PRA analysis
 - Focused LH2 acreage area of Stations Xt1130-Xt1200, the risk for cryopumping is 1/10,000 for RCC, Tile and Special Tile, and 1/1,500 for Tile shear
 - ET Project expanding focused inspections



Xt1139 Loss



Xt1146 Loss



Xt1150 Loss

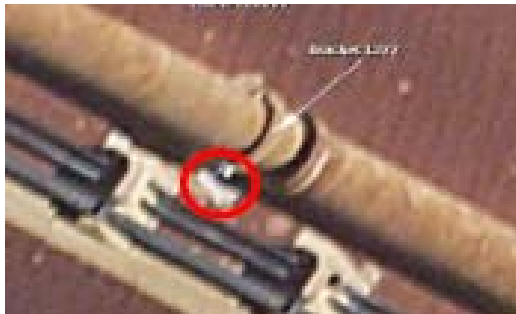
STS-120 IIFA Summary

Presenter MS2/Jim Peters

Date Nov. 13, 2007

Page 12

- STS-120-I-005: Debris Release on Outboard side of LO2 Feedline at ~277 sec
 - Multiple release were observed outboard of the LO2 Feedline Bracket at Xt1377
 - The total liberated mass (0.025 lbm) exceeded the NSTS60559 risk assessment mass for releases after 135 seconds
 - Risk assessment mass considers only the Void DeltaP failure mode
 - The failure mechanism was attributed to cryopumping
 - Consistent with cryopumping timeframe
 - The CR (S063369) to change the risk assessment mass for the cryopumping failure mode has been submitted and approved at the 11/5/07 DIG



Outboard LO2 Feedline Bracket
Acreage Loss at Xt1377



LO2 Feedline Bracket Risk Classification

Presenter **MS2/Jim Peters**

Date **10/09/07**

Page **13**

- **The LO2 Feedline Bracket (Cause AM) risk level classification is considered “Remote/Catastrophic” based on the strength of the design modifications**
 - In addition, the “Ice only” and “Foam only” risks are small
- **The design modifications do not preclude the possibility of a LO2 Feedline Bracket loss or “mixed” foam/ice debris event**
- **The STS-120 LO2 Feedline Bracket reconstructions (foam only) show “zero” risk at the time of release**
 - All the observed losses identified with release times since RTF were at or before MaxQ
 - The majority of the aggregated risk contribution from the LO2 feedline bracket releases is after MaxQ
 - Smaller mass releases were observed on STS-120 compared to STS-118 & 115
- **Preliminary impact analysis shows only SLA debris has a significant rebound potential at impact velocities greater than 500 ft/sec (10/30/07 CERB)**
 - SLA has been eliminated
 - Ice and foam tend to “break-up” at impact velocities greater than 500 ft/sec
- **Additional “mixed” foam/ice debris impact testing shows a trend towards “foam-like” impacts as the mass ratio of ice-to-foam is decreased**
 - The maximum ice-to-foam ratio for even high ice days, like that of STS-120, are below the impact test levels



LO2 Foam Risk Assessment (BX265 Foam Only)

Presenter **MS2/Jim Peters**

Date **Nov. 13, 2007** Page **14**

- **Key PRA Model Inputs for Foam Only Risk Assessment**
 - Mass Distribution: Historical, Log-Normal, capped at 0.037 lbm (risk assessment mass)
 - Time of Release: normal distribution centered around MaxQ (35-75 seconds), corresponding to Airload failure
 - Rate of Release: Historical, 0.50 releases/flight
 - Release Location: Historical release pattern by bracket
 - 15% from Station 1130, 60% from 1377, 15% from 1624, 5% from 1871 and 1973 Each
 - Rebound: Off
 - Historical data based on 8/16/07 MSFC LO2 Feedline Flight history analysis
- **LO2 Feedline Bracket Foam Only Results**
 - Tile: 1/1,110
 - RCC, Special Tile & Tile Shear: 1/10,000



<h1>Bracket Ice PRA Updates for Xt1623</h1>	Presenter MS2/Jim Peters	
	Date Nov. 13, 2007	Page 15

- The Xt1623 was selected first because this location had the highest ice risk
- Preliminary LO2 Feedline Bracket Ice for Xt1623 Probabilistic Risk Analysis Update
 - Significant improvement in risk due to corrected implementation of ice-on-tile damage model with a smaller reduction due to improved CFD fidelity
 - Forward work
 - Updating the PRA for other brackets

STS-121 DVR

XT1623	L/O-Uniform (Low Mass)	L/O-Uniform (High Mass)	L/O-MaxQ	Reduced Ice
Exponential Mass Release	1 in 197	1 in 153	1 in 1,792	1 in 311
Normal Mass Release	1 in 368	1 in 505	1 in 3,122	1 in 579
Extreme Value Mass Release	1 in 444	1 in 2,257	1 in 3,505	1 in 684

After Damage Model + CFD Updates

XT1623	L/O-Uniform (Low Mass)	L/O-Uniform (High Mass)	L/O-MaxQ	Reduced Ice
Exponential Mass Release	1 in 42,460	1 in 30,437	1 in 165,959	1 in 68,866
Normal Mass Release	1 in 88,104	1 in 74,401	1 in 215,323	1 in 109,340
Extreme Value Mass Release	1 in 106,067	1 in 100,923	1 in 219,785	1 in 135,210



STS-120 Environment Conditions Prior to Flight	Presenter MS2/Jim Peters	
	Date Nov. 13, 2007	Page 16

- Weather conditions for STS-120 were conducive for heavy icing on the vehicle
 - Light wind and nearly constant ambient temperature and relative humidity for worst case icing
 - The worst case ice conditions for ice characterization/liberation testing was a steady state 85 °F / 80% RH, no wind, no solar for 10 hours
 - Light rain during tanking could have circumvented the LO2 Feedline Bracket Condensate diverters
 - Natural Environments analysis predicts highest probability for icing conditions are late evening through early morning

Time	Wind Speed (Knts)	Wind Direction (deg)	Amb Temp (F)	Rel. Hum (%)
2:09	10.16	135.5	80	84.9
2:32	9.92	137.2	79.9	83.1
3:00	7.99	141.6	79.8	83
3:30	7	149.1	79.7	85.5
4:00	6.6	147.7	79.7	85.1
4:30	4.56	150.7	79.4	85.3
5:00	5.13	150.9	79.1	85.4
5:29	7.73	184.5	79	85.3
6:30	4.4	174	78.2	87.2
7:00	3.2	202.2	77.8	89.8
7:30	3.93	198.4	77.7	88.5
8:00	2.32	213.2	78.1	87.6
8:30	5.21	159.8	78.4	85.8
9:00	5.55	152	79.2	83
10:00	9.57	168.8	81.6	77.3
11:00	10.51	172.3	83.2	73.3
		Average	79.4	84.4

Summary of STS-120 Weather Conditions Prior to Flight



LO2 Feedline Bracket Yoke (Closeout) Flight History		Presenter	MS2/Jim Peters
		Date	Nov. 13, 2007

- Flights prior to STS-120:
 - 21 losses observed in 43 flights
 - Imagery available for 198 brackets
- Since RTF: 6 outboard losses in 7 flights

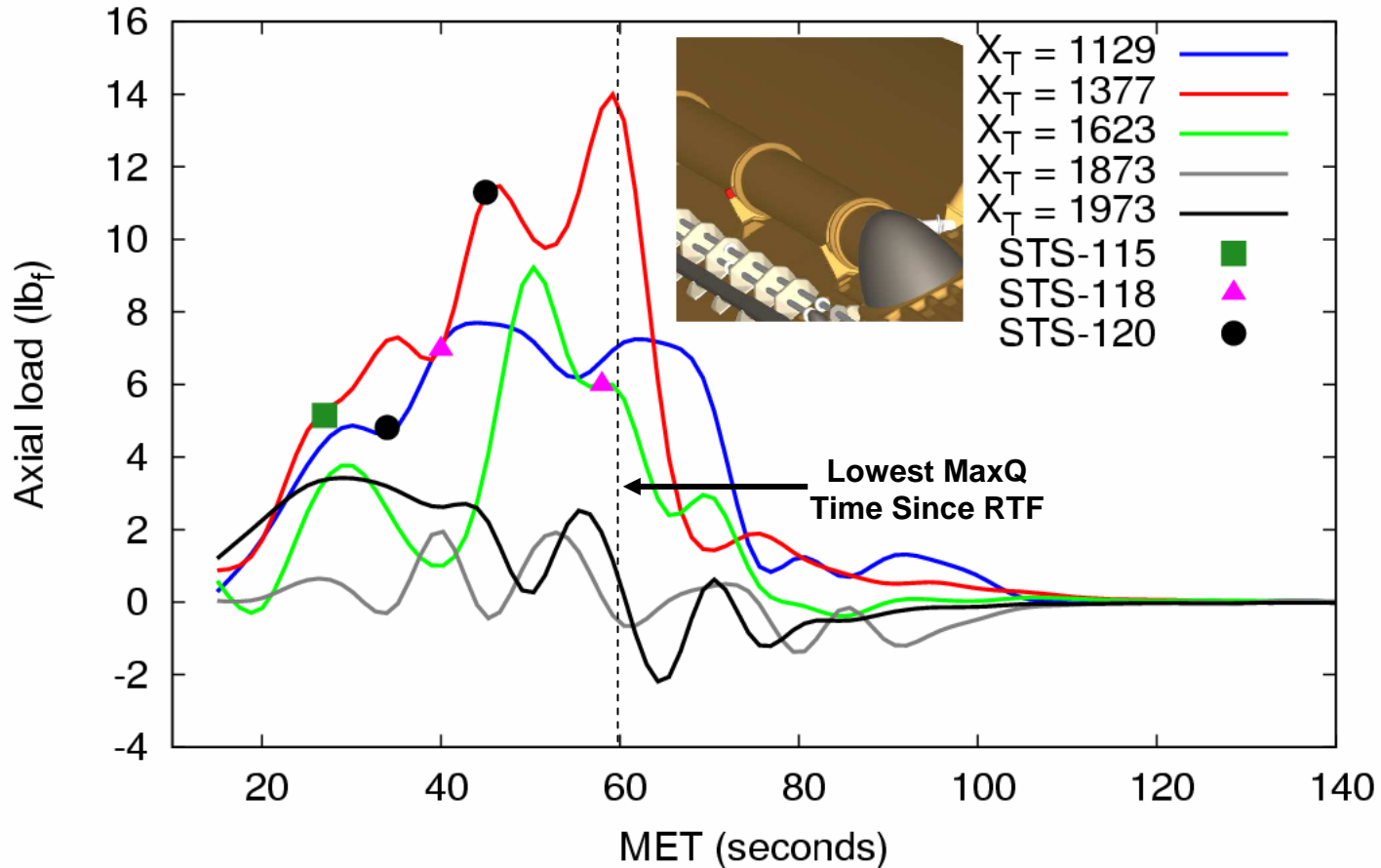
Flight	Station of Loss	Mass (foam only)	Release Time (sec)	MaxQ (sec) – from BET
STS-114	Xt1377	<0.013 lbm	Unknown	60.53
STS-121	Xt1129 (Inboard, Pad Loss)	0.0057 lbm	N/A	61.00
STS-115	Xt1377	0.022 lbm	27	60.80
STS-116	No Imagery – Night Launch			59.52
STS-117	No losses observed			65.28
STS-118	Xt1377	0.025 lbm	40	65.04
	Xt1623	0.021 lbm	58	
STS-120	Xt1129	0.016 lbm	34	~65.00 (L+2 report)
	Xt1377	0.008 lbm	45	

The STS-120 LO2 Feedline Bracket Losses were well below the 0.037 lbm Risk Assessment Mass for Foam Only

<h1>LO₂ Feedline Bracket Losses as a Function of Airload</h1>		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 18

