



STS-126 SSP Flight Readiness Review

MS/Donald S. Noah
October 21, 2008



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Agenda

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- **Systems Engineering & Integration**
 - SE&I FRR Roadmap
 - Flight Preparation Readiness
 - Special Topics
 - SSME Controller Commanded Mixture Ratio
 - DOLILU Block Update
 - RTLS Safety Enhancement From OI-33 Implementation
 - Integrated In-flight Anomalies (IFAs)
 - Integrated Debris Risk Assessment
 - Imagery/Debris Radar
 - Flight Software Readiness
 - Payload and General Support Computer Readiness
 - Non-Standard Open Work Summary
 - Alternate/Dissenting Opinions
 - Launch On Need (LON)
 - Certificate of Flight Readiness

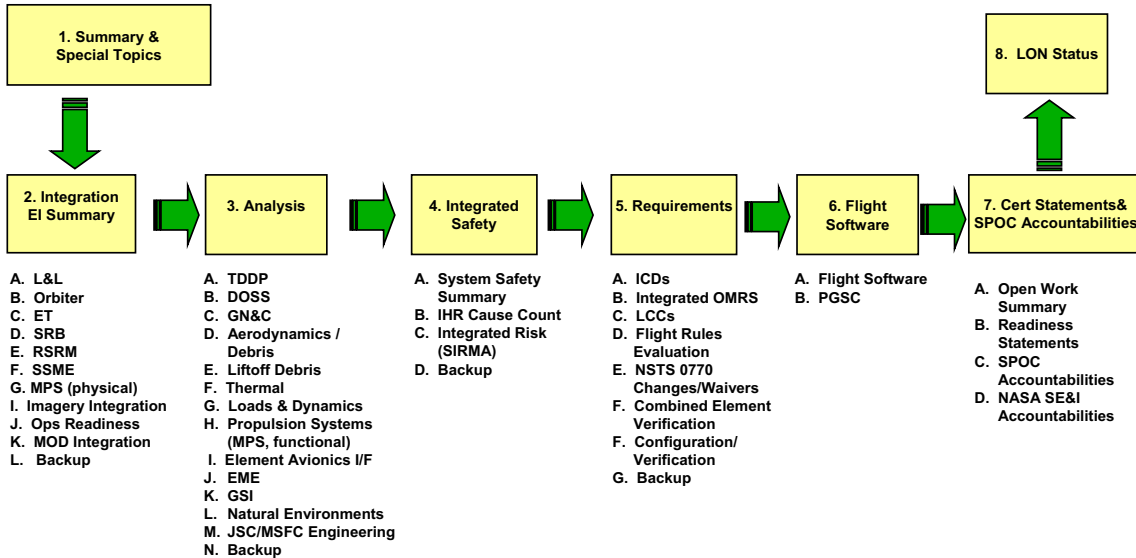




SE&I FRR Roadmap

Presenter MS/D. S. Noah

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Flight Preparation Readiness

Presenter MS/D. S. 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





Special Topic		Presenter MS2/E. M. Burns
SSME Controller Commanded Mixture Ratio Change for STS-126		Date 10/21/08 Page 5

Background:

