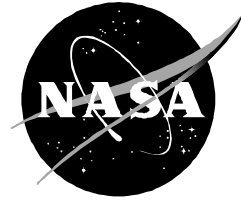


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Reply to Attn of: DS-11-01

February 17, 2011

TO: Distribution

FROM: DS/Chief, Space Transportation Vehicle Division

SUBJECT: STS-133 MOD Space Transportation Vehicle Division Flight
Readiness Review (FRR) Delta Delta Data Pack/Prelaunch Systems
Issues

The enclosed data pack is provided to aid in the preparation for STS-133. The inputs are provided from Space Transportation Vehicle Division Flight Control Team disciplines for STS elements (Orbiter, SSME, SRB, and ET). The focus of this data pack is in-flight operations and the list of items in each section is not necessarily comprehensive.

This publication coincides with the L-1 Week Division Flight Readiness Review for the flight. Changes or issues that require updates after this publication will be provided by the on console team at the L-1 briefing.

A. Open Flight Anomalies

None

B. New Operations

EECOM:

ECL-5 LCC Change - During scheduled testing, one of the Cabin Relief Valves on OV-103, and one on OV-104 were found to have new crack pressures (still within requirements). This resulted in different allowable upper limits on the cabin pressure and A/L-PLBD pressure sensors and the need to update the LCC.

Water Dump Constraint Rule Update - On STS-131, a water dump was performed in a biased posigrade attitude when it should have been performed in a retrograde attitude. Flight Rule A2-109 Preferred Attitude for Water Dumps did not cover the FD3 dump situation and an incorrect attitude was chosen for the dump. An updated version of this rule will be published in the flight specific annex for all remaining flights. The new version will cover the situation from STS-131 where the phasing rate was greater than 50 nm/rev. If the phasing rate is greater than 50 nm/rev, the dump will now be constrained to occur from ten minutes after the relative apogee to fifteen minutes prior to the next relative apogee. This will not negatively affect the dump plan. The Flight Rule update has been coordinated and approved at the Flight Techniques Panel.

B. New Operations, cont. EECOM, cont.:

Changes to the Deorbit Prep Coldsoak and Comm Attitudes - Changes to the deorbit prep coldsoak and comm attitudes were proposed and approved by the Flight Techniques Panel. They will be documented in Flight Rule A2-110 Structures Thermal Conditioning. The new flight rule will add +/- 10 deg in pitch flexibility to the current biased tail sun inertial Radiator Coldsoak attitude to improve comm coverage, while continuing to satisfy thermal constraints and provide an adequate coldsoak. In an effort to reduce structural thermal gradients and stresses on the vehicle during entry/landing the new flight rule also specifies a yaw bias to the deorbit thermal/comm attitude dependent on beta angle (direction of yaw bias opposite of beta angle). Flexibility in the magnitude of yaw bias has also been added to improve comm coverage if required. Changes to the Flight Rule were added to the flight specific annex of all remaining missions.

MMACS:

APU Operations While Docked - Analysis to examine the effect that the stack would experience from running a single APU while docked to ISS is complete. Information from that analysis was used in the ULF5_C10-1 APU Operation While Docked flight rule and has been approved. Additionally, the rule was further updated to account for new analysis for the configuration of ATV and/or HTV being docked to the ISS.

B. New Operations, cont. MMACS, cont.:

Hook Requirements for Docked Operations - Analysis to examine the docking interface loads that would be experienced with multiple hooks out scenarios is complete. Updates with information from this analysis were made to the ULF5_C10-2 Hook Requirements for Docked Operations flight rule.

SSME TVC and Elevon Hydraulic Switching Valve Failure Analysis - In response to a S0044 NO-GO call for an SSME TVC switching valve out of config, MMACS, GNC, and HYD PRT personnel have reviewed the risk and credibility of a switching valve failure.

No LCC exists for the scenario where the sole switching valve status indicates that a valve has unexpectedly swapped or failed to transition. There are no sufficient secondary indications to exonerate all the cases that were considered. A summary presented to DA8 discussed the signatures, impacts, and probability of a hydraulic switching valve jamming or unexpectedly swapping prelaunch. The hardware criticality is 1R2, and the Program has never experienced a switching valve failure. The data gathered indicated that these valves have extensive design requirements, controls, and verifications in place to ensure that they do not fail. Hydraulic fluid contamination, the leading candidate to cause a failure, is also extensively controlled. The data was presented to the Launch Integration Manager and it was determined that no LCC is needed for a single indication of a hydraulic switching valve misconfiguration prelaunch.

B. New Operations, cont.

EGIL:

Cryogenic Tank 5 removal - STS-133 is being flown with only 4 tank sets to reduce overall vehicle weight increasing up mass capabilities/ascent performance. All console applications have been updated to accommodate this configuration. Additionally, all nominal procedures have been updated. Any deltas associated with Cryogenic Tank 5 in the generic contingency procedures will be provided in realtime. PASS/BFS TMBUs will be sent to inhibit all associated onboard software caution and warning alarms.

GNC:

DAP configurations and constraints - (Awaiting C. S. Draper Laboratory Memo): The current version of the flight rules and crew procedures 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. Final memo delivered.

PM Venting Attitude Control Analysis - The venting of the failed pump module (PM) has been added to EVA 2. Draper is currently working to certify Shuttle attitude control (VRCS and ALT) during the PM venting. This capability is documented in the DAP Loads and Constraints Memo as well as in CHIT 8931.

B. New Operations, cont. GNC, cont.

Star Tracker Shutter Closures During PM Vent - The Star Tracker PRT and Orbiter S&MA have requested the star tracker shutters be closed during the PM Vent. It is unlikely particles from the Failed Pump Module (PM) vent would contact the LRUs, however this is a conservative action. The team has decided to close the star tracker shutters by powering off the star trackers and have decided not to close the doors. Appropriate steps have been placed in the timeline and the plan has been coordinated with DA8.

VRCS Overshoot and Maneuver Chasing - During certification runs of generic maneuvers performed by Draper for the STS-133 DAP certification, 0.5% of generic mated maneuvers took longer than expected to complete due to Overshoot and Maneuver chasing. This is more likely than a 3-sigma event. These phenomena have been previously seen in simulation with the ALT DAP but not with VRCS and are caused by decreased control authority with HTV and ATV both docked. All mission specific maneuvers planned in the ATL showed no signs of these problems during certification. In the unlikely event a VRCS maneuver fails to converge, the team has coordinated a plan to reduce the DAP Maneuver rate to provide the DAP with more control authority.

B. New Operations, cont. GNC, cont.

RAMBO-2 Procedure Updates - The RAMBO-2 payload of opportunity experiment uses dedicated assets to collect stereo views of PRCS plumes. The experiment requires a dedicated crew procedure to perform a sequence of a RAM, WAKE and an Out-of-Plane burns. When the procedure was developed for STS-129, the DoD originally reported the expected window duration for RAMBO-2 opportunities was on the average of 14 minutes, however, they now report it is on the order of ~ 5 minutes. Due to the shorter window, the ORB OPS FS Crew procedure was reworked to be more flexible to accomplish any combination or number of desired burns. Per the DoD request, the procedure was also modified to perform each burn at a specified TIG within an opportunity window instead of simply starting the sequence at a specified MET.

The crew procedure was P'Ved with the STS-133 crew on 6/15/10. The corresponding JOIP procedure has been updated and the ORB OPS FS procedure changes are complete.

B. New Operations, cont. GNC, cont.

MAUI Procedure Updates - The MAUI payload of opportunity experiment uses ground based telescopes to monitor PRCS and VRCS plumes. The original ORB OPS FS crew procedure called for a PRCS sequence of firings followed by a VRCS sequence. As part of this sequence, a manual RHC accel mode firing was required to fire F4D. During the STS-130 MAUI procedure this accel mode firing resulted in cross coupling which the DoD is afraid could degrade the experiment data. Thus the DoD has requested this accel mode firing be deleted for the full VRCS and PRCS sequence but maintained for a PRCS only sequence

Depending upon the duration of the opportunity and the DoD request, sometimes only a part of the MAUI sequence is performed (PRCS only or VRCS only). In these cases GNC has uplinked new MAUI procedures in the past. However, to account these cases and to completely document the desire for the accel mode firing in the PRCS only sequence three MAUI procedures are being placed in the STS-133 ORB OPS FS to cover the new full sequence and for the PRCS only and VRCS only procedures.