Reference: R. Gomez/NASA/JSCEG3, 10/25/07

LO₂ Feedline Bracket Airloads
 STS-113 α Target Line Profile

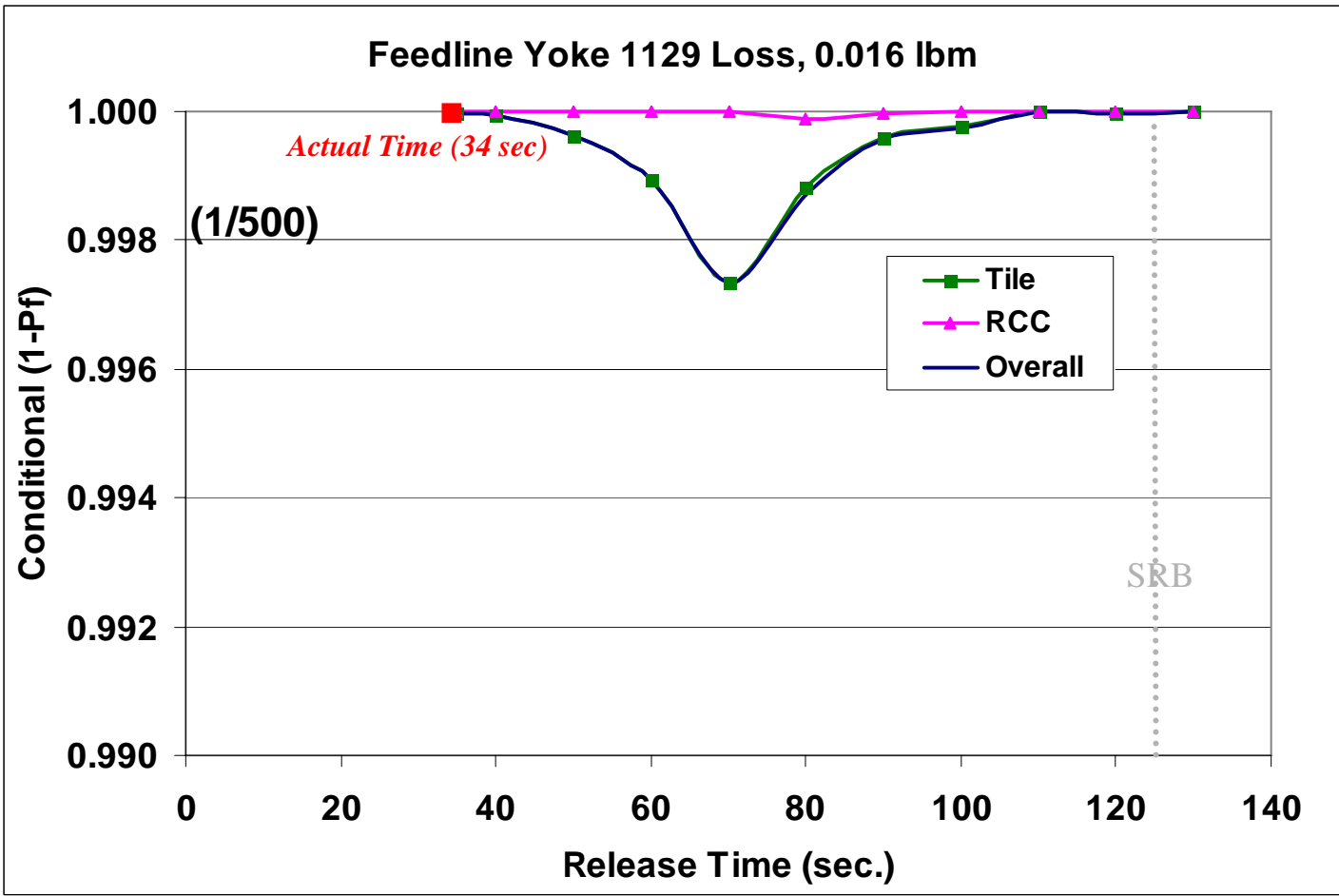


All the observed losses identified with release times since RTF were before MaxQ



STS-120 Reconstruction of Xt1129 Feedline Yoke Loss

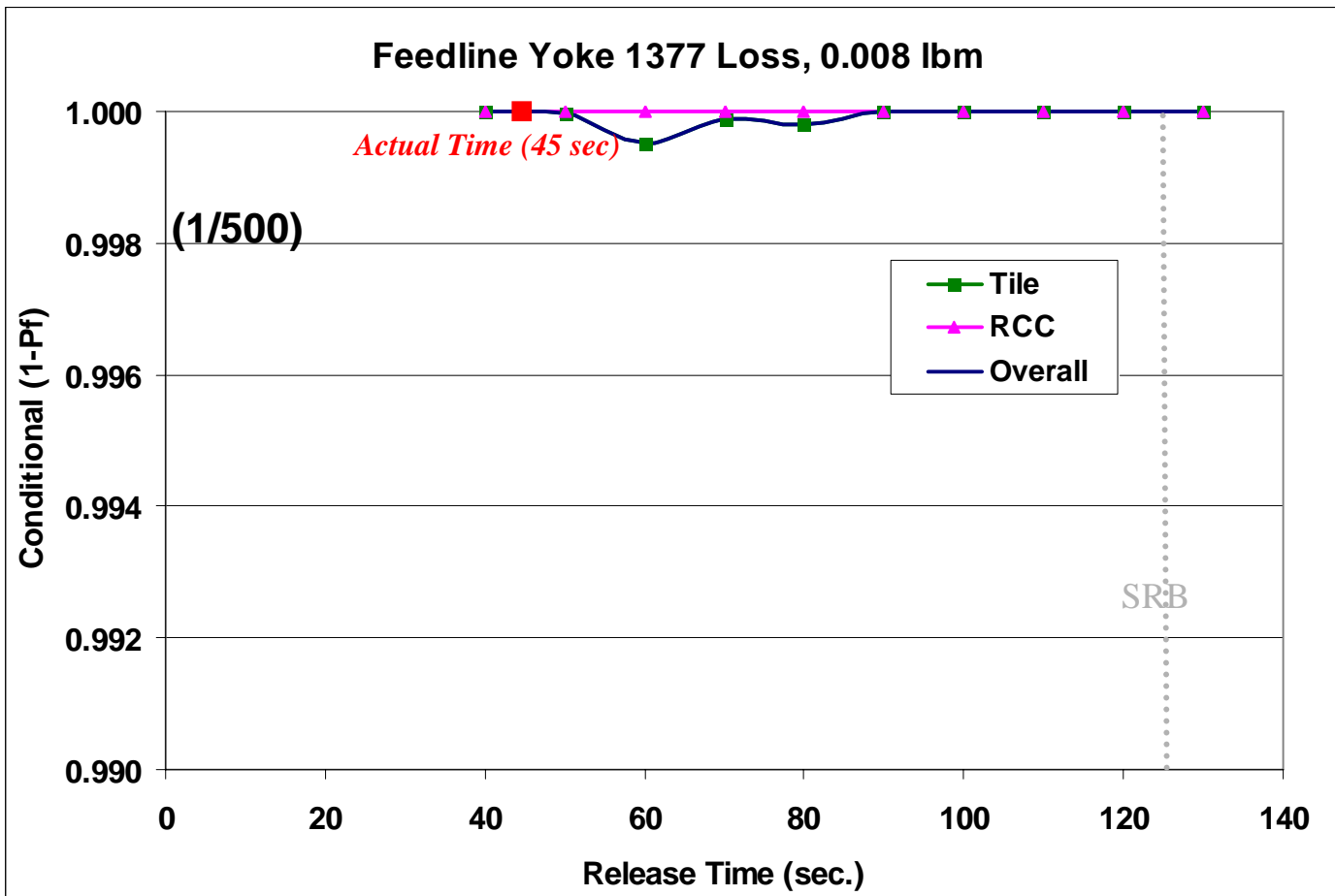
Presenter MS2/Jim Peters	
Date Nov. 13, 2007	Page 19



The low probability before MaxQ is due to the relatively low velocities along with flying negative alpha, which results in fewer impacts as long as rebound is not considered



<h1>STS-120 Reconstruction of Xt1377 Feedline Yoke Loss</h1>		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 20



The low probability before MaxQ is due to the relatively low velocities along with flying negative alpha, which results in fewer impacts as long as rebound is not considered



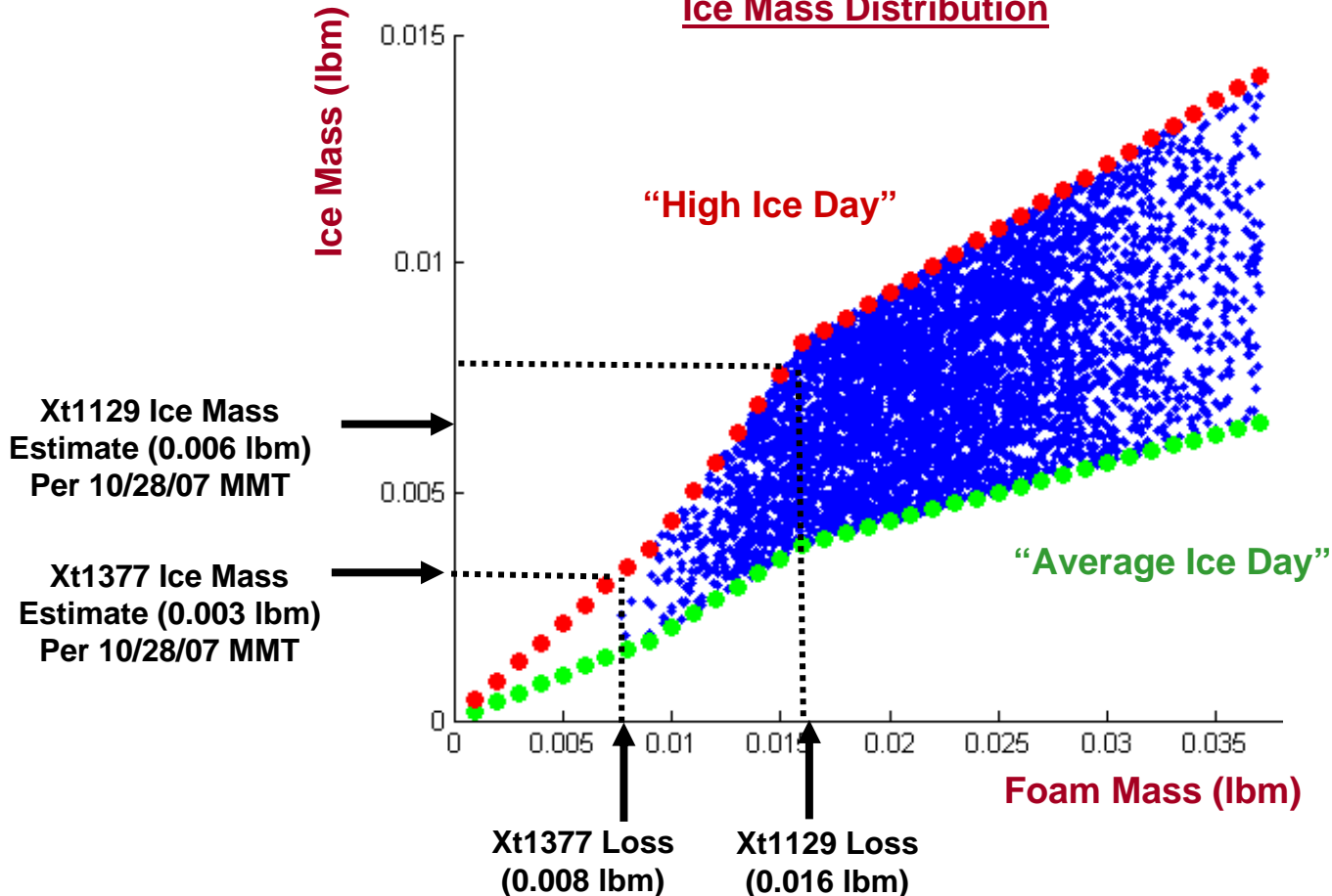
LO2 Feedline Yoke and Ice Liberation Model

Presenter **MS2/Jim Peters**

Date **Nov. 13, 2007** | Page **21**

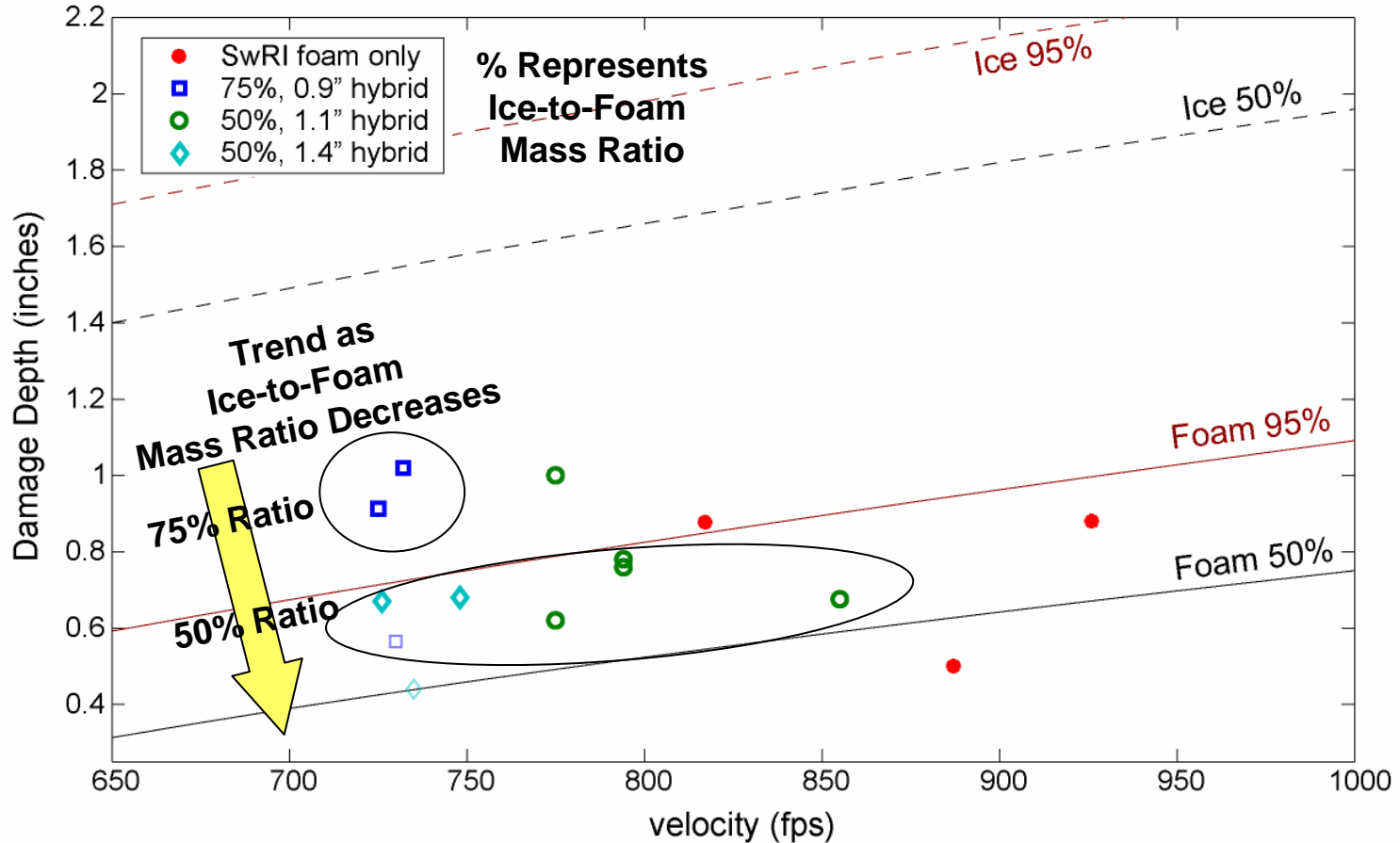
- Model Assumes that Ice Debris is a Function of Foam Mass
 - The highest Ice-to-Foam mass percentage is 30% on the “High Ice Day”
 - Curve based on Ice Testing at MSFC and ET Project analysis

