

# Space Transportation Vehicle Division



STS-131 MOD FRR

February 4, 2010

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# DS Shuttle CoFR Status Summary

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

# SSP Electrical Summary

Reactants	Tanks	Liftoff Load (lbm)	Min L/O (lbm)	Margin (lbm)	Padhold (hrs)
H2	5	455.5	337.9	117.6	298.4
O2	5	3277.7	3071.6	206.1	163.6

- NOTES:
- 1) Assumes 13+1+2 day mission with 3+1 ISS-based EVAs
  - 2) Assumes H2 target load obtained and loading completed at L- 45.0 hrs
  - 3) Assumes O2 target load obtained and loading completed at L- 38.5 hrs
  - 4) 605 lbm O2 offloaded evenly from Tanks 1, 2, 3, 4, and 5
  - 5) 22.0 lbm O2 protected for PMA/ODS Repress, 4 ISS-based EVAs, & MPLM Vestibule Repress
  - 6) SSPTS output energy provided is 1607.70 kWh based on:
    - 4 converters at full power for 209.8 hrs (including 17.5 hrs on Add Day)
    - 3 converters at full power for 4.0 hrs (p/d for water dump)
    - 2 converters at full power for 13.0 hrs (p/d for EVA 1 and unsch. EVA)
  - 7) Analysis includes an Additional Day with an unscheduled EVA and 4 SSPTS converters activated except 6.5 hrs of only 2 SSPTS converters during the EVA. Average power for the 24.0 hr day is 7.65 kW, which equates to 15.4 lbm H2 and 140.7 lbm O2.
  - 8) CSCS capability with 4 SSPTS converters allows for 24 days docked with 15.8 lbm O2 margin and unmanned undock on FD27. O2 margin includes metabolic for 3 ISS crew for the docked duration.
  - 9) For a 13+2+2 mission duration protecting Dual Docked Ops, maintaining 96 hours of Launch Hold requires the offload to be reduced to 545 lbm O2.

# SSP Environmental Summary

<b>Consumable</b>	<b>L/O Load</b>	<b>Min L/O</b>	<b>Margin</b>
<b>N2 (lb)</b>	<b>321.8<sup>1,2</sup></b>	<b>281.8<sup>3</sup></b>	<b>40.0</b>
<b>Supply H2O (lb)</b>	<b>353<sup>4</sup></b>	<b>353</b>	<b>0</b>
<b>LiOH (cans)</b>	<b>46<sup>5</sup></b>	<b>46</b>	<b>0</b>

NOTES: 1) Assumes 13+1+2 day mission

2) N2 L/O load protects/reflects KSC 6 lbm prelaunch usage requirement

3) N2 loading protects for 3 scheduled ISS based EVAs and 1 unscheduled ISS based EVA

4) Supply H2O loading reflects a 180 lbm offload

5) 90 LiOH canisters are required to support 7 Shuttle crew for 13+1+3 day mission and 6 ISS crew for 9+1 docked days. 31 cans will be stowed/installed in Shuttle Middeck and 15 cans stowed in MPLM. 1 LiOH canister will be taken from ISS inventory. The equivalent of 43 canisters will be provided by ISS CDRA (dual bed) and Vozdukh to support Shuttle docked operations.

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

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- MCC Team Certification Status:
  - All SMS training instructors have completed required training according to their Certification Guides. All operators have been certified and all certification records are complete.
  - All Flight Controller certification requirements are complete except as follows:

**Various Physicals, Proficiency and Final Certifications to be completed prior to flight with backup personnel available if required for all positions.**

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

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- 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:

**LCC STS-131 MEL-13** - The Flight Specific Minimum Equipment List has been submitted to the LMS System and awaiting review by the LCCWG. After all the votes are compiled it will go OSB to the PRCB. ECD 2/15

**Freon Loop LCC Update (ECL-40)** - Updates are in work for ECL-40 Freon Flow Rate Anomaly as a result of a PRCB action to review all LCCs that expire after T-31 seconds. In addition to some minor mods to improve the insight for this condition, they have also added a constraint that any indication of blockage would be unacceptable for launch. Additionally, the effectivity now ends at T-31 seconds instead of T-10 seconds in order to align with the new LCC guidelines. These changes are not yet approved, but all updates have been coordinated with EECOM input. ECD 2/15

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

- **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:

**DAP configurations and constraints** - (Awaiting C. S. Draper Laboratory Memo): The current version of the flight rules and crew procedures contain 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. Final memo expected L-4 weeks.