All three procedures were Pved with the STS-133 crew on 6/15/10. The corresponding MAUI JOIP Procedure has been updated and the ORB OPS FS changes are complete.

B. New Operations, cont. GNC, cont.

Antiskid Switch Guard - During a generic, stand-alone BFS entry training run in the SMS, the training team accidentally sent a command to power off Antiskid after TAEM which resulted in a Loss of Control (LOC). Software review and SAIL testing showed this is expected behavior by the BFS per requirements. On the BFS, when Antiskid power is cycled from ON to OFF after TAEM the four associated wheel speed sensor outputs switch from “1” to “0” causing Weight on Wheels (WOW) to be set. WOW triggers several changes in the DAP to ensure control in the two-point stance which will cause a LOC while still in flight. Powering off Antiskid prior to TAEM will not trigger WOW since the BFS first pass logic checks for this condition. Subsequently the PASS is not susceptible to this failure since its WOW detection logic is more robust.

To mitigate this risk in flight, an AEFTP Splinter on Jan 20, 2011 decided to place a switch guard over the Antiskid switch prelaunch and keep it in the “ON” position the entire flight. For on-orbit power down, Antiskid power will instead be controlled solely by turning off the upstream Brake Power switches (nominal configuration for orbit). Flight Rule updates were completed by GNC. FDF updates to edit Antiskid switch callouts in Ascent, Post Insertion, FCS C/O, Deorbit Prep, and Entry checklists were completed by MMACS. Power down procedures will be left as is.

B. New Operations, cont.

INCO:

Ascent Satellite Handover - With Air Force Remote Tracking Site (RTS) support going away, the TDRS network has provided overlapping satellite support for remaining missions in case of a TDRS failure. Proposed handover techniques have been approved by A/E Flight Techniques and has been used in generic and flight specific simulations. These operations are only for the case of a failed satellite; nominal operations remain unchanged. The INCO Console Handbook Command section and Command Procedures Handbook are complete.

BOOSTER

Logic Change Notice (LCN) 01312R1 - Main Engine Shutdown Switch Anomaly (SSME-36)
Update - SSME-36 protects for a failure of one or both of the Main Engine shutdown pushbutton contacts. Prior to STS-132, the LCC effectivity started at the transition to OPS 1 down to T-31 seconds, with a one-time check for a shutdown command (both contacts failed hot) at approximately T-9:30. This update takes advantage of additional monitoring capability provided in OI-30 (and subsequent software releases) and expands the LCC effectivity to include OPS 9, and will continuously monitor for a shutdown command in the GLS down to T-0. Prior to STS-132, if a shutdown command were issued at T-0, an engine shutdown would occur at MM102, resulting in an RTLS abort. The update for STS-133 provides an automatic GLS cutoff and would result only in a pad abort. This change has been reviewed extensively and approved by the MPS/SSME community. The A/E FTP approved the change on 4/30/10, the LCCWG approved on 5/5, and the Daily PRCB approved on 6/4/10. A manual implementation was used (but not needed) for STS-132, with automated GLS capability available for the first time on STS-133. No open work remains for Booster.

B. New Operations, cont. BOOSTER, cont.:

First Flight of the Solid Rocket Booster (SRB) Thrust Vector Control (TVC) Hydraulic Power Unit (HPU) Phase II Fuel Pump - STS-133 is the first flight of the redesigned SRB HPU Phase II Fuel Pump. There are two TVC Systems (Rock and Tilt) on each SRB, and the new fuel pump will fly as part of the Right Tilt TVC system for STS-133. The Phase II Fuel Pump is scheduled to fly as part of all four TVC system positions for STS-134. The fuel pump redesign prevents contact between rotating metal components, which eliminates a Criticality 1 failure scenario where the loss of the drive shaft carbon seal results in catastrophic metal on metal contact. The failure scenario was the highest SRB risk per the current Shuttle Probabilistic Risk Assessment. The redesigned fuel pump is now similar to the current Orbiter Auxiliary Power Unit fuel pump design. There is no open work for Booster associated with this change.

C. Operational Workarounds

INCO

S-band Communications – Nominally Shuttle S-band is configured in low frequency with the exception of a scheduled 24 hour period in high frequency post-undock (for KSC processing purposes). Now that STS-133 has moved into a timeframe where both ATV and HTV will also be docked to ISS, there are a few S-band constraints. As a result, INCO will configure the system to high frequency from FN1 through Late Inspection to avoid orbiter S-band forward link interference from the HTV proximity communications system. Additionally, ground site proficiency passes during docked ops will require extra pre-coordination to avoid interfering with ATV data dumps that occur for 20 minutes once every orbit. Further, S-band high frequency poses a threat to the Laser Camera System (LCS) on OBSS sensor package 2. If a docked focused inspection were required, a larger keep out zone and careful S-band PM antenna management must be observed. Appropriate flight rules have been created to govern S-band operations during ULF5.

To summarize the interference issues:

- Problem: Shuttle TDRS forward link (low frequency) is degraded by the JEM PROX (HTV) and the SM PCE (ATV).

Solution: We will fly in high frequency for the entire docked timeframe.

- Problem: ATV and HTV forward link are degraded by Shuttle GSTDN forward link (high frequency).

Solution: We will not perform ground site proficiency passes without approval from all parties.

- Problem: OBSS sensor package 2 (specifically LCS) imagery will be degraded within 11.43 meters.

Solution: The S-band PM antenna diametrically opposed to the LCS scan location must be selected.

D. Anomaly Resolution

BOOSTER:

STS-129 SSME #2044 Nozzle Leaks - STS-129 Postflight inspections discovered numerous tiny leaks on the “hot wall” side of the nozzle tubes for SSME #2044 (Center SSME for STS-133), which ultimately resulted in an R&R of the nozzle hardware. The leaks were not of significant magnitude as to result in a detectable performance impact. These leaks are thought to be caused by the use of sponges to apply a corrosion inhibitor near the top of the nozzle. The sponges were found to contain very high amounts of chlorides (up to 14% - which is six times as much chlorides as sea water). Chlorides are used to prevent fungus/mold on sponges. The corrosion inhibitor applied to the nozzles is to prevent leaks caused by use of a sulfur containing adhesive tape to seal the throat plug during the 1990’s. The sulfur embrittled the nickel finish of the nozzle when subjected to temperatures in excess of 1000 degrees F, causing cracks which allowed moisture to attack the underlying A286 material resulting in corrosion pitting and leaks. Starting with STS-130 and for all future flights, nozzle hotwalls will be protected from the environment by installing rollout covers and supplying a purge of environmentally conditioned air. The corrosion inhibitor will now be applied after each hotfire of the engine, and at least once per year. Experience and analysis shows corrosion does not lead to large changes in leak rates over short periods of time.

STS-131 Right MPS Inlet Pressure Sensor Failure - At 1:30 MET, the Right MPS LH2 Inlet Pressure Sensor failed off-scale low. This sensor is used to verify integrity of the MPS LH2 12” feedline in the event of a pre-MECO SSME shutdown, per Flight Rule A5-201. The SSME Low Pressure Fuel Pump Discharge Pressure sensor was available as a backup if needed. Failures of the inlet pressure sensors have occurred in the past, most recently on STS-117. This was originally documented as IPR 133V-0003, and later upgraded to PR MPS-3-39-1855. The failed sensor has been removed and replaced, and the refoam around the sensor (due to the extreme cold LH2 environment) is now complete.

D. Anomaly Resolution, cont. BOOSTER, cont.:

STS-131 High Pressure Fuel Turbopump (HPFTP) Vibration Sensor Failure - At 7:19 MET, a vibration redline sensor (21° location) on the Left SSME HPFTP was disqualified from redline monitoring. The two remaining sensors remained qualified and the vibration redline was active throughout the remainder of powered flight. Post flight analysis of the data indicated that the HPFTP performed nominally, and that the sensor failed a high noise floor check, which is a common failure mode. The SSME project has analyzed the hardware and determined the sensor disqualification can be attributed to a phenomenon known as pyroglitching. Pyroglitching is a result of the thermal expansion/contraction of the piezoelectric crystals utilized in the SSME accelerometers, which builds up a small electric charge that eventually discharges and affects the true accelerometer signal. Pyroglitching is most prevalent in Prelaunch during Chilldown, and more likely to occur on the HPFTP due to the colder temperatures of the LH2. The 21° sensor location is especially prone to the phenomenon, due to its proximity to the inlet of the HPFTP. There are no constraints or open work for STS-133.

