

# Systems Division



STS-116/12A.1 MOD FRR

November 8<sup>th</sup>, 2006

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# DF Shuttle CoFR Status Summary

REQUIREMENT	GNC	DPS	PROP	INCO	MMACS	EGIL	EECOM	BOOSTER	DF
Critical Processors/Applications	N/A	G	N/A	G	G	G	G	G	G
Non-Crit Processors/Applications	G	G	G	G	G	G	G	G	G
EMCC	G	G	G	G	G	G	G	N/A	G
Training - MCC/POCC	Y	G	Y	Y	Y	Y	Y	G	Y
LCC/MEL/MIL	G	G	G	G	G	G	G	Y	Y
FTP - New Ops	Y	Y	G	G	G	G	Y	G	Y
Flight Anomaly Resolution	G	G	G	Y	Y	Y	Y	G	Y
Anomaly – Procedures	G	G	G	Y	G	G	G	G	Y
Exceptions/Action Items from prior reviews	G	G	G	G	G	G	G	G	G
CIL/Hazards	G	Y	G	Y	G	G	G	G	Y
No Constraints	G	G	G	G	G	G	G	G	G
Level II Actions	G	G	G	G	G	G	G	Y	Y
Mission Requirements	N/A	G	G	G	G	G	G	G	G
Engineering Drawings	G	G	N/A	G	G	G	G	G	G
Command Procedures	G	G	G	Y	G	G	G	G	Y
Flt Prep Process Plan Requirements Met	G	Y	G	G	G	G	G	G	Y
Contractor Process Insight	N/A	N/A	G	G	G	G	G	G	G
MOD Work Guidelines	G	G	G	G	G	G	G	G	G
<b>YERO- STS-116 specific</b>	Y	Y	G	G	G	G	G	G	Y

**G** Ready to support flight

**Y** Open work with expected resolution prior to flight

**R** Open work without expected resolution prior to flight, or unresolvable constraint violation.

**N/A** Not applicable

# Status of Standard Open Work Shuttle (LCC/MEL/MIL)

- LCC/MEL/MIL - The Launch Commit Criteria Minimum Equipment List and Mandatory Instrumentation Lists have been reviewed and verified as complete and accurate. Any flight unique requirements have been specified, exceptions as noted:

**STS-116 Flight Specific MEL:** LCCWG disposition scheduled for 11/9/06, Noon Board –TBD after 11/9 LCCWG

## **ECO Sensor LCC:**

The LH2 ECO sensors for STS-115 and STS-116 are not from the originally suspect 1996 lot and passed additional screening tests (nano-focus X-ray) implemented after STS-114. The Booster team concurred with the recommendation to scrub for 24 hours for STS-115 per the June 2006 Program Requirements Control Board (PRCB) decision, since there was no new significant data between then and now indicating the most likely cause of the failure. The Booster Group's position is to retain the 24 hour scrub turnaround for STS-116. DF is still in discussions with DA8 and MOD to decide if changes to the ECO sensor LCC should be made.

# Status of Standard Open Work Shuttle (Training – MCC)

- **MCC Team Certification Status:**
  - All team member certification requirements are complete except as follows (assuming a NLT landing 01/04/07):

## FCR

Position	Name	Team	Open Item	ECD
GNC	Dave Weiler	Orb 2	Physical expires 12/2	Part I is on 11/02
INCO	Daryl Brown	Orb 3	Physical expires 12/31	Waiting on Clinic for Part I
INCO	Douglas Branham	A/E	Physical expires 11/23	Part II is on 11/13
PROP	Lonnie Schmitt	Orbit 3	Physical expires 11/30	Part I is on 11/20
PROP	Dean Lenort	Orbit 1	Physical expires 12/31	Part I is on 11/8
EGIL	Jacilyn Wilkins	O3	Certification sim on 11/21	11/26
EECOM	Rachel Hinterlang	Planning	Certification sim on 11/09	11/14

Backup Flight Controllers available for all positions

# Status of Standard Open Work Shuttle (Training – MCC)

- **MCC Team Certification Status:**

- All team member certification requirements are complete except as follows (assuming a NLT landing 01/04/07):