**APU Operations While Docked** - Analysis is in work to examine the effect that the stack would experience from running a single APU while docked to ISS. The preliminary form of the 19A\_C10-1 APU Operations While Docked flight rule has been submitted to the appropriate book manager. Once all flight specific analyses are complete, update to the rule will be made if required. ECD 2/15/10

**Hook Requirements for Docked Operations** - Analysis to examine the docking interface loads that would be experienced with multiple hooks out scenarios is complete. The preliminary form of the 19A\_C10-2 Hook Requirements for Docked Operations flight rule has been submitted to the appropriate book manager. Once all flight specific analyses are complete, updates to the rule will be made if required. ECD 2/28/10

# Status of Non-Standard Open Work Shuttle (Engineering Drawings)

- ENGINEERING DRAWINGS - Flight Rules, Flight Data File articles and ground documentation are consistent with the Cargo Engineering Mission Configuration Flight Products which include the Crew Compartment Configuration Drawing, the Cargo Arrangement Drawing, the Cargo Interface Diagram, the Integrated Schematic, and the Payload Retention Subsystem Schematic. Exceptions are noted below:

**Space Shuttle Systems Handbook (SSSH)** – EGIL will informally update the SSSH drawing for the Fuel Cell H2 flow sensor and Fuel Cell Cell Performance Monitor(CPM) instrumentation. This is due to rewiring of the Fuel Cell H2 Flow sensors, to separate them from the Fuel Cell CPM. Fuel Cell H2 Flow meters have a history of shorting, which due to common fusing with the CPM, caused the loss of that instrumentation as well. Rewiring of this instrumentation was completed for OV-103, and the H2 flow instrumentation is now separately fused from the CPM. Due to insufficient fuse locations in Mid Power Controller 3 (MPC3), the Fuel Cell 3 H2 Flow meter wiring is connected to MPC2. EGIL will track this as a known drawing error for SSSH, and only the EGIL SSSH books will be updated with a new drawing.

The MALFUNCTION PROCEDURES book will not be updated to reflect this change. It was decided that since this would not be a time critical failure, that any deltas required could be read to the crew.



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

- **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:

**1-Jet Variable ALT Delay (new on STS-131)** - As ISS became larger, 1-Jet fixed ALT control authority steadily deteriorated beginning with STS-120 and became totally uncertified with STS-127. In order to regain ALT control authority of the mated stack, a Variable ALT Delay control mode was designed for STS-129 and subsequent flights.

Variable ALT Delay uses a 10-element array of scale factors for the ALT delay time that is already in the flight software. Previously the array only held values of “1” such that the delay was non-variable. Using the variable delay allows the loading caused by PRCS jet firings to be spread out over multiple frequencies. The variable delay provided the capability to perform maneuvers with 2-jet ALT without violating load constraints for STS-129 and STS-130.

For STS-131 and subsequent flights, 1-jet variable ALT delay will be used to mitigate the concerns about limit loads and structural life when using 2-jet ALT. Flight rules and FDF updates have been submitted and are in the Workflow.

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

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- **Direct Deadband Collapse (DDC) Handover from VRCS to Momentum Manager** - The VRCS to Momentum Manager Direct Handover, successfully demonstrated on STS-129, has been certified for STS-130 and subs. This technique is planned to be used again on STS-130. Flight rule and FDF updates have been submitted and are in the Workflow.
- **RAMBO-2** - STS-131 is the second flight of the RAMBO-2 DoD Payload of Opportunity. RAMBO-2 is different than RAMBO-1 such that it collects stereo views of plumes using two satellites and can view PRCS and OMS burns. The experiment requires a dedicated crew procedure to perform a sequence of burns. A procedure verification / training session is scheduled with the crew on 2/1/10.