Ice Mass Distribution





“Mixed Ice/Foam” Impact Testing (0.004 lbm)		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 22



The maximum ice-to-foam mass ratio for even high ice days, like that of STS-120 (~30% ice), are below the impact test levels (50% ice)



LO2 Feedline Bracket Risk Assessment Summary for STS-122

Presenter	MS2/Jim Peters	
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- Recommend the LO2 Feedline Bracket Risk level remain classified as “Remote/Catastrophic”
 - The STS-120 losses do not represent an increase in risk level or performance outside expectations
 - The STS-120 losses were well below the risk assessment mass for foam only
 - The STS-120 LO2 Feedline Bracket reconstructions (foam only) show “zero” risk at the time of release
 - All the observed losses identified with release times since RTF were at or before MaxQ
 - The majority of the aggregated risk contribution from the LO2 feedline bracket releases is after MaxQ
 - The low risk before MaxQ is due to the relatively low velocities along with flying negative alpha, which results in fewer impacts as long as rebound is not considered
 - The maximum ice-to-foam ratio for even high ice days, like that of STS-120 (~30%), are below the impact test levels (50%) suggesting the “mixed” ice/foam debris risk behaves more like “foam only”
 - The Ice only and Foam only risks for this debris source remain small
 - Preliminary impact analysis shows only SLA debris has a significant rebound potential at impact velocities greater than 500 ft/sec (10/30/07 CERB)
 - SLA has been eliminated
 - Ice and foam tend to “break-up” at impact velocities greater than 500 ft/sec
- The 8/16/07 Natural Environments analysis predicts the conditions for heavy ice conditions, like that observed on STS-120, is less than 1% for all hours in the months of December, January and February



<h1>STS-122 Debris Risk Assessment Summary</h1>		Presenter MS2/Jim Peters	
		Date Nov. 13, 2007	Page 24

- Debris events observed on STS-120 did not represent an increase in risk
 - There will be no IDBR-01 debris risk level or risk number updates for STS-122
 - STS-122 is the first flight with forward ATK BSMs
 - Plume performance is similar to CSD motors (based on ATK test/analysis) and does not require update of DTA CFD solutions
 - Elements cleared the SR-NBR debris emanating from ATK BSMs
 - Orbiter cleared the windows with impact testing at GRC
 - Elements cleared the Steel Debris source from the ATK BSMs

HAZARD SEVERITY AND LIKELIHOOD OF OCCURRENCE WITH CONTROLS IN PLACE

L I K E L I H O O D	PROBABLE			
	INFREQUENT			6
	REMOTE			23
	IMPROBABLE			6
		MARGINAL	CRITICAL SEVERITY	CATASTROPHIC

- **Remaining “Infrequent/Catastrophic” Causes:**
 - Orbiter AMES Gap Filler (D)
 - ET Ice located on the LO2 Feedline Bellows (S)
 - ET Ice Located on the LO2 Feedline Brackets (T)
 - Orbiter/ET Umbilical Ice (V)
 - Lift-off Debris (AD)
 - Putty Repair (AK)



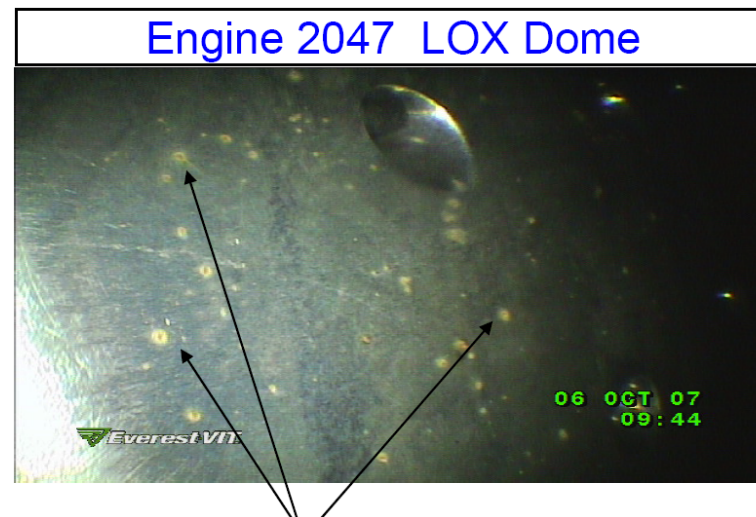
STS-118 SSME Main Injector LOX Dome Contamination Investigation

David K. Hall / PSE&I

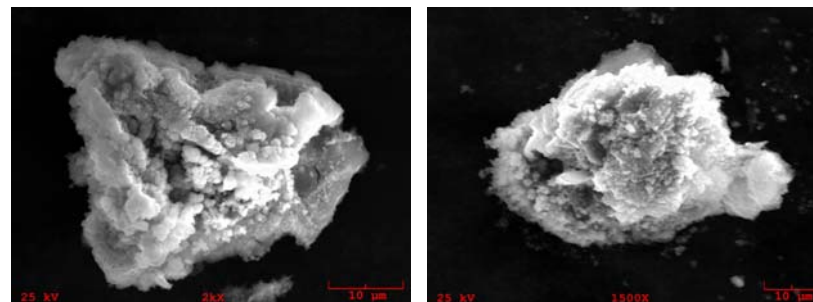
November 13, 2007

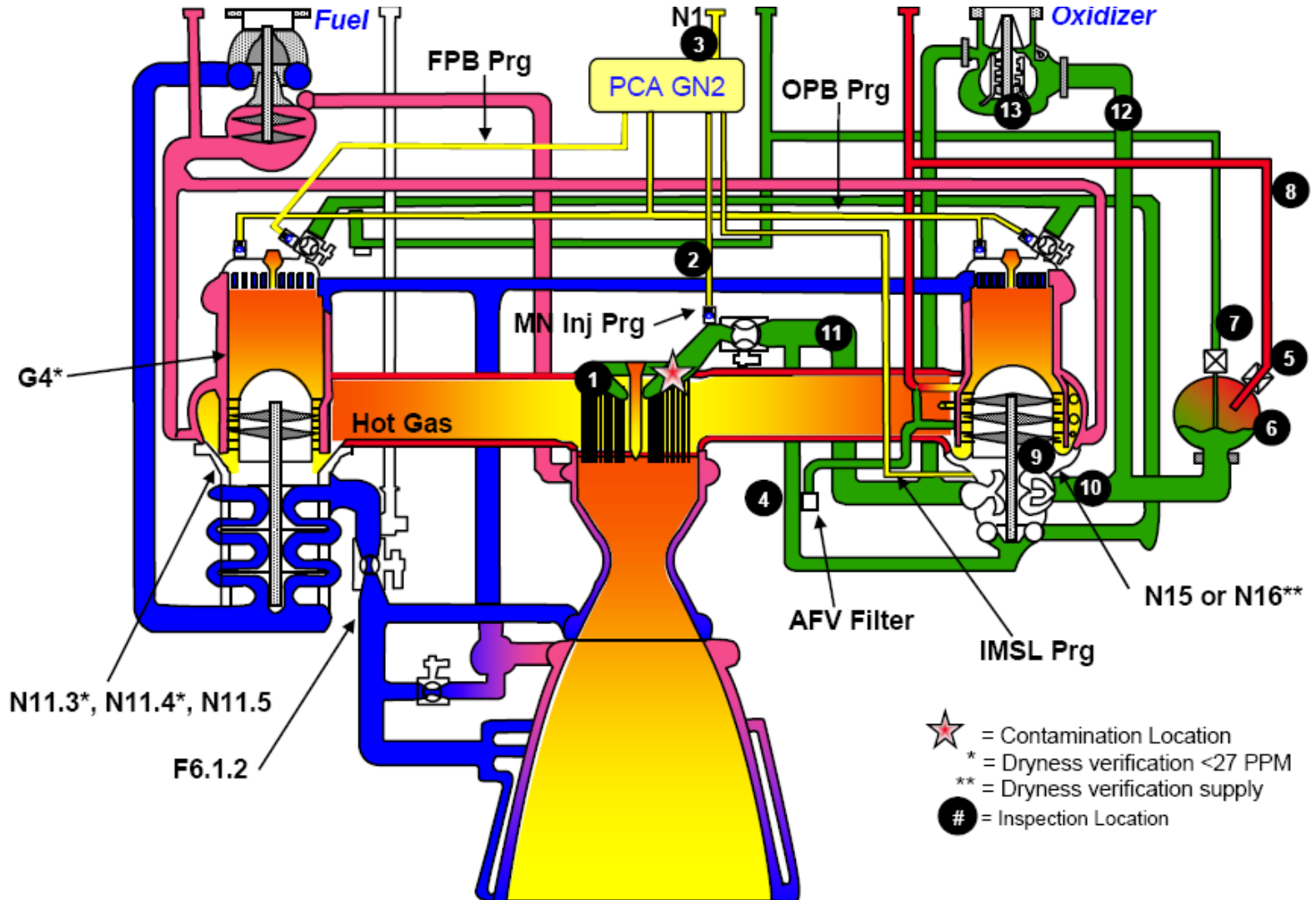
Issue

- Small (~250-1500 μ) rust stains were found in all three engines (2047, 2051, 2045) main injector LOX domes during post flight inspections
- Particle size ranges from 30 to 50 μ
- Analysis indicates particles are iron oxide (rust)
 - Most likely stemming from corrosion of low alloy based steel such as 4100 series or carbon steel
 - Unoxidized iron particles would be 2 to 3 times smaller than oxidized particles
- Source of contamination is unknown
- MLP-1 is common to STS-118 and STS-122
- SSME 2047 is ME-1 on STS-123



Iron Oxide Particles



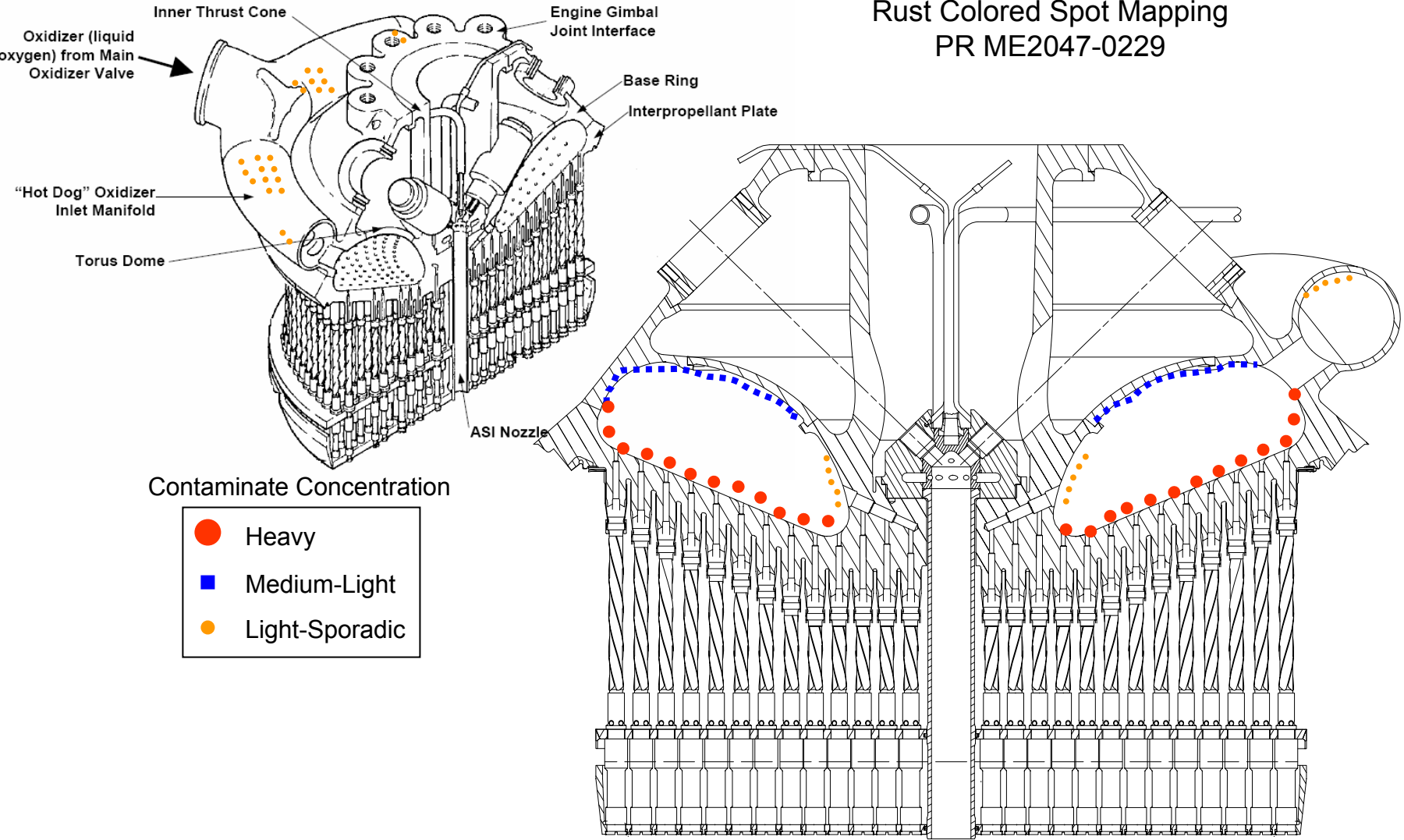


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STS-118 SSME Main Injector LOX Dome Contamination