## **MPSR**

Position	Name	Team	Open Item	ECD
Mechanical	Brandon Minica	O2	Certification sim is complete	11/13
Mechanical	Laura Slovey	PL	Certification sim is on 11/13	11/18
GNC Support	Kevin Dunn	Orb 1	Physical expires 11/30	Part II is on 11/13
EPS	Mel Friant	Orbit 2	Physical expires 11/19	Part II is on 11/3
Thermal	Bill Huebner	Orb 2	Physical expires 12/31	Part II is on 11/08

Backup Flight Controllers available for all positions

# Status of Non-Standard Open Work Shuttle (FTP- New Ops)

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- **New Ops Work Status:**

All significant differences from previous flights have been reviewed by FTP, POWG, or other appropriate operations forum and where required documented in either new procedures or new flight rules, except as follows:

**Final DAP configuration/constraints:**

The current version of the flight rules contain the preliminary data from C. S. Draper Laboratory. Upon receipt of the official memo, GNC will review the document, and update any DAP constraints in the FDF and Flight Rules as required. This will include specific DAP parameters (attitude & rate deadbands, maneuver rate, ALT config, etc.), RCS jet group selection/deselection for mated control, orbiter external airlock pressurized/depressurized constraints, and any other required system constraints. ECD - 11/13

**OBSS Procedure and Flight Rule Updates:**

GNC and Pointing are working on required DAP updates to the PDRS book for the OBSS Ops. GNC is also working with DA8 on a flight rule to define maneuver and translation firings for an unstowed OBSS in the same manner as was seen on previous flights. ECD - 11/9

**LOAC recovery plume mitigation:**

Draper labs is working to see if deselecting L5L is a realistic option to avoid pluming the P4 arrays if using VRCS to recover from a LOAC situation. This is being coordinated between DA8, Draper and as well as shuttle and station DF groups. ECD - 11/13

# Status of Non-Standard Open Work Shuttle (FTP- New Ops)

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- **New Ops Work Status:**

All significant differences from previous flights have been reviewed by FTP, POWG, or other appropriate operations forum and where required documented in either new procedures or new flight rules, except as follows:

**Year End Rollover (YERO)**

Assuming a 12+2 mission, any launch date between December 17 and December 31 may require STS-116 to fly through a YERO event. The flight rules governing flying with YERO as a nominally timed event are in work with an ECD 11/15. It is anticipated that, at a minimum, new mission duration flight rules will need to be developed that call for mission termination prior to YERO for any failure that leaves the vehicle zero fault tolerant with respect to being able to complete the YERO procedure. Additionally, development of a flight specific version of the YERO procedure has been submitted into workflow.

**A/L (Booster) Fan Ops:**

In an effort to save cryo the A/L fan will be powered down for most of the mission. In the past, the A/L Fan has been required for SpaceHab flights. An integrated ISS/Orbiter/SpaceHab atmosphere analysis has been performed by Boeing and has concluded that it will be acceptable to fly STS-116 with the A/L fan off. A new bypass duct has been manifested and mods to the External A/L Ingress and Egress procedures have been submitted.

**Supply H2O Management Plan:**

The Supply H2O management plan is still in work. There are limited dump opportunities on this flight and the CWC (Contingency Water Container) transfer requirement has been reduced to 2. This will require extensive FES dumping. Although FES dump constraint events have been identified, actual dump constraint times (METs) are still in work. A preliminary attitude timeline has been received, but may need to change. A potential issue with high FES rates and low water quantities could exist on the 1st day or two of the flight and could drive attitude changes. It is expected that an acceptable plan will be formulated.

# Status of Non-Standard Open Work Shuttle (Flight Anomaly Resolution)

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- **FLIGHT ANOMALY RESOLUTION:**

All previous in-flight anomalies have been resolved and all operational or procedural changes required have been implemented and verified. Exceptions are noted below:

## **PCMMU # 2 Data Drop Outs**

During STS-116 ground processing, two temporary dropouts of Orbiter Instrumentation data from PCMMU #2 occurred during MADS recorder erase. The concern is that if the problem is internal to the PCMMU, loss of OI data could occur during terminal count or during a flight. Dropouts of the PCMMU 2 output at both the RPS and LPS indicate that there was an actual problem with the PCMMU output signal. In both instances, the failure took place within two hours of activation.