STS-132 MPS LH2 High Point Bleed Disconnect (PD17) Leakage Post-Landing - An audible leak was heard coming from PD17 on OV-104 post-landing for STS-132. Technicians performed troubleshooting to determine if the leak originated from the High Point Bleed Valve (PV22) or the associated disconnect (PD17). PD17 failed the leak test, and was subsequently cleaned. A second leak check was performed, and the disconnect passed. IPR 335V-003 was taken to document the issue, which was later upgraded to PR MPS-4-33-1813. There is no open work for Booster for this failure.

D. Anomaly Resolution, cont. BOOSTER, cont.:

Unexpected Data Signature Observed During PV12 Relief Valve Test - An unexpected signature was observed on 6/14/10 while performing a test to verify the proper function of the LH2 Inboard Fill/Drain valve (PV12) relief valve. To verify proper function of the relief valve, the pressure on the “fill” side of PV12 was increased until the cracking pressure of the relief valve was reached (due to a differential pressure between the “fill” side and the LH2 manifold side). However, the cracking pressure was never obtained and the test terminated when the “fill” side reached a pressure limit; IPR 133V-0022 was taken to document the issue. A failed relief valve was initially suspected, however, upon further review a test plate was inadvertently left attached at another location in the Orbiter Aft compartment. This maintained a higher pressure on the LH2 Manifold side of PV12 and prevented the relief valve from cracking. The test plate was removed and the test repeated, with the PV12 relief valve operating nominally. The IPR was closed as a procedural error, and a permanent deviation will be written to verify the test plate is not attached prior to performing the PV12 relief valve validation test. There are no constraints to STS-133 for this issue.

SSME Low Pressure Oxidizer Turbopump (LPOTP) Replacement After Engine Installation - A torque check was performed on the LPOTP for each SSME after it was installed in OV-103. The LPOTP for Engine #2048 (initially in the Center position) failed the torque check, which was performed after installation to ensure nothing was binding up the rotation of the turbine/pump. A new LPOTP was procured for #2048, but in order to replace the old pump, all three SSMEs needed to be removed. Engine 2048 was then installed in the Left position, with Engine 2044 (initially in the Left position) taking its place in the Center spot. Failure analysis at Canoga Park, CA determined a tolerance stack-up and a slightly off-center rotor most likely contributed to the failed torque check. There are no constraints to STS-133 for this issue.

D. Anomaly Resolution, cont. BOOSTER, cont.:

STS-132 Integrated In-Flight Anomaly for Streaks in the SSME Plumes - An Integrated IFA was taken to document a higher than typical number of visible streaks observed in the plume of the SSMEs during STS-132. Imagery experts documented 217 “events”, while the average for a flight is approximately 40. The source of the plume streaks is still unknown, but the fact that streaks were seen in all three plumes indicates the likely cause is contamination external to the SSMEs. SSME Project conducted a thorough data review and found no indications of wear, fracture, or contamination passing through the engines. No anomalies were found during post-flight engine inspections. This IFA was reviewed at the Systems Integration Control Board on 09/21/2010. The investigation did not identify any credible sources of contamination in the MPS system, or any credible sources of parts or materials releasing from the SSMEs or the vehicle, that could have both caused the streaks and pose a flight safety issue. Therefore, the SICB unanimously agreed to close this IFA as an Unexplained Anomaly with no corrective actions required. Booster has no open work associated with this item.

MPS Pneumatic Disconnect 8 (PD8) Removal and Replacement prior to Orbiter Processing Facility (OPF) Rollout - During a final inspection and cleaning procedure prior to OPF Rollout, technicians discovered a loose poppet on PD8, which is the orbiter-side of a disconnect which fills the Orbiter MPS Helium Bottles. This disconnect is mated to the LH₂ Tail Service Mast (TSM) for flight in the Vehicle Assembly Building and it is possible the poppet could have failed any time after this mating occurred for STS-131 (the last flight of OV-103), since the only time a failed poppet could be discovered was during the final cleaning/inspection prior to OPF rollout. A decision was made to R&R the disconnect assembly prior to rollout, and this occurred successfully on 08/20/2010. On 9/14/2010, PD8 passed a leak check which was performed in the VAB after the mating for flight. Booster has no concerns about this issue, and no open work remains for flight.

D. Anomaly Resolution, cont. BOOSTER, cont.:

Solid Rocket Booster (SRB) Frangible Nut Failed to Separate During Destructive Lot

Acceptance Testing (DLAT): The fifth of a set of five SRB frangible nuts undergoing DLAT failed to completely separate into two pieces and release from the test stud, which is a requirements violation. These frangible nuts were from lot AAY, which is scheduled for use on STS-335. The nuts used for DLAT have a 10% thicker outer web and are attached with less preload than flight nuts, both of which contribute to a conservative test result. The booster cartridges (pyros used to sever the nut) were from a lot which is being used on STS-133 but were eliminated as a possible contributor to the test failure. Further investigation determined the Inconel material used in fabricating the nuts had stronger material properties than previous lots. Flight rationale exists for STS-133 based on the performance of the current lots of booster cartridges and frangible nuts and the conservatism built into the DLAT setup. Booster has no issues with the flight rationale and no open work associated with this item.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0058 - Right Space Shuttle Main Engine (SSME) Controller B Power-up Anomaly - This IPR was taken when the STS-133 Right SSME Controller AC1 Phase B power supply was slow to activate, which scrubbed the STS-133 11/2/2010 launch attempt. The accepted fix for this previously seen failure mode associated with shuttle circuit breakers is to cycle (“scrub”) the circuit breaker five times to clear suspected debris. Following those actions, the electrical connection was established and no further degradation was expected. The failure signatures and fault tree of this anomaly, failure history of shuttle circuit breakers, and potential mission impacts were reviewed at the Mission Management Team meeting on 11/3/2010. All organizations agreed to proceed to the 11/5/2010 launch attempt assuming the Right SSMEC and power supply were performing normally. Since vehicle repairs due to other IPRs and subsequent launch window constraints delayed the launch until no earlier than 11/30/2010, it was decided to remove and replace all 18 SSME AC circuit breakers on Panel L4. Prior to removal, troubleshooting was performed on the discrepant circuit breaker while it was still installed on Panel L4, with no major discoveries noted. After removal, the circuit breaker was disassembled and the source of the problem was found to be non-conductive debris build-up on the “fixed” ‘B’ contact (as suspected). Reinstallation of Panel L4 with the new circuit breakers was completed on 11/16/2010 and all functions have been successfully retested. Closure of the anomaly was approved by Space Shuttle Program management at the 11/18/2010 Program Requirements Control Board.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0068 Ground Umbilical Carrier Panel (GUCP) Hydrogen Leak - This IPR was taken when the hydrogen concentration in the GUCP helium purge area exceeded the HAZ-09 LCC value of 40,000 Parts Per Million. This scrubbed the STS-133 11/5/2010 launch attempt. GUCP leaks have previously occurred on STS-27R, 44, 52, 65, 80, 119, and 127. This GUCP leak is the largest seen to date, with a calculated value of 26 scfm (~50% larger than the next largest GUCP leak, seen on STS-119). The likely cause for the leak was a combination of two factors. The first was an out-of-family concentric offset between the GUCP and the ET-side Flight Seal - at 0.049", this was just below the maximum allowable of 0.050". The second was the resultant shift of the GUCP / External Tank Carrier Assembly (ETCA) due to uneven loading when the the Hydrogen Vent Arm is attached. During disassembly after the launch scrub, the concentricity offset had increased to .061". Work was performed to minimize the concentric offset between the GUCP, the 7" Quick Disconnect, and the ET-side Flight Seal. A new flight side seal was used, as well as a different ground side disconnect. No leaks were detected at the GUCP during the STS-133 Tanking Test on 12/17/2010. During preparation for roll-back after the tanking test, the de-mate of the GH2 vent line was reported to be off-nominal. Post-rollout, a small, but in-spec leak was observed during ambient helium leak checks performed on the GUCP. As a result, the GUCP 7" QD seal was removed and replaced again.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0070 PV13 Incorrectly Opened During Drain - This IPR was taken to document an incorrect configuration of the liquid hydrogen (LH2) topping valve (PV13) which was erroneously opened for ~7.5 minutes during STS-133 hydrogen drain operations on 11/5/2010. The two concerns for this IPR are: 1) the potential for flow induced vibration damage of the topping line, and 2) the potential for contamination to migrate from the vehicle LH2 tank through the unfiltered topping line instead of the normal drain path with an associated 400 μm screen. For subsequent tankings and launch, this contamination could then be ingested by the Main Engines during ascent. The KSC Engineering Review Board decided to remove and replace the 70 micron filter on the Mobile Launcher, since this is where any contamination would have settled. The Propulsion Systems Integration Group and the Systems Integration Control Board (SICB) both reviewed the matter and concluded that there is no structural concern for the reverse flow through the topping line, and that the increase in risk for potential contamination is small and acceptable. The 11/18/2010 Program Requirements Control Board concurred with this assessment and approved a Safety Issue Briefing for STS-133.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0072 Foam Crack at External Tank (ET) Liquid Oxygen (LO2)/Intertank (IT) Interface Flange - A large crack in the ET Thermal Protection System Foam at the LO2/IT flange closeout was observed during the Post Drain walkdown following the first STS-133 launch attempt on 11/5/2010, which was scrubbed due to a hydrogen leak at the GUCP. Video analysis showed this crack occurred during LO2 tanking, when the LO2 level was near the LO2/IT flange. During foam dissection/removal at the pad on 11/10/2010, the underlying stringer (S7 on panel 2 - on the orbiter side, adjacent to the Left SRB thrust panel) was found to have 9" cracks along both feet of the stringer. Further foam removal identified 3.5" cracks along both feet of an adjacent stringer (S6 on panel 2). The damaged segments of stringers S6 & S7 were replaced with new stringer segments and connected to the existing stringers using z-doublers and radius blocks. Backscatter X-ray and Computed Radiography X-ray examinations were performed at the pad on accessible areas for the +Z (orbiter side) LO2 and LH2 flanges and did not find any additional cracks.