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

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- ANOMALY-PROCEDURE - Any special procedures or flight rules required because of uncorrected anomalies have been written, reviewed, and verified. This applies to vehicle problems the program elected not to fix but fly "as is" as well as ground problems which were not corrected but procedurally worked around for this flight. Exceptions are noted below:

**Shuttle Urine Collection with No ISS WHC** - To avoid contamination of the JEM-  
EF, dumping urine while docked is not permitted. As a result, Shuttle crew members must use the ISS WHC during the docked timeframe in order to avoid storing urine in a CWC on the Shuttle. The ISS WHC is not expected to be available for Shuttle crew use on STS-131 due to the backlog of urine that has developed while the UPA has been down. As a result, urine from the Shuttle waste tank will likely be offloaded into CWCs and stored until it can be dumped post-undocking. The procedure to offload the waste tank will be published for STS-131. If a waste dump blockage occurs post-undocking, the 4 CWCs that are normally flown do not provide enough ullage for the full mission duration. Manifesting a 5<sup>th</sup> CWC was approved by the FCE CCB on 1/28/10.

# Items of Interest – Dual Docked Ops

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**Dual Docked Ops (DDO)** - There could possibly be a DDO occurrence on STS-131/19A with the docking of 22S at the MRM2 port location, if STS-131 were to have a launch slip. Discussions are on-going and analysis is still in work by many folks to make sure that performing a DDO will be “certified”.

From a GNC perspective, due to the complexity of docking, the DDO rendezvous would occur on ISS assets. Orbiter control is not being considered outside of the maneuver to and from attitude. Also, if required, to protect for plume impingement, the Star Tracker doors may be closed prior to the DDO and re-opened at the completion of the DDO. Discussions are still on-going.

Propellant for mated maneuvers is not budgeted pre-flight; however, 19A\_C2-12 On-Orbit Propellant Priority outlines the relative priority for planned mated maneuvers and attitude, if Shuttle maneuvers were to be required.

Dual docked ops will impact the LiOH plan such that there is the potential to take the ISS contingency reserve below the redline of 20 cans. If Dual Docked ops occurs FD7 or later, no cans would be required from the ISS reserve. Dual docked ops will also impact the waste water management plan, as the extended mission duration could result in more urine being stored in CWCs on the middeck.

# Item of Interest – LiOH Plan

- **LiOH Plan with 3 ISS Crew** - The current LiOH plan for STS-131 is to use only 1 LiOH can per docked day (37 cans required for 13+1+3 and 3 ISS crew). The current manifest for STS-131/19A is 46 cans. If the ISS crew size increases to 6, a 13+1+3 day mission can be completed by taking 1 can from the ISS contingency reserve (stockpile). If a 13+2+3 day mission is required with 6 ISS crew, a total of 3 cans will be taken from the ISS contingency reserve. EECOM is working with Flight Management to determine whether it is desirable to fly additional LiOH on STS-131 to minimize the risk of taking the ISS contingency reserve below the redline. Flight Managers are also working to ensure that the ISS program is aware of this risk. This LiOH plan may be modified based on the CO<sub>2</sub> profile during STS-130/20A and the performance of the CDRA and Vozdukh prior to STS-131. Additionally, if ISS crew size increases and CDRA fails, the docked duration may have to be shortened due to a shortage in the ISS LiOH Stockpile/contingency reserve. Updates to Vol C flight rules that document the current ISS LiOH Stockpile/contingency reserve management philosophy are in work.

# STS-131 Space Transportation Vehicle Division Readiness Statement

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The Space Transportation Vehicle Division has performed the reviews necessary to assess the flight readiness relating to vehicle systems requirements definition, crew and flight controller training, and operations. We have determined all applicable responsibilities acceptable for flight pending closure of the identified open work and issues.

*Original signed by*

*February 2, 2010*

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As compiled by: DS/Jim Azbell