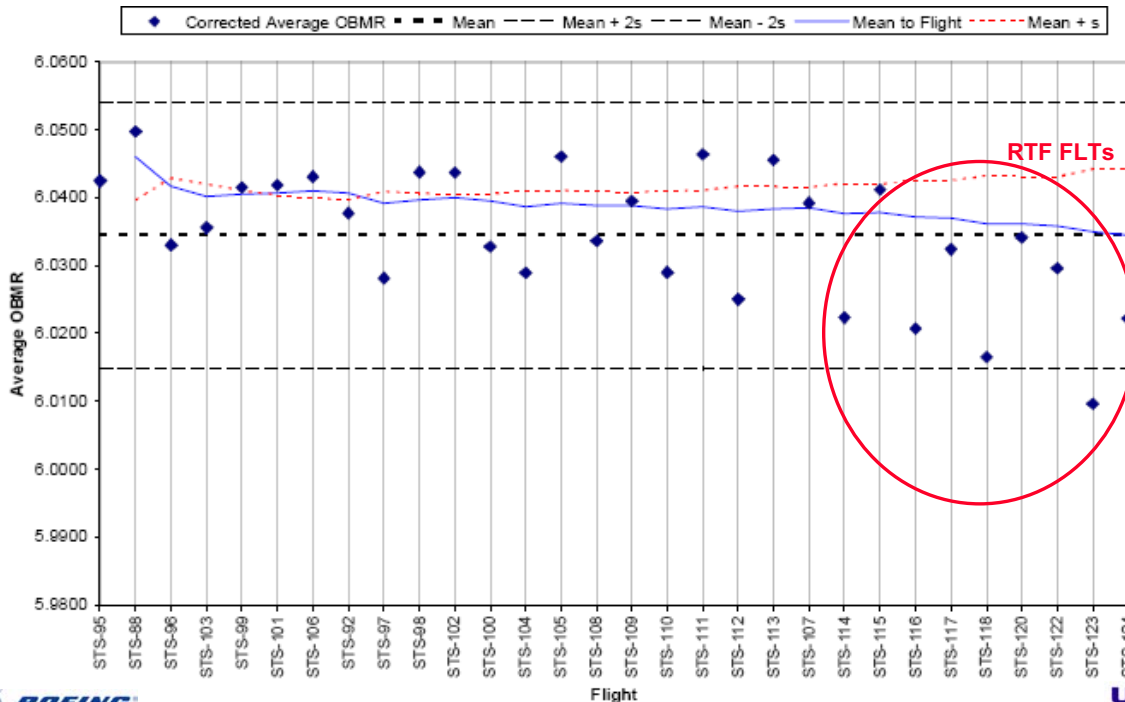
- STS-123 Post Flight Reconstruction showed lowest OBMR since RTF (-2.7 sigma)
 - All available Fuel Bias was consumed (~1200 lbs), NOT at risk of a LLCO since there was positive APM on that mission
- Review of previous flight data indicated a decreasing trend in OBMR beginning about STS-114 (RTF)
- “Low OBMR Trend” TIM held in Houston, July 15-16, 2008
 - Low OBMR trend confirmed by TIM participants
- MPS inventory (FPR, FB, OBMR) is being updated per normal reconstruction processes – in work for STS-119 and subsequent FLTs
- STS-126 will perform at a lower OBMR than the current MPS inventory will protect unless mitigation steps are implemented.
- PRCB (8/28/08) approved change to SSME Controller CMR

First Flight Effectivity Change:

- STS-126 will be the first flight of a new SSME Controller Mixture Ratio (CMR) of 6.049 mru (was 6.032 mru since STS-80)
 - SSME has conducted >10K seconds of testing at this higher mixture ratio
- CMR was changed to mitigate the effects of lower than predicted Over Board Mixture Ratio (OBMR) reconstructed on several previous flights



Reconstructed OBMR (Average), Corrected for C2 Errors and 2043 Kf Shift		Presenter MS2/E. M. Burns
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Special Topic - DOLILU Changes for STS-126

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- **DOLILU updates for RTF did not include 28.45° inclination missions**
 - Roll maneuver (RM) Q-planes and dispersions were developed for 51.6° inclination and did not cover 28.45° (due East) inclination flights
 - Existing (51.6° inclination) RM q-planes showed unacceptable launch probability for STS-125 and -400 in November (<90%)
 - Updated RM q-planes provide launch probability of 94% for November
 - Alpha/beta systems dispersions were expanded to cover due east trajectories
 - Roll maneuver wind persistence increments were updated for due east trajectories and the updated day-of-launch wind pairs database
 - Roll Maneuver Q-plane constraints and DOLILU dispersion updates to cover due East trajectories were approved at the SICB 08/19/08
 - Wind change redline updates to protect for DOL wind changes that might invalidate the DOL I-Loads were updated to protect for due East missions were approved at the SICB 8/29/08
 - All updates valid for 51.6° inclination
- **DOLILU software updates and input data changes for STS-126 were incorporated in Block Update 2008.2 (approved at the SICB 08/29/08)**