Fractography of the panel 2 S6 and S7 stringer crack surfaces revealed no indication of pre-existing flaws that may have been introduced during assembly or transport. Testing of the failed stringer's material properties revealed a lower fracture toughness when compared to control samples. It was later determined stringers from either of two "suspect" lots also show a low fracture toughness. All cracked stringers were either proven or thought to be from those two lots, which were heat treated by Aerochem between 5/2002 and 8/2002 and used on the majority of ET-137 stringers. The low values for fracture toughness may indicate out of specification heating conditions at some point during the manufacturing process.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0072 Foam Crack, cont.:

Since analytical models indicated the IT stringer design provides a factor of safety greater than 2 for the maximum flight limit load, and additional margin for the maximum prelaunch limit load - an instrumented tanking test was performed on 12/17/2010 to obtain data to verify the analytical models. Strain gauges and thermocouples were mounted to the ET IT skin and stringers on panels 2 and 3. Photogrammetry methods were used on panels 2 and 6 to determine the displacement of the LO2/IT flange under cryogenic conditions (the LO2/IT flange diameter shrinks by about 1 inch, the LH2/IT flange diameter by about 1.5 inches). Tanking test data verified the structural integrity of the ET-137 intertank stringers and repairs, verified the ET IT structural analytical models and their calculated design margins, and additionally verified the GUCP alignment process was successful (the GUCP had no hydrogen leaks).

A review of the ET IT assembly process revealed multiple opportunities for undetected structural alignment issues within the areas which use skin doublers (adjacent to the SRB thrust panels). These alignment issues can reduce load limit margins by inducing residual stress in the stringers. ET-137 inspections showed potential fit-up issues existed at both stringers S6 and S7 on panel 2. Many opportunities for induced assembly stress were given and are included in the following sentences. Open and lifted crack surfaces indicate that residual stresses were present. Burrs on the underside of stringer S6 indicate a gapping condition existed. Foam intrusion observed under the stringer foot indicated the foot was not flush with the skin doubler. X-ray data shows the gap between chord and taper shim was larger than typical. Visual inspections show the S6 and S7 stringers extended over the skin doubler panel by a slight amount.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0072 Foam Crack, cont.:

On 12/30/2010 when the vehicle was rolled back to the Vehicle Assembly Building for further inspections, three more cracked stringers were found at the LO2/IT flange where there was not access for inspections at the pad (stringers S6, S7, and S11 on panel 6 - on the side opposite the orbiter, adjacent to the Left SRB thrust panel). Panel 6 stringer S11 is also on a skin doubler, however panel 6 Stringers S6 and S7 are not on a skin doubler. These stringers have been repaired in a similar manner as S6-2 and S7-2.

A structural modification was developed for the stringer ends at the LO2 flange area to mitigate the potential contributors to stringer cracks. This modification adds reinforcing radius blocks over the 2nd to 7th fastener location to increase the local bending stiffness of the stringer feet. This modification was performed for 32 of the stringers on the skin doublers adjacent to each SRB thrust panel in the VAB beginning on 1/3/2011. On 1/10/2011 it was decided to implement the radius block modifications on all of the stringer tops at the LO2 flange. All work associated with this task has been completed satisfactorily and ET-137 was ready for rollout on 1/31/11.

Flight rationale for ET-137 was presented with open work at the STS-133 Delta SSP Flight Readiness Review, held on 2/11/11 and is expected to be approved at the Agency FRR on 2/18/11. The cause of the failures seen at the LO2 stringer ends traced to a combination of low fracture toughness, induced assembly stresses, and reduced thickness in the LO2 stringer feet. The LO2 side flight rationale relies on engineering tests and analysis showing the radius block modification increases stringer capability (FoS for prelaunch = 1.20 and flight = 2.19) and “does no harm”. It also states the modification is local to the structure and does not affect integrated stiffness or loads. Third, the repairs to the failed stringers using a similar modification have been verified with results from the 12/17 tanking test.

D. Anomaly Resolution, cont. BOOSTER, cont.:

133V-0072 Foam Crack, cont.:

Flight rationale for the LH2 side includes no cracks were found after NDE of the LH2 flanges (and also LO2 flanges with similar configurations). Analysis has shown the LH2 stringer ends have margin above their design limit ascent loads. Additionally, it was demonstrated the LH2 stringer ends are not prone to the same assembly induced stresses which can reduce their capability when exposed to the prelaunch loading. Further flight rationale will rely on Final Inspection Team imagery to determine there are no existing cracks in LH2/IT foam prior to flight.

Actions were given to MSFC Engineering and the NASA Engineering Safety Council at the Delta SSP FRR to validate the work Lockheed Martin has done to clear ET-137. These actions were brought to and closed by the PRCB on 2/16 before being presented at the Level 1 Agency FRR on 2/18. Booster has no open work associated with this issue

D. Anomaly Resolution, cont. BOOSTER, cont.:

IPR 133V-0076 - Inadvertent ET LO2 Tank Pressurization - During a test of the GUCP Quick Disconnects, the LO2 tank reached a maximum pressure of 11.8 psig. The pressurization occurred because the CLOX console operator at KSC was initially unable to turn off the LO2 tank prepress. The pressurization was eventually terminated and the ET LO2 vent valve was opened to relieve the pressure returning the system to a nominal pressure of 7 psig. It was later determined the operator was clicking on the incorrect field to send a command to turn off the pressurization. The ET LO2 tank did not reach a high enough pressure to count as a “pressure cycle” or reach the ET LO2 tank hardware limit of 30 psig. A waiver was approved at the 11/30/10 Daily PRCB and there are no constraints to flight for this condition.