The problem could be in the MTU, the coax cable between the MTU and PCMMU#2, or the circuits inside PCMMU#2 that process the MTU clock. Failure of any one criteria will result in declaring a failed PCMMU for Flight Rule EOM consideration.

At the pad, the launch team plans to run PCMMU#2 about 50% of the time but not during S0017 or S0007 activities (MCC will not get any time on it). If the problem reoccurs, KSC will R&R PCMMU#2 (LRU and coldplate spare is available). If no reoccurrence, fly as-is and KSC will probably R&R the MTU cable during the next flow.



# Status of Non-Standard Open Work Shuttle (Flight Anomaly Resolution)

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- **FLIGHT ANOMALY RESOLUTION:**

All previous in-flight anomalies have been resolved and all operational or procedural changes required have been implemented and verified. Exceptions are noted below:

**Fuel Cell 1 Coolant Pump Phase A Short:**

11 minutes 26 seconds after FC1 pump activation, there was a short circuit on AC1 phase A that resulted in the loss of phase A power to the FC1 coolant pump. The short was of insufficient magnitude or duration to open the associated circuit breaker, but it did result in an open circuit to the coolant pump phase A only. A decision was made to fly as-is with the phase A circuit breaker (L4:C AC1 FUEL CELL 1 PUMPS phase A) opened. This resulted in both the Fuel Cell 1 coolant pump and the H2/H2O Separator motor to operate on two phases throughout the mission, and FC1 also was without a H2O water purity sensor (pH).

Impact: None, unless inspection determines the failure to be a generic problem with FC motor windings. Fuel Cell R&R scheduled around 11/7

# Status of Non-Standard Open Work Shuttle (Flight Anomaly Resolution)

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- **FLIGHT ANOMALY RESOLUTION:**

All previous in-flight anomalies have been resolved and all operational or procedural changes required have been implemented and verified. Exceptions are noted below:

**Flash Evaporator Primary B Controller (STS-121 AR 1631):**

FES PRI B had transient temperature excursions that led to a shutdown on FD01. FES PRI A was selected for the remaining FES activities. On FD13, a FES test was performed on all three FES controllers. FES PRI B exhibited similar temperature excursions as were seen on FD01, but did not shut down. FES PRI A was successfully used during D/O Prep and Entry. Post flight testing revealed lagging of the FES Secondary controller mid point temperature sensor. The Topping B supply valve was deemed suspect as a contributing factor in the post insertion shutdown based on ATP testing. The Secondary Midpoint temp sensor was repacked, however post R&R testing revealed little improvement in performance. The temp sensor has been deemed acceptable to fly for 116. Although the Topping B supply valve passed original ATP testing it was replaced with a better performing valve. Due to limited ground testing capability, full resolution will not be known until real time on STS-116.

# Status of Non-Standard Open Work Shuttle (Flight Anomaly Resolution)

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- **FLIGHT ANOMALY RESOLUTION:**

All previous in-flight anomalies have been resolved and all operational or procedural changes required have been implemented and verified. Exceptions are noted below:

**STS-121 CWC and PWR Overboard Dump Temperatures (STS-121 AR 1699):**

During a simo dump of condensate CWCs and EVA PWRs on FD13, abnormal nozzle temps were observed. Post flight investigation concluded that the most likely cause was particulate interference with the nozzles due to wider spray patterns from the dump nozzles which result when dumping unpressurized bags. To preclude, further occurrences, it was agreed that simo unpressurized dumps would be avoided in the future. A Flight Specific FR CR to reflect this new philosophy is in workflow.

# Status of Non-Standard Open Work Shuttle (CIL/Hazards)

- **CIL/HAZARDS:**

All procedures and flight rules which furnish and operational control for a Crit 1 or 1R Critical Items List item have been verified. Any new CIL items have been reviewed for possible operation control requirements and the appropriate procedure or flight rule implemented and verified. All such procedures or flight rules are flagged in the documents where they appear. The payload hazards have been reviewed and any flight rules or procedures required to provide operational control of the hazards, as identified in the Integrated Cargo Hazard Assessment and all applicable Payload Safety Packages, have been implemented and verified. Required "Cautions" and "Warnings" have been incorporated. Exceptions are noted below:

## IPL SOURCE Switch IFM:

A Hip pocket IFM to work around a failure of the IPL SOURCE Switch is being evaluated but has not yet been fully developed. It is anticipated that the IPL SOURCE Switch will be deemed a 1R item if the STS-116 launch date causes YERO to occur during the nominal timeline. Under those conditions, it is likely that an IFM will be needed as an operational control. Estimated completion date for hip pocket IFM procedure is November 15.