ME2047 Main Injector LOX Dome
Rust Colored Spot Mapping
PR ME2047-0229



Note: Contamination evenly concentrated 360°



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STS-118 SSME Main Injector LOX Dome Contamination



STS-122 Flight Rationale

- Filters in the MPS system prevent particles larger than the 800 micron limit
 - Oxygen: LOX Tanker 25 μ , MLP 175 μ , ET 800 μ , Orbiter 1000 μ
 - GN2: MLP 10 μ , SSME 15 μ
 - Helium: MLP 10 μ , Orbiter 25 μ , SSME 15 μ
- STS-122 uses different hardware than STS-118 (ET, SSME, Orbiter)
 - Hardware inspected with no contamination noted
- No Integrated MPS performance anomalies experienced during STS-118
- STS-118 contamination is within allowable specifications ($\geq 50\mu$)
- STS-120 SSME LOX domes will be inspected prior to STS-122 launch (ECD 11/26/07)
- Contamination hazard captured in IMPS-02, Contamination in the Integrated MPS O2 System (Accepted Risk)
 - To date, investigation has not discovered anything that invalidates hazard controls



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STS-118 SSME Main Injector LOX Dome Contamination



Investigation Status

- LOX Dome Contamination Review Board established 10/30/07
 - Board membership includes representation from all associated Elements, Ground Processing, and Operations
 - Fault tree developed to isolate contamination source
- Contamination introduction I.D.s: LOX system, Purge systems, Ingestion
- Filter and component inspections in process
- STS-118 IIFA declared 11/5/07 (STS-118-I-008)
- STS-118-I-008 interim closure approved at SICB 11/9/07, STS-122 effectivity requested.
- Final IIFA closure planned to support STS-123
- Board meeting held 11/8/07 to initiate fault tree closeouts
 - Closed SSME components as contamination source (O₂, N₂, He)
 - Closed ET hardware as contamination source.



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Systems Engineering & Integration Office
STS-118 SSME Main Injector LOX Dome Contamination



Fault Tree Investigation Board Membership

D.K.Hall / PSE&I, Chair

Karen Spanyer / CE PSE&I, Co-chair

Brenda Eliason / SE&I

John Brewer / CE SE&I

Shawn Holcomb / PSE&I (EI MPS)

Jay Gurecki / MK SIO

Bill Ondocsin / ET

Tim Kelley / SSME

Mike Stefanovic / Ground Ops

Henry Bursian / Launch & Landing

Tom Goebel / Orbiter

Keegan Jackson / SSME S&MA



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Systems Engineering & Integration Office
STS-118 SSME Main Injector LOX Dome Contamination



Fault Tree Branch Leads

G1: John Sterritt / USA

Contamination introduced into IMPS during processing

G3: Frank Travassos / USA

Contamination introduced into SSME during IMPS operation (S007 through MECO)

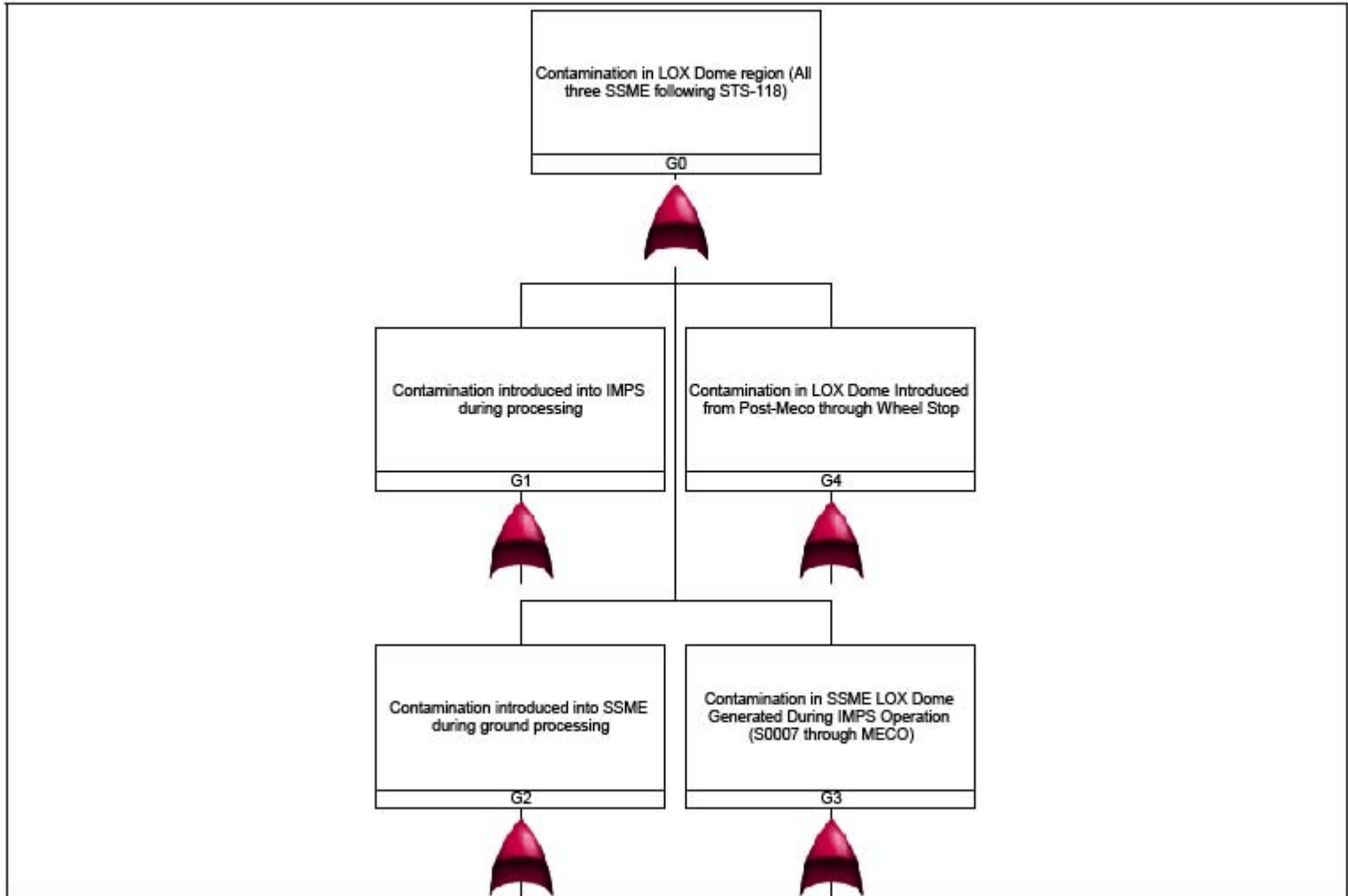
G2: Bill Muddle / PWR

Contamination introduced into SSME during ground processing

G4: John Albright / JSC

Contamination introduced into LOX Dome from Post-MECO through Wheel Stop

Fault Tree Top Layer





SPACE SHUTTLE PROGRAM

Systems Engineering & Integration Office

STS-118 SSME Main Injector LOX Dome Contamination



INSPECTIONS			ENGINES		
Description	Filter Size in micron	Loc	2047	2051	2045
MCC LOX Dome		(1)	X	X	X
MCC LOX Inlet		(1)	X	X	X
Joint N7.1 filter	20	(2)	No visual	TBD	TBD
R055613 line assy (N7-N7.1)		(2)	No visual	TBD	TBD
PCA GN2 Filter	15	(3)	No Visual/Preliminary Lab results: several Fe particles	Removal I/W	TBD
R0019561line assy (N1.2-N2)			No Visual	TBD	TBD
PCA inlet(N2)			No Visual	Removal I/W	TBD
PCA inlet(P2)			N/A	Removal I/W	N/A
AFV Filter	100	(4)	No Visual/Preliminary Lab results: Several Non metallic particles	TBD	TBD
RS007284 Line assy (O26-O27)		(5)	No Visual	TBD	TBD
POGO Z Baffle		(6)	No Visual	TBD	TBD
POGO Walls/ Baffles			No Visual	TBD	TBD
RIV standpipe		(7)	No Visual	TBD	TBD
GCV(O26)		(8)	No Visual	TBD	TBD
HPOTP I.P.S		(9)	Complete no Fe contamination noted	Samples to be taken	TBD
HPOTP Inlet		(10)	Complete, no FE contamination noted	Samples to be taken	TBD
RS007021(HPOD)		(11)	No Visual	TBD	TBD
RS007015 (LPOD)		(12)	No Visual	TBD	TBD
Joint O1.1 (LPOTP Speed Transducer)		(13)	No Visual *(CP)	TBD	Swab complete. Sample sent to CP
SSMEPF GN2 Filters	10	N/A	Backflush complete samples at CP	Backflush complete samples at CP	Backflush complete samples at CP
SSMEPF Throat plug vent hoses			Swabs at CP for analysis	Swabs at CP for analysis	Swabs at CP for analysis
Nozzle (3 locations)			Preliminary No Fe contamination noted	TBD	TBD
Main Injector Face Plate			Analysis I/W at CP	TBD	TBD
* Swab samples to be taken & tested			Contamination Noted	Inspection Complete	



SPACE SHUTTLE PROGRAM

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STS-118 SSME Main Injector LOX Dome Contamination



Areas to be inspected	Commodity	Micron Rating	Status	Responsible Organization
MLP1				
MLP1 S72-1107-01 GN2 Panel Outlet Filter	GN2	20	Completed	SSME
MLP1 S72-1107-01 GN2 Panel Outlet Filter Inlet line	GN2	N/A	Swabbed awaiting results	SSME
MLP1 S72-1107-01 GN2 Panel Outlet Filter Outlet line	GN2	N/A	Swabbed awaiting results	SSME
MLP1 GN2 PD14 Filter	GN2	10	Completed	LAA
MLP1 LO2 GN2 Leak Check and Blanket Press Filter - A86487	GN2	20	Completed	LOX
MLP1 LO2 Drain Assist Filter - A86481	GN2/Ghe	10	Completed	LAA
750 Gn2 Supply Press (inlet to 1107-03).	GN2	20	Completed Particulate Awaiting MSL Report	LAA
MLP1 LO2 SSME Bleed Purge Filter - A131194				
MLP1 S72-0685-01 Ghe Panel Outlet Filter	Ghe	10	Completed	MPS
MLP1 S72-0685-01 Ghe Panel Outlet Filter Inlet Line	Ghe	N/A	Samples at MSL	MPS
MLP1 S72-0685-01 Ghe Panel Outlet Filter Outlet Line	Ghe	N/A	Samples at MSL	MPS



SPACE SHUTTLE PROGRAM

Systems Engineering & Integration Office

STS-118 SSME Main Injector LOX Dome Contamination



Areas to be inspected	Commodity	Micron Rating	Status	Responsible Organization
OPF2				
OPF2 S70-0679-06 GN2 Panel Outlet Filter	GN2	20	Completed	SSME
OPF2 S70-0679-06 GN2 Panel Outlet Filter Inlet line swab	GN2	N/A	Swabbed awaiting results	SSME
OPF2 S70-0679-06 GN2 Panel Outlet Filter Outlet line swab	GN2	N/A	Swabbed awaiting results	SSME
OPF2 GN2 PD14 Filter	GN2	10	Completed	SSME
OPF2 MPS T-0 PD8 GHe Fill Filter	GHe	10	Filters Removed CDR I/W	MPS
OPF2 MPS T-0 PD12 LO2 Fill Filter	GHe	10	Filters Removed CDR I/W	MPS
OPF2 MPS T-0 PD13 LO2 Bleed Fill Filter	GHe	10	Filters Removed CDR I/W	MPS



SPACE SHUTTLE PROGRAM

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STS-118 SSME Main Injector LOX Dome Contamination