IPR 133V-0083 - Center Helium Regulator B OMRS Violation - During the SSME Flight Readiness Test (FRT) at Pad A on 2/3/11, the Center Helium Regulator B pressure increased from 778 psia to 782 psia two separate times, each time for 0.1 seconds duration (the bit toggle is 4 psia). This violated the OMRS limit of 780 psia for this portion of the FRT. The cause of the violation appears to be due to variations in the upstream helium tank pressure during the test and a regulator design that outputs a higher pressure when the upstream helium tank is at the lower standby pressure (~2000 psia) instead of flight pressure (~4300 psia). Waiver WK10816 was approved at a joint OCCB/ERB on 2/10/11, and Booster has no concerns for the proper operation of this regulator on launch day.

D. Anomaly Resolution, cont. BOOSTER, cont.:

IPR 133V-0085 - Left SRB Tilt TVC Hydrazine Leak - When the cap was removed from the GN2 Fill/Purge Air Half Coupling (AHC) for the Left SRB Tilt system, vapors and liquid were noted escaping. These vapors were suspected to be a mix of hydrazine and nitrogen. The cap was reinstalled and no further leak was detected. After the system was loaded and pressurized to flight level with hydrazine, two different leak checks were performed, again with no leaks detected. The system was last accessed to drain hydrazine prior to rollback to the VAB in late December, and afterwards the tank contained a mixture of hydrazine vapor and GN2 at 120 psi. This IPR will be closed as an explained condition due to the cold weather cycles on the AHC. Appropriate levels of redundancy are built into the system and LCCs exist to prevent launching if a leak develops during the launch count.

IPR 133V-0086 - Engine 3 LO2 Inlet Temperature Behaving Erratically - This IPR was generated as a result of work to R&R five cryogenic temperature transducers in the MPS. The work was performed to avoid a potential launch-day waiver condition in the event of two launch scrubs. The five transducers are: LH2 Manifold Disconnect Temperature (V41T1428A), LO2 Manifold Disconnect Temperature A and B (V41T1528A and V41T1527A), Engine 2 LO2 Inlet Temperature (V41T1231C), and Engine 3 LO2 Inlet Temperature (V41T1331C). Four were replaced and retested nominally, but the Engine 3 LO2 Inlet Temperature was behaving erratically, generating IPR 133V-0086. Wiggle tests isolated the failure to the transducer's wire harness and resulted in replacing the damaged section of cable and connector (50P642) as documented in PR OEL-5579. On L-1 day, when the MCC is configured for the mission, Booster will be updating the calibration curve coefficients for these transducers per FCOH 4.7.5.

D. Anomaly Resolution, cont.

PROP:

Anomalies occurred during STS-131 (last flight of OV-103)

RCS Fuel Helium Isolation Valve Leak - The Right RCS Fuel Helium Isolation valves failed combined leak checks during servicing for flight. System access at the pad prevented identification of which parallel valve (A or B) was leaking. Review of valve performance during flow processing suggested that the A valve was the discrepant one. Both A and B valves were left open during the flight. Post flight the pod was removed and taken to the HMF. Testing found the A valve to be the leaking one and the valve was removed and replaced. Post valve replacement testing was nominal.

Left RCS Fuel Helium B Isol Valve - The Left RCS Fuel Helium B Leg isolation valve was sluggish during the deorbit wave-off valve re-configuration. The oxidizer valve indicated closed as expected, but the fuel valve took 47 seconds to indicate closed. The post landing valve test cycle was nominal. There is an existing deferred PR (LP01-A0069) that documents valve position indication anomalies that have occasionally occurred on this valve. Post flight troubleshooting of the valve was performed per IPR 133V-0006 and all cycles of the valve were nominal.

Forward RCS Fuel Helium Isol Valve - The Forward RCS Fuel Helium A Leg isolation valve was sluggish during the post landing valve test. The oxidizer valve indicated closed as expected, but the fuel valve took 82 seconds to indicate closed. A similar signature was seen during the STS-119 post landing valve test. During post STS-119 troubleshooting and during the STS-128 flight, valve performance was as expected. Post STS-131 troubleshooting of the valve was performed per IPR 133V-0007 and performance was nominal.

D. Anomaly Resolution, cont.

PROP, cont.:

Anomalies occurred during STS-132 (last flight)

L3D Heater Failure - Primary RCS Thruster L3D heater failed off. On flight day 2, it was discovered that the heater on L3D had failed off. The L3D thruster, along with the other manifold 3 thrusters (L3L and L3A), have been removed and replaced.

Anomalies during launch preparations

IPR #133V-0047: OMS/RCS Crossfeed Line Fuel Flange Leak: During aft compartment closeout for flight, technicians detected the odor of MMH. The source of the odor was traced the right hand “doghouse” which contains the crossfeed line attachment flange fitting to the Right OMS pod. The source of the leak was the flange fitting, a “fizzing” leak was found with a bubble about every six minutes. Some troubleshooting was performed which stopped the leak. The OMS/RCS PRT and the OPO had several meetings on the leak and developed several plans of action including checking the integrity of the primary and secondary seals. At the KSC ERB, after reviewing all of the options, the decision was made to drain the OMS and RCS fuel tanks, drain and remove fuel from the crossfeed line, and remove and replace the flange seals. The seals were successfully removed and replaced on 10/23/10.

D. Anomaly Resolution, cont. GNC

-Z Star Tracker Shutter IPR - During the Star Tracker Light Shade Post Flight inspection task which was performed on May 12, the -Z Star Tracker shutter was heard to click open but not closed which normally would indicate the shutter was hanging up or sticking. Subsequent power cycles showed the shutter was working nominally. The test was repeated on 6/6/10 with no issues and IPR 133V-0019 was closed.

D. Anomaly Resolution, cont.

EECOM:

Anomalies occurred during STS-132 (last flight)

FES Topping Core Icing during D/O Prep (STS-132) - The Flash Evaporator System (FES) shutdown while on the Pri B controller during the final moments of the radiator coldsoak prior to payload bay door closure for Deorbit Prep. The MODIFIED RAD BYP/FES C/O AND TOPPING CORE FLUSH (ORB OPS, ECLS) procedure was then performed and successfully cleared the Topping core of ice. The remainder of Deorbit Prep and Entry was done using the FES Pri A controller . No impact to STS-133.

Viewing of ISS ECLSS Data on EECOM Display (STS-132) - In support of the ISS “Operator” console support, ECLSS switched to using their ETHOS data server prior to STS-132/ULF4 which prevented ECLSS data from being shown on the EECOM display. ECLSS parameters were still viewable on ETHOS displays, however this required these displays to be brought up on the EECOM workstations (taking up valuable real estate). Mid way through the mission ECLSS started an ECLSS “null” server which then allowed the ECLSS parameters to be seen on the EECOM display. Changes have been made to the EECOM ISP dictionary to pull data from the ETHOS server to get ISS ECLSS data on the EECOM display and verified in the sim environment.

D. Anomaly Resolution, cont.

EGIL:

Anomalies occurred during STS-131 (last flight of OV-103)

Fuel Cell 2 Pump Motor Condition Anomaly (IPR 133V-0001) - After Fuel Cell (FC) start during STS-131 prelaunch, the FC 2 H2 Motor Stat had an unexplained rise over a 5 minute period before dropping back down to its original value. The event was also seen in AC2 currents (a reduction in phase C current and a rise in phases A and B), and all three phases returned to their baseline values at the conclusion of the event. During this period, KSC noted that there were no cabin lighting adjustments or any other load changes that may have affected the H2 Motor Status indication. Historical data shows that similar events have occurred during previous flights of this vehicle (STS-42, STS-63, STS-120 and STS-128), and all had varying FC configurations. Through data review and troubleshooting, KSC has concluded that the condition was not the result of a FC H2 Motor problem and was like the result of an AC phase imbalance or possibly other unexplained AC bus condition. The anomaly does not appear to have been induced by the panel L4 circuit breakers or the associated harness to FC2. The IPR was closed as a Unexplained Anomaly (UA) and the program decided to remove and replace all three AC2 inverters to reduce the potential of a reoccurrence. If this event were to occur again during the prelaunch timeframe, KSC developed a procedure to isolate AC equipment from the bus to try and identify the cause. From the OPO/ERB meeting held on 10/14/2010, a decision was made that troubleshooting for this anomaly would only become mandatory only if KSC declares a launch scrub. If the condition reoccurs and does not result in an LCC violation and subsequent troubleshooting, there will be an increased risk for an AC problem during the flight. A follow up OPO meeting to discuss the troubleshooting with Launch Integration Manager Mike Moses is scheduled for 10/28.