## Uplink Switch IFM:

A Hip pocket IFM to work around a failure of the Uplink Box Switch is being evaluated but has not yet been fully developed. It is anticipated that the Uplink Switch will be deemed a 1R item if the STS-116 launch date causes YERO to occur during the nominal timeline. Under those conditions, it is likely that an IFM will be needed as an operational control. Estimated completion date for hip pocket IFM procedure is November 15.

# Status of Non-Standard Open Work Shuttle (Level II Actions)

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- **LEVEL II ACTIONS:**

All Level II actions assigned to this area have been evaluated and determined to be neither an exception nor a constraint to the review, except as follows:

**Level II Action S050425BK 6-1 “Evaluate H2 underpressurization scenarios”**

Action S050425BK 6-1 was assigned 07/01/05: “Evaluate H2 underpressurization scenarios and rule on risk mitigation procedures as referenced in causes in IMPS-06-L and IMPS-06-W of hazard report IMPS-06”. In March 2006, Rocketdyne personnel identified that the Block II SSME High Pressure Fuel Turbine (HPFT) Turbine Discharge Temperature (TDT) redline may not protect safe shutdowns for low LH2 Net Positive Suction Pressure (NPSP) cases, such as LH2 ullage leaks and multiple Flow Control Valves failed closed. The data indicates that the Low Pressure Fuel Turbopump (LPFTP) has the potential to cavitate and violate shaft speed limits before the HPFT TDT redline is violated. Current Flight Rules assume that the HPFT TDT redline does provide protection for low LH2 NPSP, which was the case with the Phase II SSME. This situation and operational response was discussed and approved at the Flight Techniques Panel. OSB Closure with PSIG/SE&I is in work, Pink Sheet has been submitted.

# Status of Non-Standard Open Work Shuttle (CMD PROC)

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- **CMD PROC:**

The following command procedures have not been reviewed by personnel with command responsibility to assure clarity, completeness and compatibility with this vehicle/flight.

Updates to the INCO Console Handbook (ECD 11/13) and the Command Procedures Handbook (ECD 11/27) for the changes in SSR operations with the addition of the MADS data recording and post flight dump plan.

# Status of Non-Standard Open Work Shuttle (FPPP)

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- **FPPP REQUIREMENTS MET:**

The MOD Flight Preparation Process Plan and the SFOC Flight Preparation Process Plan (NSTS 08117, Appendix G and Appendix R, respectively) which defines the processes and products required for a successful flight has been executed and the applicable Program CoFR requirements satisfied. Exceptions are noted below:

## **Mission Operations FPP 2.1 Flight Rules**

The flight rules governing flying with YERO as a nominally timed event are in work. It is anticipated that at a minimum new mission duration flight rules will need to be developed that call for mission termination prior to YERO for any failure that leaves the vehicle zero fault tolerant with respect to being able to complete the YERO procedure. Additionally, flight specific rules are needed to override existing requirements for onboard time accuracy and existing rules dealing with how YERO is managed. Estimated completion date is November 15.

# Status of Non-Standard Open Work Shuttle (Year End Rollover)

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- **YERO:**

All MCC Tools, Flight Procedures, LCC/MEL/CIL, Flight Rules have been reviewed and verified to be ready to support Year End Rollover. The flight control team has been trained and all equipment, software, and documentation has been identified and are ready for YERO. Exceptions are noted below:

## **YERO Training**

More flight controller training is needed for the STS-116 Planning and Orbit 1 team on the YERO procedures. Negotiations are underway with DA8 and DT to schedule the training, but a sim has yet to be allocated or even agreed to. Additionally, other YERO items are in work as previously noted non-standard open items.



# MOD Work Guidelines Violation Shuttle

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- Due to the scheduled mission length and the limited number of qualified personnel, the following groups will have operators that violate the MOD work guidelines of not exceeding 12 consecutive work days:

– NO Violations

- \* Work Guidelines account for nominal planned L-1 prelaunch shift through nominal planned landing. Additional days due to launch scrubs and weather extension days are not included.