Areas to be inspected	Commodity	Micron Rating	Status	Responsible Organization
OV-105				
E-1 LO2 Feedline O-1 Swab	LO2	N/A	<u>Completed</u>	MPS
E-2 LO2 Feedline O-1Swab	LO2	N/A		MPS
E-3 LO2 Feedline O-1 Swab	LO2	N/A		MPS
E-1 LO2 Bleedline O-15 Swab	LO2	N/A		MPS
E-2 LO2 Bleedline O-15 Swab	LO2	N/A		MPS
E-3 LO2 Bleedline O-15 Swab	LO2	N/A		MPS
E-1 GN2 line N1 Swab	GN2	N/A		MPS
E-2 GN2 line N1 Swab	GN2	N/A		MPS
E-3 GN2 line N1 Swab	GN2	N/A		MPS
E-1 GHe line P1 Swab	GHe	N/A		MPS
E-2 GHe line P1 Swab	GHe	N/A		MPS
E-3 GHe line P1 Swab	GHe	N/A		MPS



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Systems Engineering & Integration Office
STS-118 SSME Main Injector LOX Dome Contamination



Other areas of investigation:

- Components within the Orbiter MPS were identified to contain metal parts similar to the suspect steel alloy contamination source
 - MC284-0396-0009 12" LO2 Pre-valves
 - MC284-0403-0003 LO2 Repress solenoids LV40/41
 - MC284-0403-0011 Pneumatics Iso valves LV7/8
 - MC284-0406-0002 LO2 Manifold Relief Iso valve PV7
- MPS personnel are reviewing the design specs of these components to determine if the parts containing the suspect material are exposed to LOX flow or “wet” and could have liberated iron particles
- *SSME and ET components were determined to be free of the suspect material*
- MPS, SSME, and PSIG personnel have reviewed the performance data from STS-118 of valves and actuators that are in the LOX, and purge gases systems and have found all to have been in family with no signs of component operational degradation
- Swabs have been taken from sources outside of the MI to rule out ingestion (I/W)



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Systems Engineering & Integration Office
STS-118 SSME Main Injector LOX Dome Contamination



Forward Work:

- **Completion of collection and analysis of swab samples**
- **“Wet” component material determinations**
- **Board will reconvene on Wednesday 11/14/07 to continue review of fault tree team close out rationales**
 - **Board will meet on as often as necessary to continue fault tree close out**
 - **Target completion date is NLT STS-123 L-2 Review**
- **Documentation of Board findings**



STS-122 FLIGHT SOFTWARE SUMMARY

Presenter	MS4/Darrell E. Stamper	
Date	11/13/07	Page 40

- **No FSW code changes from STS-120**
 - **Primary Avionics Software System (PASS) and Backup Flight System (BFS)**
 - Second Flight of OI-32
 - One new BFS-only K-load patch to update N₂/O₂ flow rate FDA limits
 - **Multifunction Electronic Display Subsystem (MEDS)**
 - Second Flight of MEDS Integrated Display Processor/MEDS Display Unit Function (MDUF) combination (VI 5.00/5.00)
 - **Miniature Airborne Global Positioning System (GPS) Receiver Shuttle - 3 String (MAGRS-3S)**
 - Sixth flight of Link 7



STS-120 In-Flight Anomaly

Presenter **MS4/Darrell E. Stamper**

Date **11/13/07** Page **41**

- **STS-120-S-001, (MER-18) Spec 205 Displaying Incorrect Data**
 - **PASS Reconfigurable SPEC 205 (ISS MSC Moding) was tested during STS-120 and displayed data that was inconsistent with actual ISS Configuration**
 - **Investigation showed the issue to be broader than SPEC 205**
 - **Issue appears to be caused by incorrect transmission of OIU datastream to PASS SM GPC and may have broader effects**
 - **Most significant effect is a loss of annunciation of ISS C&W messages from SPEC 211**
 - **Includes ISS Cabin pressure, fire and toxic atmosphere**
 - **Both the RF and hardline configurations showed anomalous behavior**
 - **ISS to Shuttle downlink path was unaffected by anomaly**
 - **Status**
 - **SPEC 205 is not required or planned for use during STS-122 but we continue to investigate the broader impacts**
 - **Anomaly remains unresolved - Working to determine root cause**
 - **Working with SSP and ISS safety to determine if there is an STS-122 requirement for SPEC 211 C&W messages**
 - **Acquiring ISS hardware required to support planned (11/14 or 11/15) end to end SAIL test**
 - **Will return at L-2 with the results of the testing**



STS-122 FLIGHT SOFTWARE READINESS SUMMARY

Presenter	MS4/Darrell E. Stamper	
Date	11/13/07	Page 42

- **Integrated Avionics Verification (IAV) is complete**
 - A total of 14 test cases were performed in the Shuttle Avionics Integration Laboratory (SAIL) and successfully analyzed in support of STS-122
- **SAIL facility will be in a condition of readiness for mission support**
- **Formal Software Readiness Review (SRR) was conducted on 11/01/07**
 - No known constraints
- **With the successful completion of scheduled open work, FSW is in a condition of readiness for flight**



STS-323 (STS-122 Rescue Mission)

Presenter **MS4/Darrell E. Stamper**

Date **11/13/07**

Page **43**

- **In the event of call-up by SSP, STS-323 would be flown on OV-105 using the STS-123 Base Load as well as the flight specific I-load patches released for the STS-323 Rescue LON.**
 - **Pre-Callup work**
 - **Patch for flight specific I-Loads was generated and released for training**
 - **Post Call-up**
 - **Development/release of PASS 6X Traj Altitude Initialization data patch**
 - **Development/release of BFS HUD Velocity Scaling patch**
 - **Level 8 and Integrated Avionics Verification**
 - **No changes required for MEDS or MAGRS-3S**
- **Formal Software Readiness Review will be conducted after call-up.**
- **Per template, LON call-up is required by 12/12/07 to support a 01/31/08 LON launch date.**



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



	Presenter MS/Darrell Stamper
	Date 11-13-07 Page 44

PGSC Readiness for STS122 Payload and General Support Computers

November 13, 2007

Pre-decisional. Internal Use Only



STS-122 PGSC Flight Readiness Review

Presenter
MS/Darrell Stamper

Date **11-13-07**

Page **44.1**

- **Integrated PGSC Hardware and Software test to be completed on Nov. 16, 2007**
- **All PGSC's, Docking station's, peripheral cards, and cables are different serial numbers for STS-122.**
- **8th Flight of A31p Laptops, 2nd Flight of A31p Docking Station, 2nd Flight of Windows XP**
- **Numerous PGSC Issues occurred on STS-120 mission**
- **Typically each issue would be tested upon return of hardware to Houston**
- **Testing may not complete before flight of STS122 occurs**



STS-120 Issues Status	Presenter MS/Darrell Stamper	
	Date 11-13-07	Page 44.2

- **Windecom Docking station didn't have power during setup**
 - **Spare cable used, test original cable upon return**

- **TCS connectivity issues during rendezvous tools checkout**
 - **Swapped Quatech card because couldn't see COM2 Port**
 - **TCS data cable and extension cable swapped with spares**
 - **All Cables and Quatech cards will be tested upon return**
 - **TCS will be tested in Bldg44**

- **Intermittent network**
 - **Entire Coax pre-routed network swapped out with cables from ISS**
 - **Pre-routed Cables will be tested upon return to Houston**



STS-120 Issues Status (Cont.)

Presenter

MS/Darrell Stamper

Date

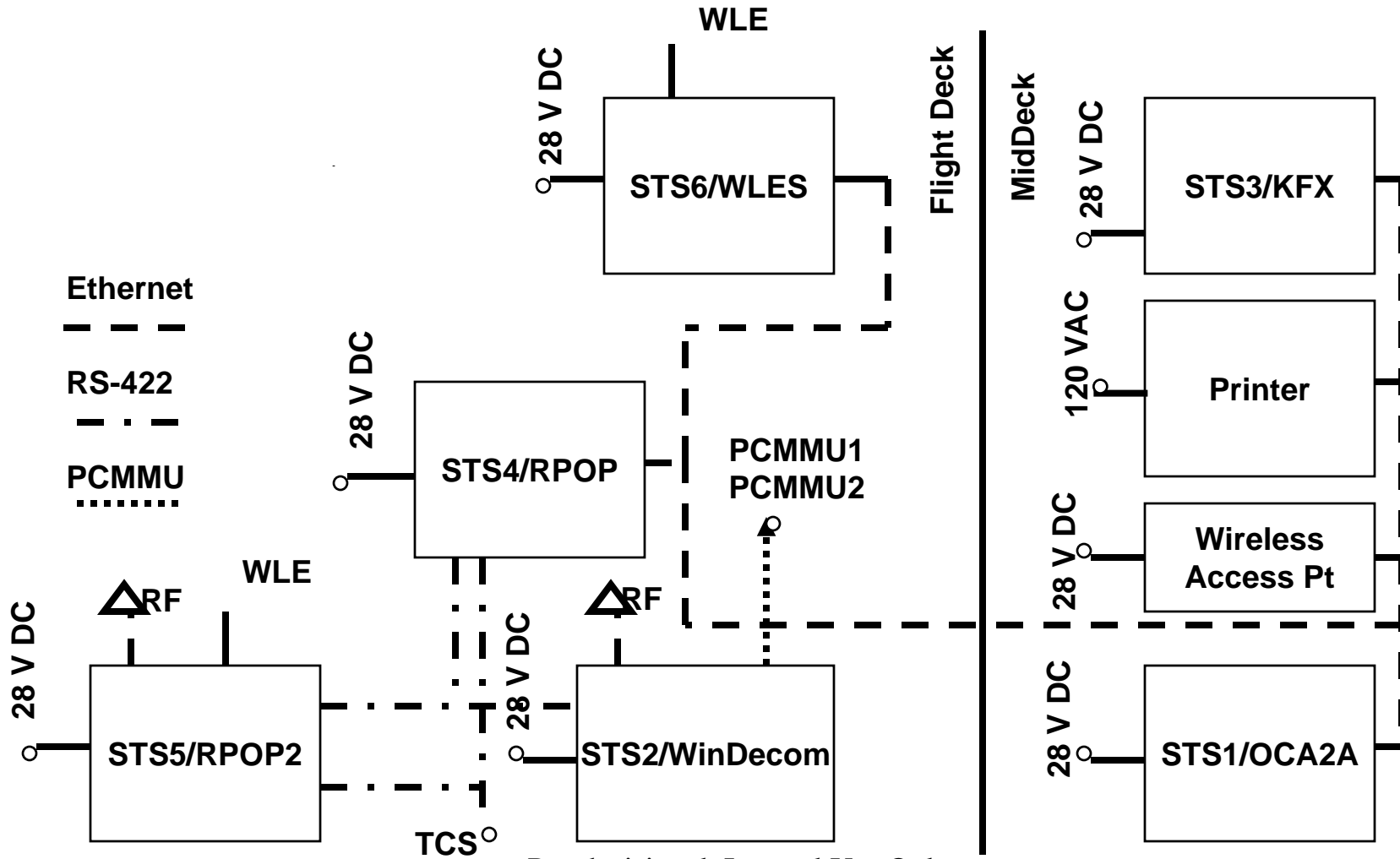
11-13-07

Page **44.3**

- **WinDecom Fuel Cell Monitoring (FCM)**
 - **Fuel Cell Data updates for 5 or 6 seconds and periodically goes static**
 - **SAIL testing confirmed anomaly. FCM Software modified, retested successfully.**
- **STS-6 monitor failure**
 - **Very low hours on this unit**
 - **Unit will be tested upon return to Houston**
- **WLES Timeouts during crew sleep periods**
 - **Hardware will be tested upon return to Houston**



<h1>STS-120 PGSC Configuration</h1>		Presenter MS/Darrell Stamper
		Date 11-13-07 Page 44.4