D. Anomaly Resolution, cont.

MMACS:

Anomalies occurred during STS-131 (last flight of OV-103)

AR 4654 (STS-131/OV-103) - ODS X4 Connector Mate Indication Never Received - The ODS X4 Connector Mate Indication (V53X0523E) never indicated ON with hook closure during docking. All 12 hooks successfully closed and the ODS X3 Connector Mate Indication (V53X0528E) was received at the nominal time. This can be indicative of a bad ODS X4 connector or simply a bad connector mating in which it is possible to be loss of the functions wired through ODS X4/PMA X3 connectors (i.e. PMA Hooks drive, docked audio, and payload data). Of these functions, ICOM A in Talk and 1553 Bus 1B were verified to be working, ICOM A Out Listen was not working, and the rest could not be verified. During postlanding testing, the ODS X4 connector was jumpered and the indication come ON. Inspection of the connector and pins was also conducted and was unable to identify any problems.

AR 4684 (STS-131/OV-103) - Window 1 MMOD Impact - The crew reported that Window 1 had an MMOD impact estimated to be less than 1 mm in diameter. The thermal pane was not considered failed. During turnaround operations, this window has been removed and replaced.

D. Anomaly Resolution, cont. MMACS, cont.:

Anomalies occurred during STS-132 (last flight)

AR 4791 (STS-132/OV-104) - Vestibule Lights Not Working - In preparation for undocking, the crew reported that the vestibule lights were not illuminating. The crew verified that the associated circuit breakers on Panel A6L were closed (MN A DOCKING LT VEST PORT cb and MN B DOCKING LT VEST STBD cb). Additionally, EECOM verified good indications downstream of the SYS PWR MN A switch (Panel A6L), indicating that the port vestibule light circuit breaker is getting good power. For undocking, the crew set up an LED headlamp pointing into the vestibule through the ODS Hatch window for lighting. During postlanding inspection, it was discovered that the the lights were plugged into the incorrect, 'dummy' outlets. These dummy outlets are located immediately adjacent to ODS light installation location and are only there to hold tethered caps for ascent and entry. For STS-133/ULF5, during CEIT, the crew was informed of this issue and was offered the option to label the 'dummy' outlet in which the crew declined. The crew will be trained on this specific issue in two training classes (Stowage Review and Ingress/Egress Timeline). Additionally, Joint Ops 4.102 Shuttle/ISS Duct Removal and Hatch Closing and 4.103 Duct Removal and Hatch Close (Bypass Config) has been updated to include plug identification.

D. Anomaly Resolution, cont. MMACS, cont.:

Anomalies occurred during ground processing

PLBD Centerline Latches 1-4 Failed To Drive Fully Closed During Functional Test - On 8/10/10, during PLBD closing in the OPF, Centerline Latch Gang 1-4 was commanded to latch dual-motor (simo with C/L 13-16) for ~20 seconds using GSE software. Neither latch microswitch was received and the latch was only 85% latched (expected to be fully latched within 20 seconds of drive). The latch was driven dual-motor to fully released which took ~14 seconds. A second attempt to latch dual-motor was nominal. It was unknown why the actuator did not perform nominally with dual-motor operations the first attempt so the actuator was R&R'd on 8/17/10. Functional checkouts of the new actuator were all nominal. No further action required.

OV-103 Right Main Gear Bracket Crack – Prior to STS-131, a small crack (~.35 in) was found in the composite bracket that serves as a mount for the brake lines and the telemetry lines to the MLG. This rotates with the gear and serves as an interface between the flex lines above and the hard lines mounted on the gear. Based on stress analysis, the crack was not expected to propagate and the was sufficient margin that the bracket will meet its intended function. It was MR accepted to fly as is for one flight. Post STS-131, the crack was measured with no noticeable changes. It was approved at the PMRB on 6/29/2010 to MR accept to fly as is again for another flight (STS-133) based on the previous analysis.

D. Anomaly Resolution, cont. MMACS, cont.:

B Hatch Lock Mechanism Missing A Detent Locking Ball - During ground ops, the inner airlock hatch's removable actuator handle was removed and 1 of 4 detent locking balls was found missing. Further inspection revealed damage (dents) on the actuator stem, indicating the handle may have been previously inserted incorrectly. The handle was reinserted and a functional check was performed, not meeting specifications. The latch actuator and actuator handle was then removed and replaced. A functional check showed the new mechanism to be within spec.

Window Fastener Torque Loss - Recent torque check data has determined that torque loss is continuing on some fasteners, despite previous beliefs that the issue had been resolved. The OPO decided to accept the risk of some fasteners losing some of their torque. The risk acceptance is based on analysis that determined that positive margins of safety still exist for windows that have lost some preload on some of the fasteners. Lab data has also determined that fasteners that have lost some of their installation torque may still be providing sufficient preload to the joint. To mitigate the torque loss issue, Window 3 on OV-103, which has self-locking fasteners, has been retorqued to 70 in-lbs in order to provide sufficient torque and preload margin.

D. Anomaly Resolution, cont. MMACS, cont.:

Hydraulic Return Line Support Bracket Crack (IPR STR-3-39-9992) – During ground inspections, a fiberglass support bracket for a Hydraulic System 2 return line was found to be cracked. Upon removal of the insulation in efforts to further examine the cracked bracket, a scratch on the hydraulic line (0.0037” in depth, max allowable is 0.002”) was noticed (IPR STR-3-39-1417). It is believed that the scratch will be able to be MR accepted to fly as is, but still pending stress analysis. For the support bracket, there are no spares in stock and fabrication would take several days. Additionally, the current bracket configuration is questionable to produce positive margin to fly as-is. Therefore, the Hydraulic PRT’s forward plan was approved by the OPO on 2/16/11 which is to attach an MR “Z” bracket to the cracked bracket and have everything complete by 2/19/11. Stress analysis and efforts to understand the failure mode are still in work. This will be brought to the Noon Board on 2/17/11.

D. Anomaly Resolution, cont. MMACS, cont.:

ET Umbilical Retract Actuator - It has been discovered post-flight that there have been some issues with the ET Umbilical Retract Actuators not fully retracting or failing to consistently retract both in-flight (STS-119) and during ground processing. The leading theory for the cause is very small contamination in the hydraulic fluid such that it affects the internal control valves of the actuator. The contamination is likely due to the minimal internal hydraulic fluid circulation and it is believed that cycling the actuator several times will flush the fluid out and clear the potential contamination which is causing the issue. The six ET umbilical retract actuators on OV-103 were cycled at the pad five times nominally on 2/3/11. After this test was performed, the actuators were left uncommanded with full hydraulic pressure to assure there were no uncommanded extend failures. Unfortunately, several actuators unexpectedly extended. IPR 133V-0084 was opened, but upon careful review of the hardware drawings, the actuators reacted as expected. The cause of the confusion was due to a difference in how the uncommanded extend test at the pad was setup compared to the typical uncommanded extend test setup in the OPF. The team at the pad reverted to the procedure used in the OPF and successfully verified that no uncommanded extension failures were present and that the actuators are good for flight. This story was brought to the OPO on 2/9/11 and everyone is happy with the configuration to fly as is.

D. Anomaly Resolution, cont.

INCO:

Anomalies occurred during STS-131 (last flight of OV-103)

AR# 4644 - Ku-Band Failure - During Post Insertion as the crew worked through Ku-Band Deploy and Activation, the Ku-Band failed the Self Test. After two more self tests and numerous troubleshooting attempts, the system was declared failed and was not used for the entire flight. No impact to STS-133. The Deployed Assembly was replaced during KSC processing.

AR# 4677 - Camera C Commanded Zoom Issue - During FN 7 ISS External Surveys, Payload Bay Camera C zoom function stopped operating properly. Camera C was left fully zoomed out and remained unresponsive to zoom commands for the rest of the flight. All other commands to the camera worked. No impact to STS-133. Camera C was removed and replaced during KSC processing.

AR# 4674 - SSR2 Unexpected Mode to Standby - On FD7, Solid State Recorder 2 (SSR2) unexpectedly moded itself to STBY and reported a corresponding Critical Bite Failure (CBF) for 2 seconds. After some troubleshooting it was determined that the CBF was not a position-dependent fault, and may be more of an unexpected software exception, and there were no impacts to the mission. Solid State Mass Memory was unaffected. No impact to STS-133. MMU2 was removed and replaced during KSC processing.