RTLS Safety Enhancement From OI-33 Implementation

Presenter	MS2/E. M. Burns	
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- **A Return To Launch Site (RTLS) abort has the most risk of any intact abort**
 - With the External Tank (ET) Separation phase being the biggest threat
- **OI-33 Software modification included:**
 - Trajectory design changes in the Alpha profile during the Powered Pitch Down phase (last 20 seconds of powered flight) to improve the initial separation condition
 - Updates to the Reaction Control System (RCS) jet selection logic for quicker separation
 - Opening the Rudder/Speed Brake to help with aerodynamic pitching moment
 - An improvements to the steering commands during powered and mated coast flight
- **Previous OI's, the RTLS ET Separation provided:**
 - A success rate for RTLS abort with General Purpose Computer (GPC) failed condition was ~84% as Documented in NSTS-07700 Volume X
 - This was due to ET Separation failures in re-contacts with the Orbiter/Tank, umbilical plate contact during separation or Loss Of Control (LOC) after separation
- **With implementation of the OI-33 RTLS Enhancements:**
 - **The success rate for RTLS abort with GPC failed condition is ~97%** (up from ~84%)
 - **The success rate without GPC failure is now 99.67%** (up from 96%)
 - **ET Separation re-contacts failures improved from 12 failures to one**
 - **The LOC issues was reduced by 60%**





**Integrated In Flight Anomalies
 Closed for STS-126**

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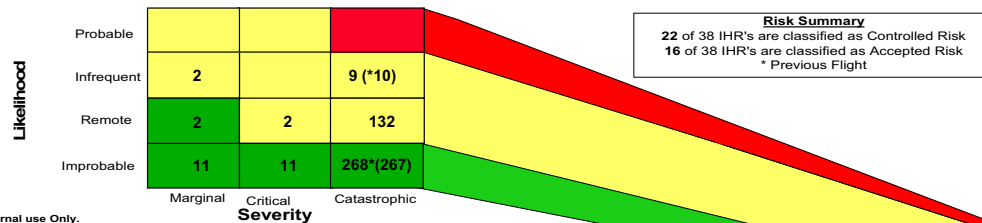
- STS-122-I-001, Stinger tile observed falling after SSME startup
- STS-123-I-002, Stub Tile Damage During SSME Ignition
- STS-124-I-001, Unexpected Debris/Expected Debris Exceeding Mass Allowable Prior to Pad Clearance (Liftoff Debris)
- STS-124-I-002, Liberated Refractory Brick, NE Flame Trench Wall Pad A
- STS-124-I-003, Late Tyvek Partial Cover Releases
- STS-124-I-004, Roll Moment During SRB Tail off
- STS-124-I-005, ET TPS Loss at ~Xt 1129, near LO2 Feedline Bracket

No new causes or increase in risk to existing causes



Integrated Hazard Risk Matrix

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Hazard Report #	Integrated Hazard Titles	Controlled				Accepted Risk								
		Controlled Risk	remote-marginal	improbable-marginal	improbable-critical	Accepted Risk	probable-marginal	infrequent-marginal	remote-critical	remote-catastrophic	probable-critical	infrequent-critical	infrequent-catastrophic	probable-catastrophic
														
	"Accepted Risk" Hazard Reports													
IDBR-01	Ascent Debris Impact to SSV	7		7	27					24				3
ICOM-01	Adverse Effects due to Intentional RF Environment	2		2						1				
IEEM-01	Adverse Electromagnetic Effects (EME)	0			18					18				
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	11		11	3					3				
IMPS-04	Off-Nominal Purges	11		11	1					1				
IMPS-09	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	45		1	1	42				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	22			22	26				26				
ILIT-01	Adverse Effects of Lightning	0				6				6				
	Accepted Risk Distribution Totals	(see next page)				145	0	2	2	132	0	0	9	0