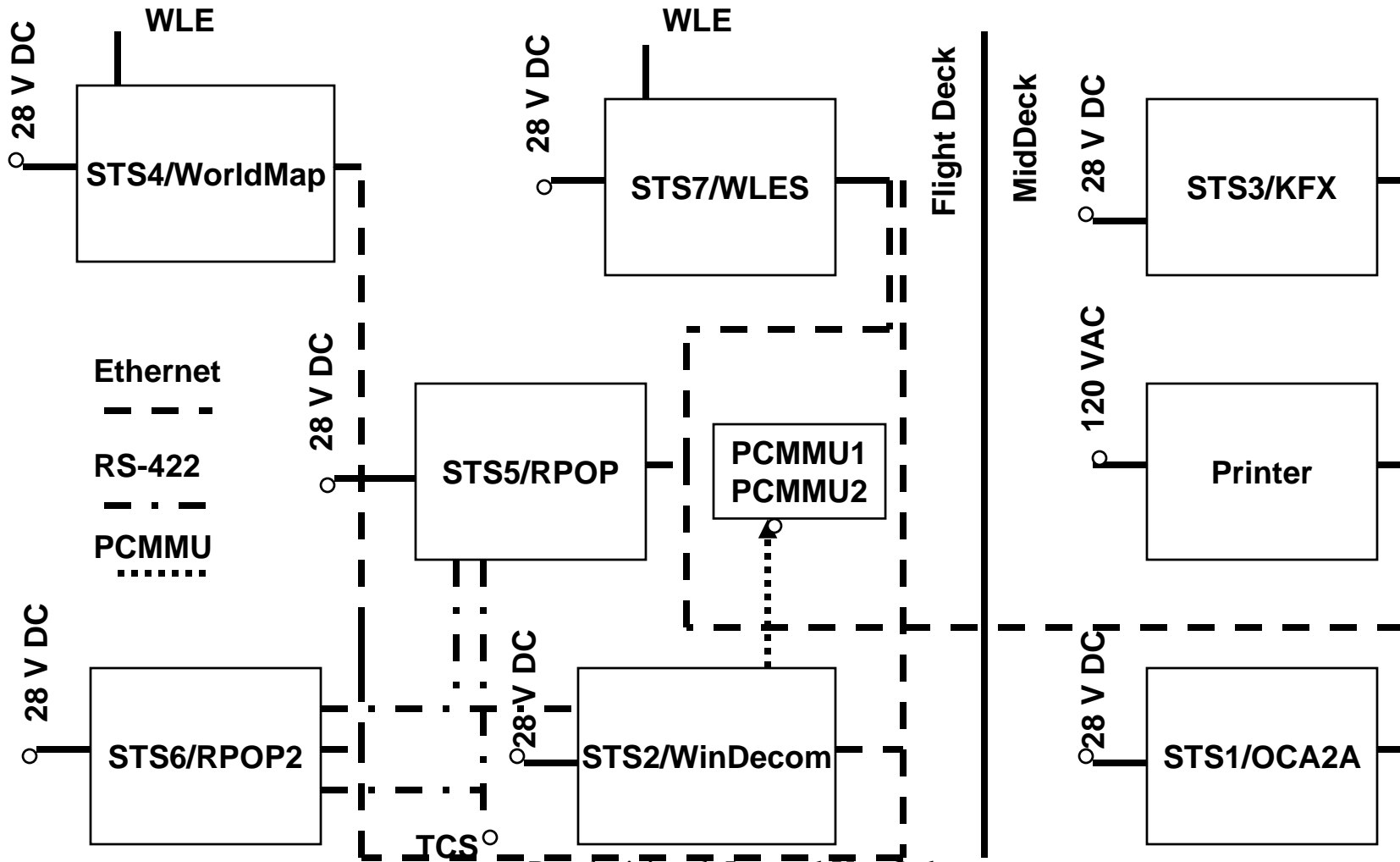


Pre-decisional. Internal Use Only



STS-122 PGSC Configuration

Presenter	MS/Darrell Stamper	
Date	11-13-07	Page 44.5



Pre-decisional. Internal Use Only



STS-122 PGSC Flight Readiness Review

Presenter

MS/Darrell Stamper

Date

11-13-07

Page 44.6

The following steps are being taken for risk mitigation for the STS-122 mission

- Test on vehicle on PAD in work to verify flight cables and all flight hardware is good. Network will be set up and verified for proper operation. Chit requesting this test will be submitted today. Additional test in SAIL is being planned for STS-122 PGSC configuration.
- SAIL testing to verify PCMMU interface with Fuel Cell Monitoring (FCM) System. SAIL testing on Nov. 11, 2007 duplicated STS-120's FCM anomaly. FCM Software modified, retested, and successfully resolved issue
- Flight Data File change to test network after each interim configuration being proposed. Due lateness of request, flight note offered and will be satisfactory.
- Additional cables and terminator being added to manifest
- Manifesting all new PGSC hardware, successfully passing the integrated test, and the completion of all risk mitigation steps provides adequate justification of flight readiness of PGSC system for STS-122



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



STS-120 PGSC IFA/Anomaly List	Presenter MS/Darrell Stamper
	Date 11-13-07 Page 44.7

Tracking #	Description
STS-120-S-002 (INT-15)	PGSC Windecom Anomaly-- Tested, Duplicated, S/W modified, retested, success
STS-120-S-003 (MER-05, INT-09)	Trajectory Control Sensor (TCS) Error Message During RNDZ Tools Checkout
STS-120-S-004 (INT-06)	PGSC Network Communication Issues
STS-120-S-005 (MER-03)	Wing Leading Edge Laptop Local Timeouts
STS-120-S-006 (MOD-2826)	STS6 PGSC Loss of Monitor
STS-120-S-007 (INT-04)	Suspect Power Cable to Windecom PGSC

Pre-decisional. Internal Use Only



INTEGRATED HAZARD REPORT CHANGES SINCE STS-120	Presenter MS/Don Noah	
	Date 11/13/07	Page 45

- **Five Integrated Hazard Reports updated since STS-120**
 - **IEPD-01, “Inability to Power Critical Functions”**
 - **ISPR-05, “SRB Umbilical System Malfunction”**
 - **ILIT-01, “Failure to Avoid Lightning”**
 - **IARO-01, “Aerodynamics Environment Not Per Specified Design”**
 - **IMPS-01, “Contamination in the Integrated MPS H2 System”**



SIGNIFICANT INTEGRATED HAZARD REPORT CHANGES SINCE STS-120	Presenter MS/Don Noah	
	Date 11/13/07	Page 46

- **IEPD-01, “Inability to Power Critical Functions”**
 - **Decreased Risk Classification from Accepted Risk to Controlled**
 - **Elimination of Cause AR, Fuel Cell Failure to Meet Demand due to Contaminated Reactants in PRSD/Cyro Tank**
 - **Was Remote/Critical (Accepted Risk)**
 - **Resulted from assessment of very low likelihood and very strong controls in place**



STS-120 INTEGRATED IFAs	Presenter MS/Don Noah	
	Date 11/13/07	Page 47

IIFA / MSFC PRACA Record	Integrated In Flight Anomaly Title	Integrated Hazard Report	STS-122 Closure Status
STS-120-I-001 I00107	LH2 Umbilical Ice Noted Prelaunch	IDBR-01	CLOSED
STS-120-I-002 I00108	GUCP Ice Bridged to ET Intertank Foam	IDBR-01	CLOSED
STS-120-I-003 I00109	LH2 Tank Acreage Debris Losses	IDBR-01	CLOSED
STS-120-I-004 I00110	Unexpected Debris/Expected Debris Exceeding Mass Allowable Prior to Pad Clearance (Liftoff Debris)	IDBR-01	CLOSED
STS-120-I-005 I00113	Debris Release on Outboard Side of Feedline at 277 seconds	IDBR-01	CLOSED



STS-117/118 INTEGRATED IFAs	Presenter MS/Don Noah	
	Date 11/13/07	Page 48

IIFA / MSFC PRACA Record	Integrated In Flight Anomaly Title	Integrated Hazard Report	STS-122 Closure Status
STS-118-I-002 I00103	LO2 Feedline Bracket Loss	IDBR-01	CLOSED
STS-118-I-008 I00112	Rust Colored SSME LOX Dome Contamination	IMPS-02	CLOSED
STS-117-I-007 I00096	FOD Found in Aft Compartment	IMEO-01	CLOSED



LON Status

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- **Mission Design & Support Requirements**
 - **STS-323 Flight Requirements Document, September 21, 2007**
 - **NSTS 17462-323, Rev. 3**
 - **The primary objective of the STS-323 crew rescue flight is to return a stranded STS-122 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 CPCS capability**
 - **The STS-323 targeted launch date (1/31/08) is 56 calendar days from the planned launch of STS-122**
 - **STS-323 would utilize the STS-123 vehicle (OV-105) in the empty payload bay configuration (no payloads installed)**
 - **Sidewall payloads are removed post call-up**
 - **Sidewall carriers and associated hardware will remain installed (approximately 1460 lbs)**
 - **First flight of OI-32 flight software on OV-105**
 - **First Flight of ET Umbilical digital flash**



LON Status

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- **System Integration's STS-323 Flight Products**
 - **FRV required for first flight of OI-32 on OV-105 (Completed on 10/03/07)**
 - **Leverage STS-123 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-123**
 - **Requirements documented in the STS-323 FRD and TDDP**

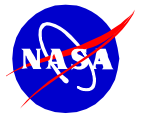


LON Status

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- **Flight Readiness Verification**
 - FRV results to SIRB **Completed**
 - No updates to process, methods, or databases
- **Mission Unique Open Work (Post call-up for Launch NET 1/31/08)**
 - **Loads & Dynamics**
 - Liftoff Loads Flight Margins Assessment (FMA) **ECD: L-3 Wks**
 - **Integrated Propulsion**
 - ET Pressurization Assessment **ECD: L-2.5 Wks**
 - RSRM Preflight Assessment **ECD: L-2.5 Wks**
- **Standard Open Work (Post call-up for Launch NET 1/31/08)**
 - Uplink (Update) FRV Assessment **ECD: L-1 Wk**
 - Normal Pre-launch Configuration and Testing **ECD: L-1 Wk**

No technical and/or schedule constraints to STS-122 or STS-323 call-up



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Back-up charts



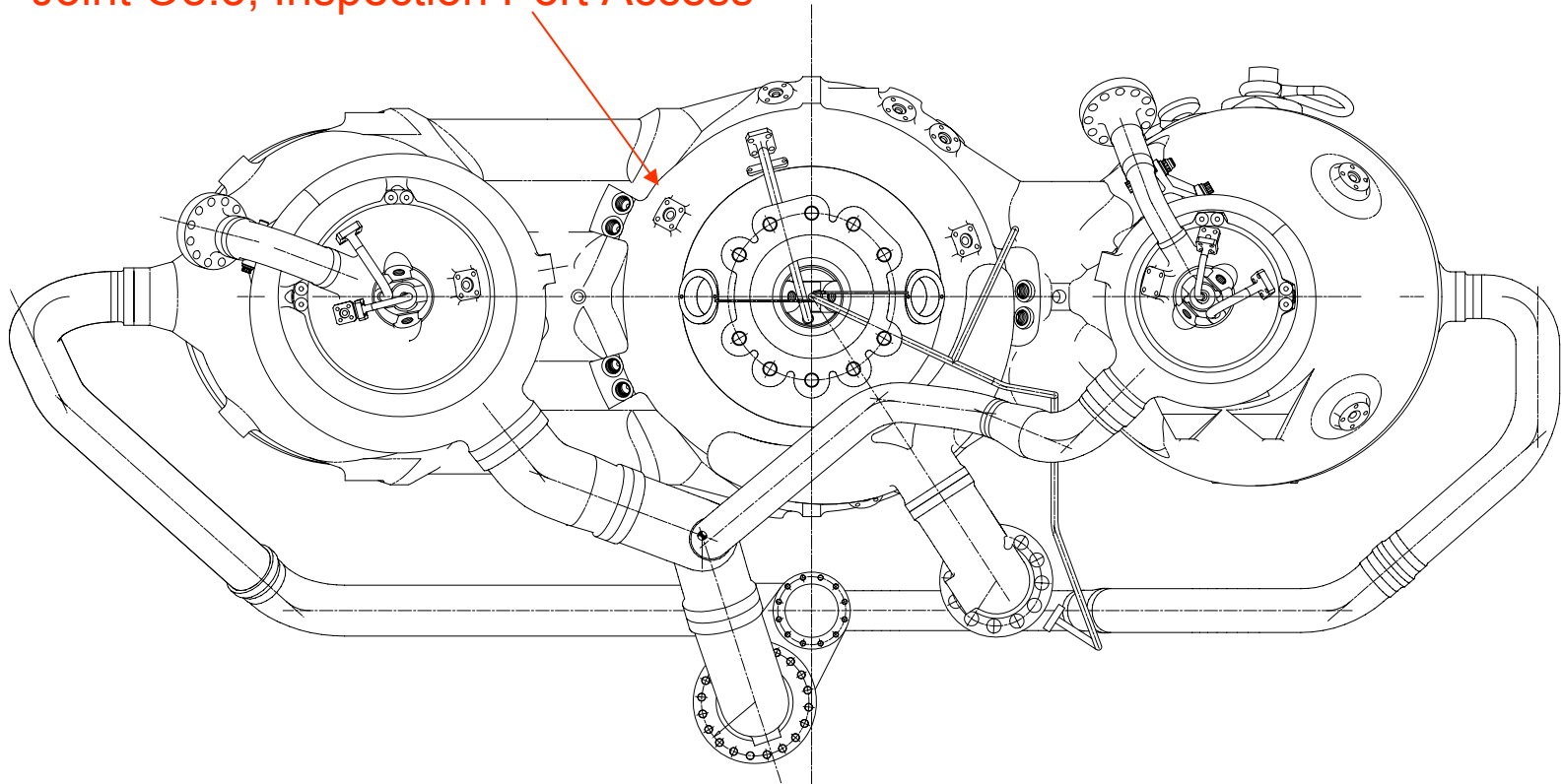
Standard Open Work Summary

Presenter	MS/Don Noah	
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Open Work	Completion Date
DOSS	
- L-3 week test / TCDT	11/20/07
- L-7 day SIRB review	11/30/07
- L-2 verification test (incorporate L-8 day TDDP & L-3 day change notice)	12/04/07
GN&C	
- Update FRV results to SIRB	11/30/07
- Normal prelaunch configuration & testing	12/03/07
Loads & Dynamics	
- Normal prelaunch configuration and testing	12/03/07
Ground Systems Integration (GSI)	
- Incorporate RCN KS16931, Prepress Control Valve Timing	11/09/07
- Verify incorporation of integrated ground software changes	11/09/07
Integrated OMRS	
- Approval of OS17520, S00-RCD RCN STS-122 PCM/PDI Table	11/09/07
Program Configuration / Verification	
- MECSLSI update to reflect removal of ET sep camera flash unit	11/09/07