D. Anomaly Resolution, cont.
INCO, cont.:

Anomalies occurred during STS-132 (last flight)

AR# 4762 - OBSS Sensor Package 1 ITVC Pan Tilt Unit Cable Snag - During the FD2 OBSS Inspections the crew was unable to pan/tilt SP1 LDRI to the nominal position for imaging of the Orbiter RCC. Further troubleshooting determined that the Pan/Tilt Unit was hung up on an exterior sensor cable. FD2 Inspections were completed using a combination of SP2 and ISS imaging assets via RPM and external cameras. The cable was secured during EVA#2 and SP1 regained nominal Pan/Tilt motion for Late Inspections. No impact to STS-133.

E. Miscellaneous (i.e. catch all category)

GNC:

Boundary Layer Transition Flight Experiment (BLT FE) – OV-103 is being modified to perform another BLT FE to study the effects on boundary layer transitions at high Mach numbers. The STS-133 protuberance was increased from 0.35” high on STS-131 to 0.5” high and remains 4” long. The protuberance is being placed on the bottom of the port wing. Analysis has been performed which suggests that no significant impact to flight control margins or propellant usage can be expected from this experiment, assuming the protuberance height does not exceed 0.75”. This effort is expected to play a significant role in understanding boundary layer transition and influencing development of high-fidelity computational modeling techniques. The results from the 0.25” protuberance on BLT FE #1 (STS-119) were favorable but the results from the 0.35” protuberance on BLT FE #2 (STS-128) were inconclusive.

OMS TVC Controller issue (AR 003365): On STS-124, the Left OMS Secondary TVC (S/N 131) pitch and yaw position transducers failed to null during ascent. Subsequent testing and troubleshooting has determined that the problem was due to a low likelihood failure of the A6 circuit card becoming unseated, the exact cause of which has not been identified. Previously, it was thought the cause of the failure was compression set of the viton foam strips between the circuit cards and the TVC cover. However, testing has proven that the foam strips alone do not provide circuit card retention, so the 124 failure was not due to degradation in the viton foam. Flight rationale for STS-119 and subs was developed based on system redundancy and likelihood of a similar failure.

E. Miscellaneous (i.e. catch all category), cont. GNC, cont.:

MLS Decoder T/R Limiter Life Time Exceeded: The OPO on 8/27/10 approved Shuttle to “fly as is” with MLS Decoder Transmit/Receive Limiters which have exceeded their useful lifetime.

The purpose of the limiter is to protect the MLS receiver mixer crystal diode by preventing too strong of a transmitted RF signal. With the expiration of the limiters, it is possible that an extended exposure to a high level of RF could damage the decoders but this is not likely except during vehicle rollout or post landing.

The original lot of limiters was manufactured in 1975-1980 but an additional lot was manufactured in 1990. The limiters have a lifetime of 7.2-26.8 years depending upon how many millicuries of tritium was originally loaded within the limiter. As the limiter degrades it will allow more RF to pass to the receiver mixer. All three vehicles have a mix of both lots with OV-103 specific information below:

OV-103 Slot 1	Decoder S/N 18	Original T/R Limiter
Slot 2	Decoder S/N 17	T/R Limiter replaced 6/20/94 with lot date 9044
Slot 3	Decoder S/N 28	Original T//R Limiter

The MEL allows for launch with one MLS failed unless there is an RA failure or if no high speed tracking is available for a night landing in which case three MLS are required.

E. Miscellaneous (i.e. catch all category), cont. GNC, cont.:

SRB RGA Failed Ground Testing - While performing ground tests designed to screen for damaged gyros, S/N 119 (last flown on STS-126) failed due to an out of tolerance condition in the yaw axis. The test was repeated and the unit passed. During further testing the unit exhibited out of tolerance conditions on one more occasion, however it was in the pitch axis. The OPO's proposed flight rationale relies on the redundancy of the SRGA system, as well as the pre-launch torque tests performed at T- 3:00 hours. There is still testing being done to identify the root cause of the SRGA failures and the rationale will be readdressed, if appropriate, based upon any further data.

IMU Slip Ring Issue - A flaw exists in the design of the IMU tape cables used to transmit data to and from its inertial components (gyros, accelerometers, etc.) and the clamp used to hold the wires in place. The current design can create a small amount of flexure in some of the wires. This condition can, and has, led to breakage of slip ring wires during ground calibrations and flight operations. A modification to the IMU hardware has been designed and successfully implemented on S/N 204 and S/N 208; these IMU has been installed in OV-103 in slot 1 and slot 2, respectively. The remaining IMU (S/N 216) on OV-103 has not had the modification performed and is susceptible to this failure mode. The modified IMUs eliminate the susceptibility of all three IMUs to the generic failure mode, and thus the need for early mission termination under the generic failure mode section of the flight rules.

E. Miscellaneous (i.e. catch all category), cont.

DPS:

GMEM load verification and Command Server discrepancy - During an ILC it was discovered that the verification feature for the GMEM application was displaying incorrect address values from what the builder had chosen. After further troubleshooting, the issue was found to be at the command server end. The command server is sending back the incorrect address to the GMEM application for verification. The issue has been isolated only to the address return for GMEM specific Op Code commands of upper memory address values. A GMEM build is still valid but the load cannot be verified accurately using the GMEM verification feature in the GMEM application. A test was performed during an 335 ILC sim load to make sure that a GMEM build command would be uplinked accurately and to make sure it was only a command server return address to GMEM issue. The test proved that the GMEM application did build the load correctly and that the Command Server did store and uplink the command correctly as well. This is a generic problem (Not STS-133 specific) and only affects upper memory GMEM builds verification, which we would normally not uplink due to ground verification constraints (insight) and as practice would have the crew perform the GMEM. If the team does build a GMEM for upper memory for some reason, a work around for verification for a good build once it has been sent to the command server is via the Command Data Word application. This is not an issue for flight and is currently being tracked in the DRTS system.

**E. Miscellaneous (i.e. catch all category), cont.
DPS,cont.:**

MDM FF2 failed BITE Test 3 (MDM Power Supply Test) during BTU Interface test (133V-0008)

MDM FF2 failed BITE Test 3 (BT3) on both ports. On 4/26/2010, MDM FF2 failed BT3 again during power up on both ports. The BT3 tests are BITE tests to verify healthy MDM power supplies (2). On 4/27/2010, troubleshooting indicated the MDM was operating normally with a single power source when only using one power supply at one time. Both power supplies were able to power the MDM with no issues. Power Supply BITE performed prior to and after the bus drops confirmed the anomaly was still present. Indications could be evidence of a faulty BITE circuitry or a marginal power supply. PRT decision was to replace MDM FF2. MDM slot FF2 was R&R'ed and tested nominally.

E. Miscellaneous (i.e. catch all category), cont.

DPS,cont.:

MEDS Adjustment during Prelaunch time frame (Crew Coordination - JSC/KSC)

During the countdown of STS-132, a MEDS BITE was annunciated at approximately T-28seconds. This MEDS BITE would have held the count had it occurred outside the T-31seconds (LCC affectivity). One of the three ways this BITE may be annunciated (User Note Condition) is if brightness adjustments are made to the MDUs. Previous JSC and KSC crew coordination was out of sync with each other. Recently during an exercise to see how to mitigate nuisance MEDS BITEs from potentially holding the count (UN condition or Excluded Errors) JSC DPS and KSC DPS agreed on coordinating with the crew the following:

- a) If performing adjustments outside of the T-9min Hold, please inform the ground of action but not required to inform the ground if performed inside of T-9min Hold.
- b) Crew is not restricted in performing adjustments at anytime, but preference from ground to is to perform outside of the T-9min Hold timeframe.

The STS-133 crew is aware of the STS-132 MEDS BITE and has been briefed based on new JSC/KSC coordination.

E. Miscellaneous (i.e. catch all category), cont. EECOM

Water /Pressure Plans - These items are standard open work.