Integrated Hazard Risk Matrix

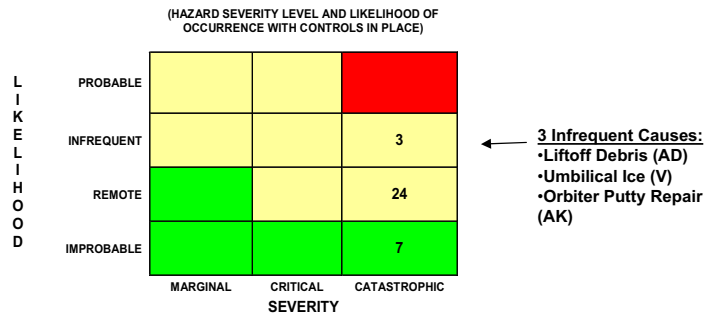
Presenter **MS/D. S. Noah**
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"Controlled Risk" Hazard Reports															
IARO-01	Aerodynamics Environment not per Specified Design	1				1	0								
IEPD-01	Inability to Power Critical Functions			3	5										
IFSI-01	ET/SRB System Interface Failure	6			6	0									
IFSI-02	ET/Orbiter System Interface Failure	10			10	0									
IFSI-03	SSME/Orbiter System Interface Failure	14			14	0									
IFSI-04	Outer Mold Line Configuration Error	3			3	0									
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	9			9										
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									
IMPS-05	Over pressurization of the Integrated MPS H2 System	7			7	0									
IMPS-06	Under pressurization of the Integrated MPS H2 System	7			7	0									
IMPS-07	Over pressurization of the Integrated MPS O2 System	7			7	0									
IMPS-08	Under pressurization of the Integrated MPS O2 System	7			7	0									
IMPS-12	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									
ISPR-03	Tail Service Mast (TSM) T-0 Umbilical System Malfunction			5	6	29									
IVLD-02	System Instability Results In Structural Failure of SSV	13			13	0									
Controlled Risk Distribution Totals		242	2	11	11	268	145	0	2	2	132	0	0	9	0



STS-126 Debris Risk Assessment Summary

Presenter **MS2/Doug Drewry**
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Debris Risk Assessment, 10/2008

- Three IDBR-01 debris risks remain at the 3/5 level for STS-126
 - ET redesigns and process-oriented debris mitigations since RTF have significantly reduced the risk to the vehicle
 - Debris model updates since RTF have also improved the ability to characterize the debris risk
 - Results are a significant reduction of “Infrequent/Catastrophic” debris causes
 - Controls are in place to further mitigate these causes



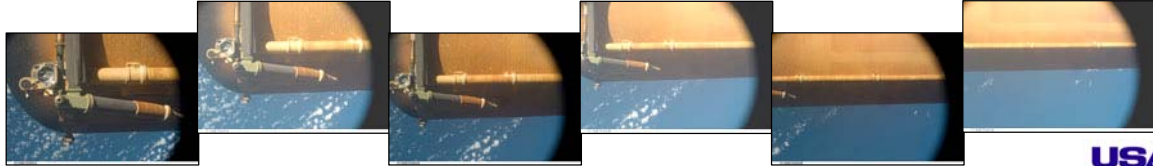


Imagery Hardware
ELVIS

Presenter	MS/Beth St. Peter	
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- **ET LO2 Feedline Camera (ET-129):** First flight of XC-555 camera – simple model upgrade, no change in imagery or video signal. **Ready to support. No open issues.**
- **Ground Network & TV:** All ground stations (JDMTA, MILA, WFF, PDL) configured for ET LO2 Feedline video downlink. **Ready to support. No open issues.**
- **SRB Cameras:** ET Attach Ring (ETAR) cameras, Fwd Skirt Aft Pointing (FSAP) cameras, ET Observation cameras, Data Acquisition System (DAS) recorders, and Solid State Video Recorders (SSVRs) hardware installed and closeouts complete. **Ready to support. No open issues.**
- **Digital ET Thermal Protection System (DETPS) Camera & Flash:**
 - Configured for NIGHT.
 - To improve chances for good exposures (day *and* night), two-step (0EV, +1EV) exposure bracketing will be enabled for all flights beginning with 126:
 - Camera takes 1 picture every 2 sec.
 - Shots of equiv exposure now 4 sec apart, verified NLT 65% downtrack overlap (requirement is 60%).
 - Bracketing function is physically enabled/disabled on camera.
 - Updating the camera exposure settings is PGSC controlled.
 - Camera and flash **ready to support. No open issues.**

DETPS Camera Settings	
• Daylight:	<ul style="list-style-type: none"> • Flash (f/8, ISO 100, 1/250) • No Flash (f/11, ISO 100, 1/250) • Bracketing: 0EV=f/8, +1EV= f/5.6
• Night	<ul style="list-style-type: none"> • Flash (f/4, ISO 200, 1/250) • No Flash (f/2.8, ISO 400, 1/250) • Bracketing 0EV=f/4, +1EV= f/2.8



Examples of relative bracketed image brightness shown here are not calibrated and are for illustration purposes only.