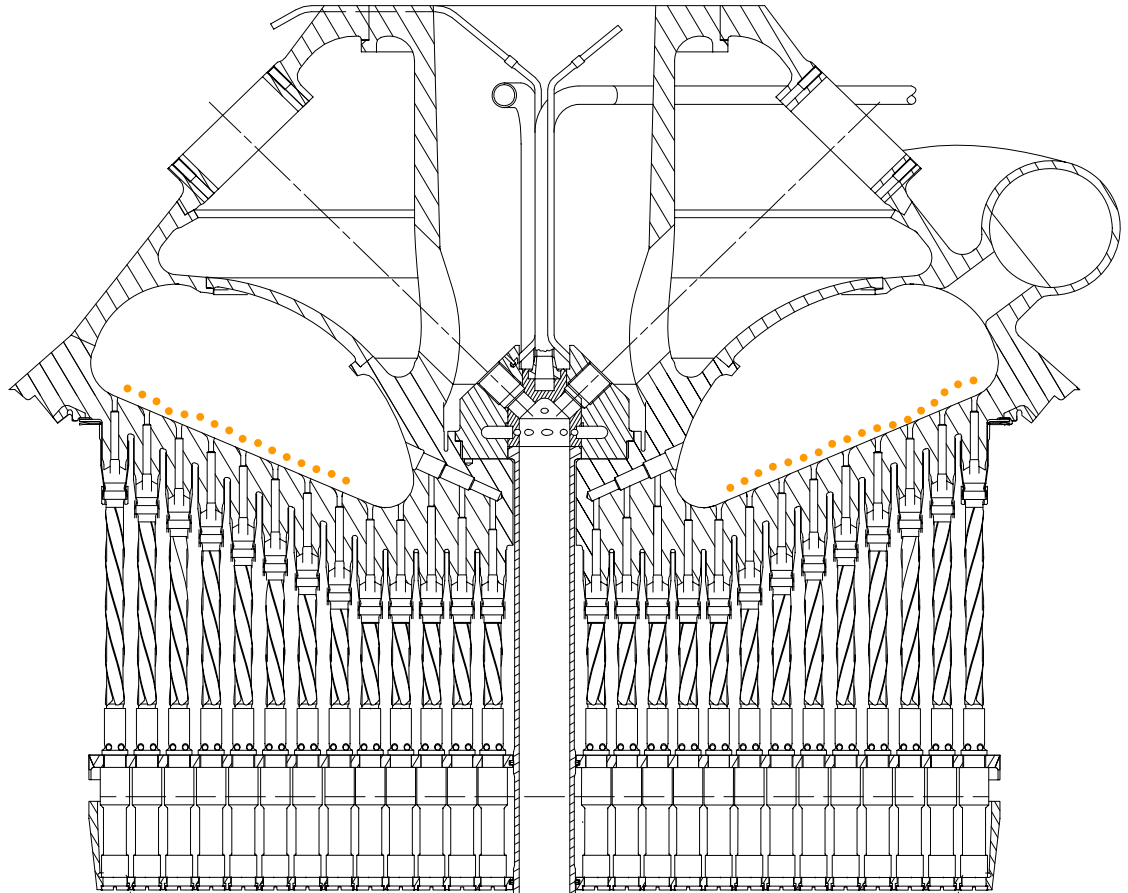
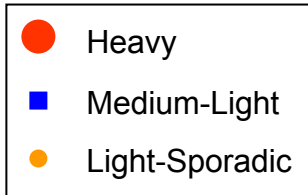
Powerhead Orientation

Joint O8.3, Inspection Port Access



ME2051 Main Injector LOX Dome
Rust Colored Spot Mapping
PR ME2051-0210

Contaminate Concentration

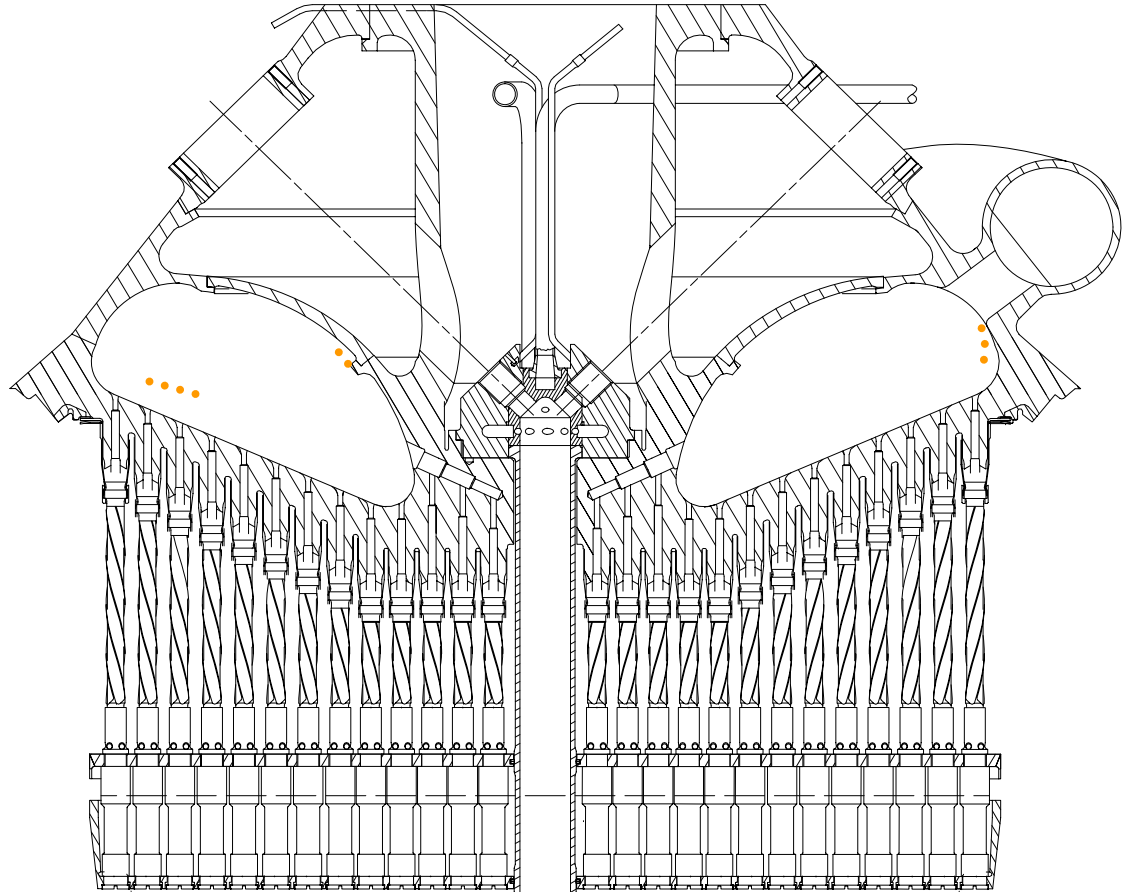
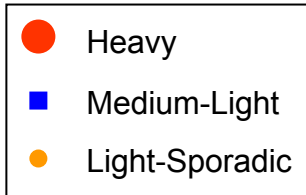


Note: Contamination is evenly distributed 360°

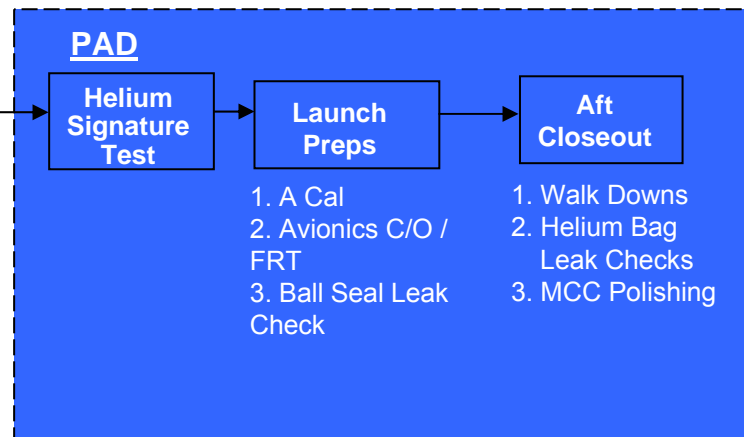
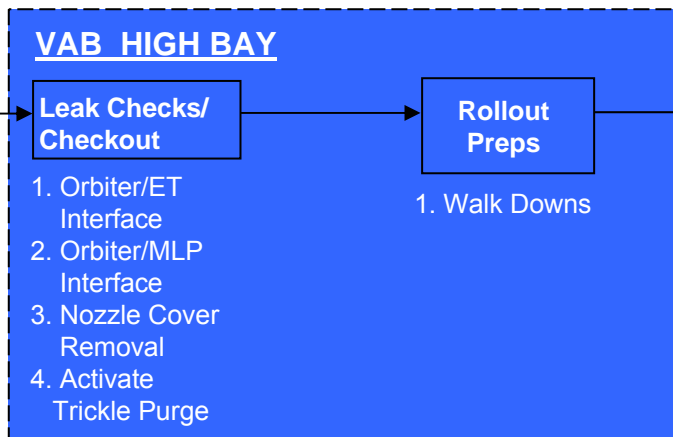
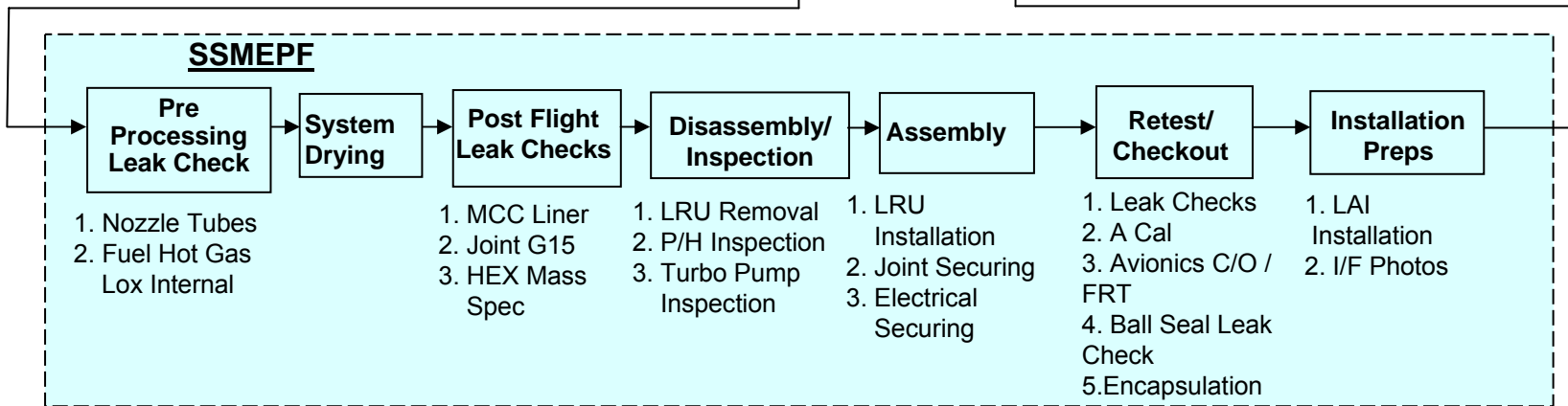
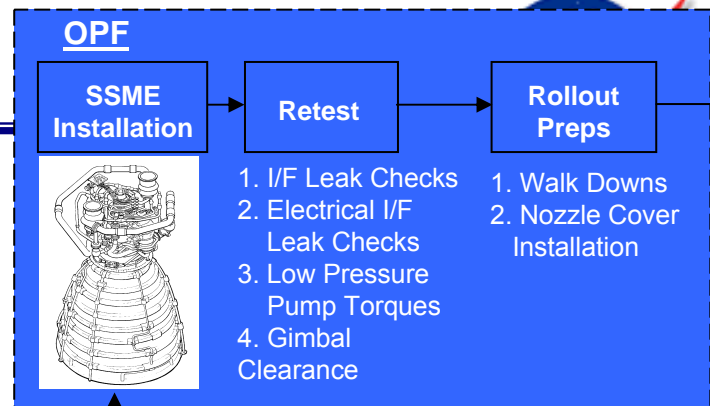
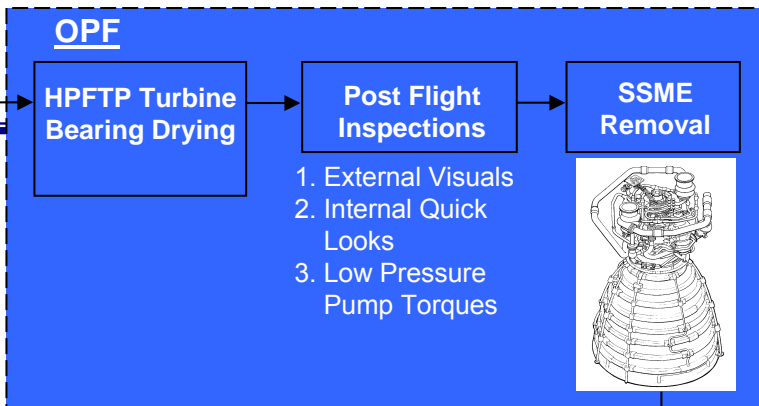
ME2045 Main Injector LOX Dome
Rust Colored Spot Mapping
PR ME2045-0291