# Significant New Operations with NO Open Work

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## **Water Spray Boiler PGME:**

All three Water Spray Boilers will be loaded with H<sub>2</sub>O/PGME mixture for STS-116. DTO/FTO objectives were successfully completed on STS-121 and STS-115 leading to the final implementation on STS-116.

## **ET TV:**

The External Tank for Discovery (OV103) maybe fitted with filter on the ET TV camera to allow better imaging during night launches. If the Launch slips to daylight there is no need to remove the filter.

## **Space Shuttle Main Engine (SSME) Advanced Health Management System (AHMS):**

STS-116 is the first flight of an SSME Controller modified with the AHMS synchronous vibration monitoring system for the High Pressure Pumps (Right SSME only). The AHMS system will operate in “monitor only mode” on STS-116. Booster products are complete to support “monitor only mode”. Final completion of Booster products to support “redline active mode” is planned for STS-116 L-30. STS-117 is the earliest AHMS could be flown in “redline active mode”. When active on a three engine cluster, the synchronous vibration redline provides a calculated 23% reduction in SSME Ascent risk, and a 10.3% reduction in overall vehicle ascent risk.

# Significant New Operations with NO Open Work

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## **CO2 Management:**

Several reports of crew CO2 symptoms were received during the STS-115 flight which ultimately resulted in the use of 3 cans from the ISS inventory. Post flight investigation has concluded that the greatest contributing factor leading to the reported crew CO2 symptoms were highly localized concentrations of CO2 around the head and CO2 "pockets" in the orbiter due to degraded air exchange in the Shuttle caused by blocked airflow vents and port interdeck access. Lessons learned have been passed on to the STS-116 crew to ensure better airflow distribution.

## **Hardline "Big loop"**

Station troubleshooting was inconclusive. OV104 testing has not been performed. RF "Big Loop" will be used if this problem reoccurs on STS 116/12A.1. EVA Comm Config/Deconfig procedures will be modified to support this configuration if needed. Post flight testing has been unable to recreate the problem on OV 104. All indications are that there are no hardware problems on the Orbiter or the ODS X4 connector. The troubleshooting procedure developed to test ICOM A from STS 114 combined with some newer work done by both MOD and Boeing Engineering will be used to develop a procedure to test the integrated links between the Shuttle and ISS. This procedure will not be in an as flown document but will be uplinked if needed since OV103 has not demonstrated any audio anomalies during docked operations.

# Conclusion Shuttle

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All identified open work will be completed in time to support STS-116/12A.1.

# Shuttle Backup Charts

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**Significant Anomalies from STS-115 that are not a constraint to STS-116/12A.1**

# STS-115 Shuttle

## Flight Anomaly Resolution

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### **STS-115 ECO Sensor IFA:**

The 9/8/06 launch attempt was scrubbed due to the failure of Liquid Hydrogen (LH2) Engine Cutoff sensor (ECO) #3 to the wet state several minutes after initiation of LH2 fast fill during tanking. The pre-planned contingency procedure in Launch Commit Criteria: Main Propulsion System 22 was run which isolated the failure to a short somewhere in the wiring circuit originating in the point sensor box out to the sensor itself in the External Tank. The LH2 ECO sensors for STS-115 and STS-116 are not from the originally suspect 1996 lot and passed additional screening tests (nano-focus X-ray) implemented after STS-114. The Booster team concurred with the recommendation to scrub for 24 hours per the June 2006 Program Requirements Control Board (PRCB) decision, since there was no new significant data between then and now indicating the most likely cause of the failure. Approximately 4.5 hours after LH2 drain, ECO #3 was erratic and then recovered - this is similar to what was seen on the 5% LH2 sensor failure on STS-121 and other previous ECO and liquid level sensor failures. All the ECO sensors performed nominally during drain and subsequent launch attempt. The Booster Group position is to retain the 24 hour scrub turnaround per the PRCB.

### **LR Antenna:**

The Lower Right S-Band antenna did not operate as well as the other 3 S-Band antennas on OV104 (STS 115). KSC found the cabling from the Power Amp to the LR antenna was out of family on temperature at 200 + degrees F, which is 100 degrees F higher than expected. KSC cleaned the connectors on the LRU ends and replaced the cable. The new cable is operating nominally.