Imagery Hardware
ELVIS (cont.)

Presenter	MS/Beth St. Peter	
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Crew Handheld Digital Camera

- Nikon D2Xs now certified for both IVA and EVA use.
- **Ready to support. No open issues.**

Crew Handheld High Definition (HD) Video Camera

- First flight of new Canon G1 HD camcorder, replaces older standard definition camera.
- G1 not planned for STS-126 ET photography use until late November (see lighting predicts)
- JAXA-provided Multiprotocol Converter (MPC) required to get digital camera output routed to Orbiter DTV for Ku downlink..
- **Ready to support. No open issues.**

First Flight of Crew Monitoring during FCS Checkout

- Schedule the APU operation during daylight pass.
- Single crew member stationed at aft windows (during this time only).
- The crew member will use the Nikon camera with 400 mm lens to photograph APU operations (HD camcorder to be used as a backup).

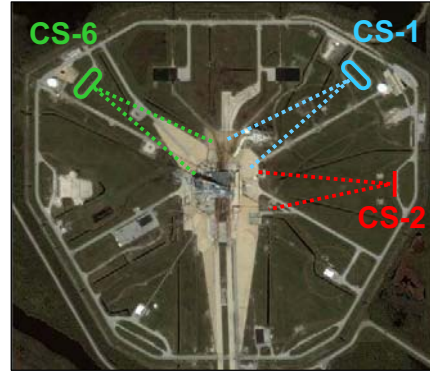




Imagery Hardware		Presenter MS/Beth St. Peter
Ground & Airborne		Date 10/21/08 Page 15

Ground Cameras

- Cameras configured nominally per Launch & Landing PRD.
- New Cameras
 - Flame Trench Monitoring Effort:
 - 4 new IR Cameras (2 cooled, 2 uncooled) have been purchased for monitoring flame trench liftoff debris: CS-1 and 6 will each receive 1 cooled and 1 uncooled IR camera. (Existing IR camera at CS-2 will again be used)
 - 6 Visible-range film cameras to be placed at CS-1 and 6 to provide additional comparison data for flame trench liftoff debris
 - Two high powered flood lights placed near each camera site to help illuminate the exit of the SRB flame trench for the visible light cameras
 - KSC imagery support teams performed testing to verify no interference between the high powered flood light placement and the cameras assets (visual and IR).
 - Additional LOD Monitoring:
 - 2 new HD OTV cameras in place on NE and SE corner on FSS at 235' level
- **Ready to support. No open issues.**



Airborne Cameras

None.



Lighting Predicts, November 14 –		Presenter MS/Beth St. Peter
December 19		Date 10/21/08 Page 16

**Beta Cutout November 26 – December 17*

Launch

- November 14 – November 20: **DARK**
- November 21 – December 15: **DAYLIGHT**

Post ET-Sep Mnvrs

- November 14 – November 24: Nominal +X, No Pitch
- November 25 – December 19: Nominal +X, Nominal Pitch

ET Sep Imagery

- November 14 – November 21: **DARK**
- November 22: **DAYLIGHT, Non-Optimal**
- November 23 – December 19: **DAYLIGHT**

Handheld ET (post-pitcharound) Imagery

- November 14 – November 24: **DARK**
- November 25 – November 26: **DAYLIGHT, Non-Optimal**
- November 27 – December 19: **DAYLIGHT**

MOD, SE&I Agreements for Crew HH ET Photography

1. Pitch mnvr for handheld ET photography will not be attempted if nominal photography time is dark.
2. Pitch mnvr will not be performed "late"
3. Pitch mnvr and ET handheld photography will not be attempted on LON mission





Debris Radar Configuration for STS-126:

Presenter	MS/A. D. Griffith	
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- **STS-126 NDR Configuration:**
 - 1 MCR C-band radar (NDR-C1)
 - 2 NASA X-band radars
 - NASA #1 on SRB vessel *Liberty Star* (NDR-X3)
 - NASA #2 on *Runnymede-Class* ARMY LCU (NDR-X4)
- Operational SRB tracking, following ASTT, by both X-bd radars
 - Plan is for X4 to track the boosters from 150-310 MET, and X3 from 270-420 MET
- Mission plan is a hybrid of prior 124 and 125 plans accounting for systemic changes to the C-bd, but familiar ISS trajectory
- In cooperation with the DIG, an updated material ID card will be used during STS-126. This update reflects recent ground truth measurements at AFRL
- NIRD reporting process is continuing to be improved
 - Reportable item criteria updated to reflect ops improvements



NDR Readiness:

Presenter	MS/A. D. Griffith	
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- **Team Readiness**
 - Complete, both ascent and analysis teams ready
- **Facility Readiness**
 - Complete, user testing completed first week of October
- **Radar Readiness**
 - NDR-C1 - GREEN
 - NDR-X3 - GREEN
 - NDR-X4 - GREEN





STS-126 FLIGHT SOFTWARE SUMMARY

Presenter	USA/John Magley	
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- **First flight of PASS and BFS Operational Increment 33 (OI-33) and MEDS Integrated Display Processor (IDP) / Multifunction Display Unit Function (MDUF) combination (VI 6.00/5.00)**
 - **Standard capability releases that include changes for:**
 - Enhanced Crew Situational Awareness
 - Improved Abort Performance
 - Increased Manifest Flexibility
 - Improved System Robustness and Fault Tolerance
 - Improved Software Maintainability
 - **STS-126 flight system includes two BFS patches applied after the release of the Mass Memory**
 - Correct display-related issues identified in the OI-33 base software during verification
- **Ninth flight of MAGRS-3S Link 613-9966-007 GPS FSW**
 - No changes from STS-124 software



**MAJOR NEW OI-33 CAPABILITIES
 PASS, BFS and MEDS**

Presenter	USA/John Magley	
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- **Enhanced Crew Situational Awareness**
 - **Ascent/Entry Bearing Displays (SPEC 54)**
 - Two new graphical displays that enhance on-board situational awareness and no-comm abort selection capabilities
 - Integrate data to provide on-board information on current vehicle location and performance
 - Support on-board assessment of ascent/abort vehicle performance
 - Support on-board selection of most appropriate landing site





**MAJOR NEW OI-33 CAPABILITIES
 PASS, BFS and MEDS**

Presenter	USA/John Magley	
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- **Improved Abort Performance**
 - **Reduced ET recontact risk during RTLS scenarios**
 - Changes RTLS guidance/flight control to reduce the ET Separation maneuver failure rate during some RTLS intact aborts
 - **Improved control early in RTLS Second Stage**
 - Increases the number of jets that can fire simultaneously from 4 to 5
 - **Improved controllability during Three Engine Out scenarios**
 - Automatically selects Single Engine Roll Control (SERC) for three engines out in first stage
 - **Improved ECAL energy management**
 - Compensates for energy over weight oscillations due to phugoid motion, resulting in more correct S-turn initiation/termination
 - **Improved Glide RTLS “Alpha Trap” logic**
 - Prevents inadvertent moding from Alpha Recovery phase to Nz Hold phase

- **Improved Manifest Flexibility**
 - Provides the ability to modify scaling for all vehicle SM parameters via uplink
 - Reduces the number of Class 1 patches for late flight updates



**MAJOR NEW OI-33 CAPABILITIES
 PASS, BFS and MEDS**

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- **Improved System Robustness/Failure Tolerance**
 - **Eliminated MPS timing scenarios that unnecessarily delay close of pre-valves and expose orbiter to some low probability catastrophic scenarios**
 - **Improved robustness of RMS error checking during very low rate RMS maneuvers (e.g. OBSS survey)**
 - **Improved crew ability to assess DPS system health by raising the error class for errors not detected by all PASS redundant set GPCs**
 - **Added robustness to the existing Remote Controlled Orbiter capability by adding drag chute, landing gear, and GPS automation**