ME2045 spot count is < 10 spots

Contaminate Concentration



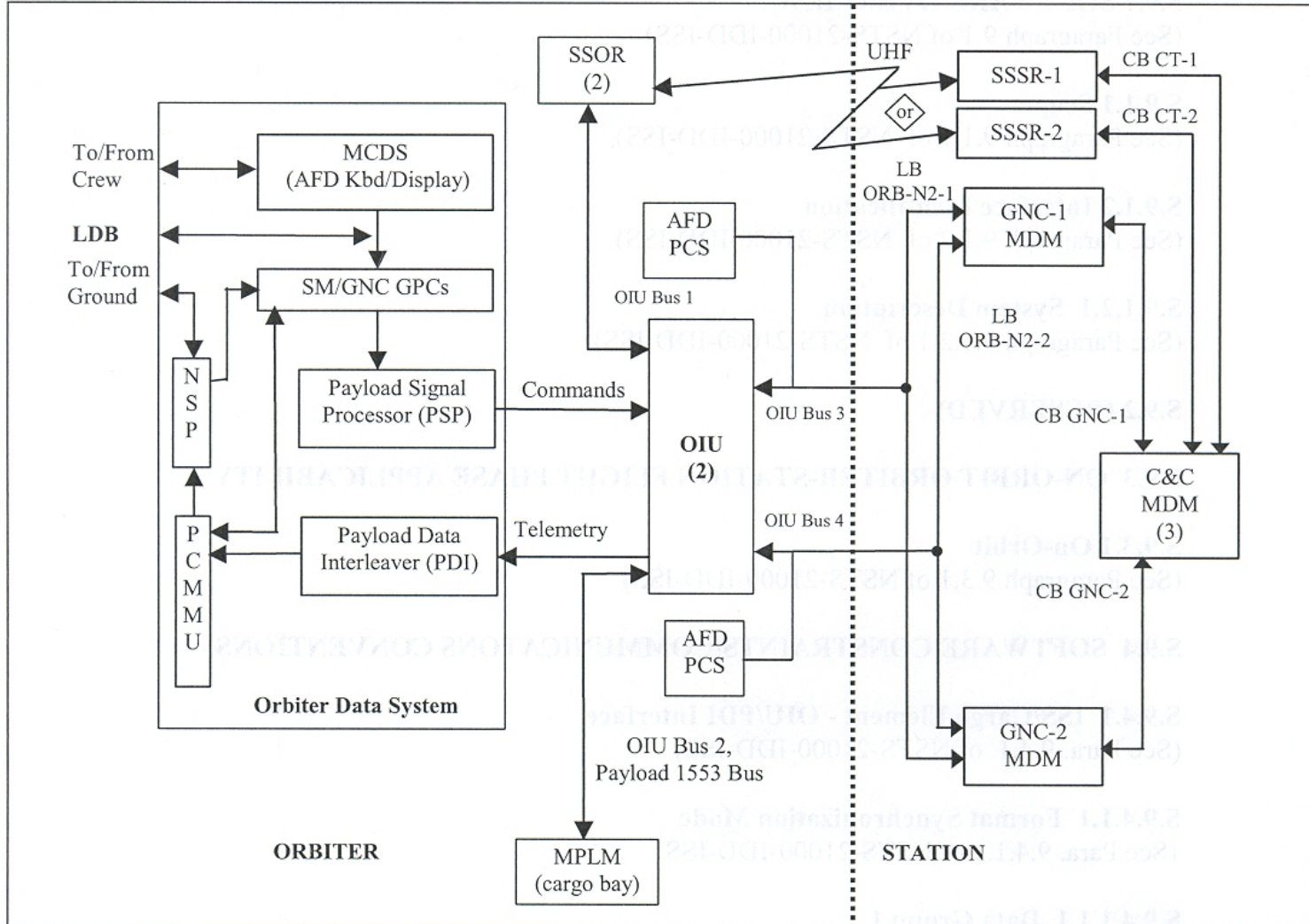
KSC SSME VALUE STREAM





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OIU Interfaces Diagram





SPEC 205 - ISS Motion Control System

Presenter **MS4/Darrell E. Stamper**

Date **11/13/07** Page **61**

FIGURE 6.03-1
ISS MODE CONTROL SOFTWARE MODING

JSC-19478-120
6/12/07 B 5

5	10	15	20	25	30	35	40	45	50
XXXX/205/XXX ISS MCS MODING XX X DDD/HH:MM:SS									
STATUS									
US GNC MODE XXXXXXXX CONTINGENCY DOCKING									
RS GNC MODE XXXXXXXX DOCK SOFTWARE ENA 10									
US/RS GNC COMM XXXX SEQUENCE INIT 11X									
GNC MDM FRAME COUNT XX									
US PRI GNC MDM XXXXS CONTINGENCY UNDOCKING									
CMG ATT CNTL XXXXS POST DEP CNTL MODE XXXXXXXX									
REROUTE TO SSOR 1 UNDOCK SOFTWARE ENA 12									
ROUTE NORM HARDLINE 2 SEQUENCE INIT 13X									
NO OP COMMAND 3 XXX TIME SINCE SEP XXX									
OFF NOMINAL COMMANDS									
15 INHIBITS ENA INH INCORP MASS PROP 14									
MODE XTION 4 8 XXX DOCKED IND 15X									
ATT MNVR 5 XXX UNDOCKED IND 16X									
DESAT REQ 6 XXX HOLD CURRENT ATTITUDE 17									
ATT CNTL SHDN 7 XXX RS TAKE LVLH ATT CNTL 18									
HANDOVER CNTL TO ORB									
US DRIFT AVAIL XXX									
MODE TO DRIFT 9									
HANDOVER CNTL TO ISS									
RS PREP FOR CMG DESAT 19									
THRSTR AVAIL FOR DESAT XXX									
MODE TO CMG TA 20									
(XX)									




<h1>INTEGRATED HAZARD RISK MATRIX</h1>	Presenter MS/Don Noah	
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Likelihood	Probable		
	Infrequent	2	17
	Remote	2	3(*4) 136(*138)
	Improbable	11	11(*13) 308
		Marginal Critical Catastrophic	

Risk Summary
 22 of 38 IHR's are classified as Controlled Risk
 16 of 38 IHR's are classified as Accepted Risk
 * Previous Flight

Pre-decisional. Internal use Only.

Hazard Report #	Integrated Hazard Titles	Controlled					Accepted Risk					proable-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
		"Accepted Risk" Hazard Reports													
IDBR-01	Ascent 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				
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					1				1				
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 ²	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	1				1				
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	
	Accepted Risk Distribution Totals	(see next page)					158	0	2	3	136	0	0	17	0



SE&I UAs SINCE RTF

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- **19 Unexplained Anomalies for SE&IO since RTF**
 - **PRACA dispositioned and closed**



SE&I UA SINCE RTF EXAMPLE

Presenter	MS/Don Noah	
Date	11/13/07	Page 66

- **STS-114-I-018 and STS-115-I-004 - LH2 ECO FAILED WET (PRELAUNCH)**
 - **Description**
 - **STS-114 tanking test 1 experienced two intermittent LH2 ECO failed WET anomalies on circuit #3 and #4**
 - **STS-114 tanking test 2, LH2 ECO circuit performance was nominal**
 - **ET swap for heater mod occurred after tanking test 2 (120 R&R'd with 121)**
 - **Point Sensor Box 110 experienced power card failure during post-mate testing and was replaced with PSB 111**
 - **STS-114 launch attempt experienced a WET failure on LH2 ECO circuit #2**
 - **STS-115 launch experienced a WET failure on LH2 ECO circuit #3**
 - **STS-121, LH2 5% sensor channel failed WET (same failure mode)**



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- **STS-114-I-18 and STS-115-I-004 - LH2 ECO FAILED WET (PRELAUNCH)**
 - **Most Probable cause is Cryogenic tanking induced high impedance/open in measurement path (internal or external to point sensor box)**
 - **System checkout enhancements implemented**
 - **Expanded Point-Sensor Box ATP**
 - **PSB Sensor Excitation, Return, Output wires separated and/or protected with Teflon sleeving**
 - **Orbiter instrumentation installed for real-time monitoring**
 - **OMRSD expanded**
 - **LH2 sensor manufacture/test enhancements**
 - **Swage inspection/measurement**
 - **Nanofocus inspections**
 - **Continuity/isolation tests per OMRSD File IV**
 - **LCC modifications, sensor monitoring (sim commands)**
 - **System redundancy and likelihood of occurrence were included as part of flight rationale**



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- **STS-112 – System A pyrotechnics on the SRB HDP frangible nuts and External Tank Vent System (ETVAS) failed to fire**
 - **Description:**
 - **Immediately after liftoff the Ground Launch Sequencer Indicated that the Pyrotechnic System A for the Hold Down Post (HDP) and ET Vent Arm System (ETVAS) did not discharge**
 - **System B performed nominally**
 - **Most probable cause was an electrical open at the T-0, within the TSM/Orbiter interface connector.**
 - **Mating process, pin surface corrosion, and a weak spring were the possible contributors.**
 - **Several Investigations performed and several enhancements have been implemented**



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- **STS-112 – System A pyrotechnics on the SRB HDP frangible nuts and External Tank Vent System (ETVAS) failed to fire – FLIGHT RATIONALE**
 - **New Requirements/Controls:**
 - General connector pre-mate inspection
 - Spring rate testing
 - End gap measurements
 - Cable fabrication procedure update to verify minimum pin set back
 - Connector inspection spec, go/no-go tool for pin engagement, USA quality buy
 - New connector assembly drawing to control overall connector length
 - Conduct post-flight launch data review on all circuits active at T-0
 - **Process Enhancements**
 - Replace all T-0 8 ft cables every flow
 - Each mate is video-scoped/recorded to ensure proper connector mate
 - Use of new connector alignment tool minimized risk of connector mis-alignment
 - Mating procedure and MLO specification revised to reflect best mating process



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- **STS-112 – System A pyrotechnics on the SRB HDP frangible nuts and External Tank Vent System (ETVAS) failed to fire – FLIGHT RATIONALE**
 - **Design Mods**
 - **Pyro Redundancy modification**
 - **Kapton elimination in long-run TSM cables**
 - **TSM Bulkhead modified to allow production break in J65 and J71 T-0 cables**
 - **Modeling/Verification**
 - **Finite Element Model was completed by Rocketdyne in 2005**
 - **Rocketdyne used actual acceleration and displacement data from STS-115 and STS-117 to validate the FEM**
 - **Actual accels less than those predicted by FEM**
 - **Actual displacements less than those predicted by FEM**
 - **Loads Panel and NESC reviewed the report and agree with assessment**



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- **STS-114**
 - I-034 – MISSING AFT SKIRT SHOE SIDEWALL MATERIAL (POST LOCATION 7)
 - I-018 – LIQUID HYDROGEN (LH2) ENGINE CUTOFF (ECO) #2 SENSOR FAILED WET DURING TEST
 - I-025 – POTENTIAL ASCENT IMPACT SITE TO RH SRB ET ATTACH RING FOAM
 - I-026 – RT 455 MISSING AFT OF INBOARD RH BOOSTER SEPARATION MOTOR (BSM) TRIPLE MOTOR HOUSING
 - I-043 – SSME 1 RECIRCULATION ISOLATION VALVE (RIV) DID NOT RETURN TO 100% OPEN AFTER PROPELLANT DUMP
 - I-044 – AFT COMPARTMENT HIGH O2 CONCENTRATIONS
- **STS-121**
 - I-006 – LH2 5% SENSOR CHANNEL FAIL WET
 - I-015 – AUXILIARY POWER UNIT (APU) 1 FUEL TANK UNEXPLAINED PRESSURE DECAY
 - I-016 – ANOMALOUS SHIFT NOTED IN SSME 3 PRESSURES



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- **STS-115**
 - I-004 – STS-115 LH2 ECO #3 FAILED WET
 - I-003 – SRB EDAS CHANNEL 4 DATA DROPPED AT T+50 SECONDS INTO STS-115 LAUNCH
 - I-008 – FDO ABORT REGION DETERMINATOR(ARD) INDICATED ERRONEOUS RTLS ABORT AT 18 SECONDS MET.
 - I-012 – SUSPECT IMPACTS ON SINGLE AFT BSM COVER TPS
- **STS-116**
 - I-006 – MISSING STIFFENER RING FOAM WITH HEAT EFFECTS
 - I-007 – FELT REUSABLE SURFACE INSULATION (FRSI) PLUGS MISSING
 - I-011 – ORBITER TILE DAMAGE AROUND ET DOOR
- **STS-117**
 - I-003 – HELIUM BUBBLING OUTLET PRESSURE DECAYED TO 6 PSIG PRIOR TO T-0
 - I-005 – TILE PIECE FROM THE AFT FUSELAGE BODY FLAP INTERFACE LIBERATED DURING LIFTOFF/ASCENT
- **STS-118**
 - I-005 – ROPE-LIKE OBJECTS FLAPPING NEAR AFT LSRB & RSRB NOZZLE