- **Improved Long-Term Maintainability**
 - **Improved long term maintainability of FSW systems by scrubbing unneeded capabilities and optimizing memory usage**
 - **Improved ability to assess in-flight problems by enhancing BFS debug parameters**
 - **Restructured Inter-Computer Communication (ICC) messages to increase throughput and efficiency**





FSW Verification Summary

Presenter	USA/John Magley	
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- **Integrated Avionics Verification (IAV) complete**
 - A total of 72 test cases were performed in the Shuttle Avionics Integration Laboratory (SAIL) and analyzed in support of OI-33
 - A total of 17 cases were executed and analyzed in support of STS-126
 - Included testing of full flight system (PASS/BFS OI-33 and STS-126 changes; MEDS VI 6.00/5.00; MAGRS-3S Link 7; and SSME AD04 software)



Launch on Need Status

Presenter	USA/John Magley	
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- **In the event of call-up, the STS-119 Base Mass Memory would be flown on OV-103 using:**
 - STS-119 Base Load and associated products
 - Flight specific I-load patches for STS-119 (full payload bay)
 - OI-33 compatible MEDS load (VI 6.00/5.00) – no changes from STS-126
 - MAGRS-3S link 7 - no changes from STS-126
- **Completion of the development and verification of flight-specific FSW products for STS-119 can be performed to support the 02/08/09 target LON date**
- **Formal Software Readiness Review to be conducted after call-up**





FSW READINESS SUMMARY

Presenter	USA/John Magley	
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- **SAIL facility will be in a condition of readiness for mission support**
- **Formal Software Readiness Review (SRR) was conducted on 10/14/08**
 - **All actions will be tracked to completion prior to FRR (or applicable post-FRR milestone)**
 - **Only standard open work expected at FRR**
- **With the completion of planned open work, FSW will be ready to support STS-126 launch**



STS-126 FLIGHT SOFTWARE FLIGHT READINESS STATEMENT

Presenter	USA/John Magley	
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Full compliance with NASA and SPOC Flight Software CoFR requirements is documented in the STS-126 Software Readiness Review packages along with signed readiness statements and identification of open work.

Pending completion of standard open work and identified non-standard open work, Flight Software is ready to support flight.

/s/Patti A. French 10/15/08

Patti A. French Date
Associate Program Manager
USA Flight Software

/s/Daryl A. Peltier 10/15/08

Daryl A. Peltier Date
Manager
NASA Flight Software Office



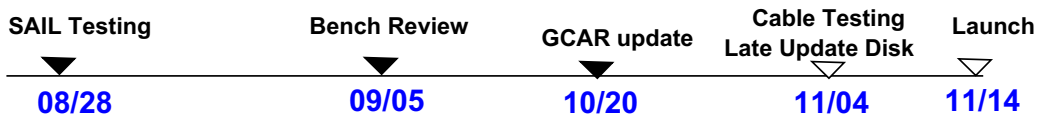


PGSC STS-126 Readiness

Presenter MS4/Alan Currie

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- **Hardware and Software Summary**
 - The Payload and General Support Computers (PGSC) were developed to enhance crew situational awareness.
 - **STS-126 will be the eleventh flight of the IBM ThinkPad A31p PGSC**
 - 7 PGSC units
 - Fifth flight of the A31p Docking Station
 - Third flight of Netgear Wireless Access Point.
 - Note: No network issues observed during STS-124
 - First re-flight of WAP hardware requires PIA updates and GCAR updates
- **PGSC Milestones**



Non-Standard Open Work Summary

Presenter MS/D. S. Noah

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Open Work	Completion Date
PGSC	
- WAP Hazards update CR	10/20/08
- WAP GCAR update signed (PAI update)	10/20/08





Alternate/Dissenting Opinions

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- **Alternate/dissenting opinions were actively solicited at the SE&I STS-126 Pre-FRR.**
 - No dissenting opinions were identified.



LON Status

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- **USA PI has identified no technical or schedule constraints to the support of LON requirements for STS-126 using the SSP baseline “Fly the Next Flight” approach**
 - STS-119 is scheduled to have DTO 854 Boundary Layer Transition Flight Experiment





CoFR Endorsement

Presenter	MS/D. S. Noah	
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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-126, pending completion of open work.

Donald S. Noah
Manager Systems Engineering and Integration Office