LiOH – To buy back Ascent Performance Margin (APM), 5 LiOH cans have been offloaded from the vehicle since the November launch attempt. To prevent a future violation of the ISS contingency reserve minimum of 20 cans, the requirement to protect EOM+3 on STS-133 was deleted. As a result, 24 cans are being launched in the middeck and 6 cans will be taken from the ISS contingency reserve to complete the 11+1+2 day mission. The 24 cans in the middeck will protect for a case in which Shuttle cannot dock to ISS.

Vozdukh R&R - A Vozdukh R&R is planned during the STS-133 mission. METOX and Russian LiOH (if required) will be used to make up any shortfall in CO2 removal capability during this R&R. This will not affect the Shuttle LiOH plan or the ISS contingency reserve.

Shuttle Crew Using ISS WHC - To avoid contamination of the JEM-EF, dumping urine while docked is not permitted. As a result, three Shuttle crew members will use the ISS WHC during the docked timeframe to preclude the need to perform a waste dump while docked.

E. Miscellaneous (i.e. catch all category), cont. EECOM,cont.:

O2 Crossover System 1 Valve Position Indicator Anomaly - During vehicle processing and troubleshooting the O2 System 1 Crossover valve position Indicator (VPI) on OV-103 has been shown to operate anomalously under certain repeatable conditions. The VPI will indicate a false open indication when the valve is closed, a delta pressure of 190 psi or greater exists across the valve and the VPI sensor power is cycled. These conditions are not present during launch or on-orbit operations since the valve will be in the open position throughout. Normal function of the valve in both the closed and open positions has been verified. The current O2 Crossover Valve LCC (ECL-12) is still valid and the PRT recommendation to fly as-is was approved.

Middeck Cabin Temp - Postflight, the STS-131 the crew reported that the middeck was excessively warm in the hours just after post insertion. There were several powered middeck payloads on that flight that contributed to this situation. STS-133 has a very similar powered middeck payload complement with respect to middeck heat load. In an attempt to improve crew comfort in the post insertion timeframe by reducing the cabin temperature and improving middeck airflow, several mitigation actions have been proposed and are still being evaluated for implementation by the community. This is not a constraint to flight.

E. Miscellaneous (i.e. catch all category), cont. EECOM,cont.:

Freon Loop 2 Pump A cb found open - Prior to TCDT on Friday 10/15, Astronaut Support Personnel (ASP) observed the Freon Loop 2 Pump A, AC3 phase A circuit breaker was open. IPR 133V-0049 was picked up and the circuit breaker was reconfigured to closed. A flight deck switch list was completed at 2235 EDT on 10/14, at which point the cb should have been verified in the closed position. The cb was discovered open ~ 3 hrs later at 0119 EDT 10/15. The pump had been run earlier in the day on 10/14. This pump is not run nominally during missions. We operate on the B pumps on both loops during missions, the A pumps are only run during ground processing (to even out usage on the pumps).

Ops impacts: if the cb does open and we can't close it or lose that phase of the pump, we will be very close to the loss definition on the pump for Freon loop flow (We have documentation that says 2 phase flow will be below the FR limit, but with induced current we may actually be above). Per the FR's we can run a pump for 168 hrs on 2 phases. This is based on testing – but they only tested for 168 hrs (they did not test to failure). Loss of a single Freon Pump is no mission impact (would still have 1 good pump on that loop remaining), and per the LCC's, we are go for launch with 3 of 4 good pumps.

E. Miscellaneous (i.e. catch all category), cont.

EGIL:

Consumables Status - The following consumables status is based upon Final Summary Chart delivery dated 02/07/2011 for an 11+1+2 mission duration with the following assumptions:

- 120 lbm O2 offloaded evenly from tanks 1-4
- 2-2-2 (KSC-KSC-EDW, respectively) deorbit opportunities
- 18 lbm O2 protected for PMA/ODS repress, PMM Vestibule repress, 3 EVAs
- 75 lbm O2 transfer
- 3 hrs extended postlanding power for middeck payloads
- 1 Glacier from L/O to EOM, and an additional GLACIER from FD4 thru EOM.

Consumable	Number of Tanks	L/O Quantity (lbm)	Min L/O Rqmt (lbm)	Margin (lbm)	Launch Hold Capability (hours)
Cryogenic H2	4	364.4	305.5	58.6	201.7*
Cryogenic O2	4	2988.5	2803.9	184.6	220.2*

* Launch Hold Capability is based on early inputs from last last attempt. Updated ISS PRO inputs are expected prior to L-5 days and a redelivery of E-Consumables may be required but, not expected.

With an on-time launch, this equates to the following on-orbit margins:

	H2	O2
At Projected Non-SSPTS Ops Use Rate	2 day 0 hrs	0 day 18 hrs
At Projected SSPTS Ops Use Rate	4 day 10 hrs	1 day 14 hrs

E. Miscellaneous (i.e. catch all category), cont.

MMACS:

APU Inhibit Management - During a 133 Flight Specific Ascent simulation, there were discussions between MMACS and the Flight Directors pertaining to the APU diagnostic restart philosophy and the use of the auto shutdown inhibit management. The MMACS group has since identified a failure mode, which could result in a catastrophic hot restart, if the APU is restarted with its auto shutdown switch in inhibit. The current flight rules do not account for this failure mode; therefore, a change in diagnostic restart philosophy was warranted and an update to the inhibit rule was also needed. In considering this new failure scenario, the MMACS operational consensus was coordinated with the APU PRT and agreed to by the A/E Flight Directors (Richard Jones, Tony Ceccacci, and Bryan Lunney). Training for the STS-133 mission has incorporated this new philosophy. Flight rule revisions will be officially documented in the STS-134 and STS-135 annex.

INCO:

UA-3-A0059: OI Data Bus drop outs and forward plan for STS-133: During KSC processing prior to STS-131, communication errors were experienced on Instrumentation Bus 1 as detected by Pulse Code Modulation Master Unit (PCMMU) and Multiplexer-Demultiplexer (MDM) Built-In Test Equipment. The decision was made to fly with PCMMU2. During STS-133 troubleshooting, no further anomalies were seen, however the INS team recommended flying PCMMU 2 again. This was discussed and approved during the KSC Engineering Review Board, and will be discussed at DPRCB for approval.

**E. Miscellaneous (i.e. catch all category), cont.
INCO, cont.:**

Anomalies occurring during KSC processing

IPR #133V-0005: S-band PM coaxial cable replacement - following benchmark testing, it was discovered that one of the coax cables in a junction in the upper left antenna was measuring hot (208 degrees). After more testing and discussion, the decision was made to swap out the cable. Unfortunately the 'new' cables were deemed too short. The installation team performed a fit check on the connection and installed a different cable ("flex" instead of "semi-rigid"). Testing of this cable revealed an improvement in temperature but not in signal fidelity. This configuration will be flown during STS-133.

E. Miscellaneous (i.e. catch all category), cont. INCO, cont.:

IPR #133V-0037: Ku band Radar failed Self Test: Ku-Band Radar self test failed the Task 8 Angle Track sequence 8.3 Delta Beta Error Test. The Pitch Rate was 0.0 mrad/sec and should have been -285.883 mrad/sec. The self test set the failure bit for EA-2 (Radar Signal processor) for this condition. The delta beta error signal is generated by EA-2 from a received self test signal from the Deployed Assembly (DA) and sent to EA-1 (Interface and Control Module) for verification. Five more self tests were performed with the same results, except on the last one performed, sequence 8.3 Delta Alpha Error Test also failed. However the Roll rate during this last test showed good at -285.883 mrad/sec. The system was tested in Radar Mode and Comm Mode with nominal results. The final self-test repeated the same failures as seen before. After further analysis and comparison with self test results from OV-104, it was determined that the self test circuit was processing the signals properly, but the OV-103 EA-1 microprocessor was continually producing a failure indication. Because the self test is self contained within EA-1 and the Ku band is working properly in COMM and RADAR modes, a waiver (WK10794) was approved to fly the system as-is.

E. Miscellaneous (i.e. catch all category), cont. PROP

IPR #133V-0052: Right OMS Engine GN2 Fill QD (MD525): During GN2 tank fill valve leak checks, the quick disconnect (QD) indicated flow through leakage. An attempt to slam the Air Half Coupling (AHC)/Ground Half Coupling (GHC) closed by bypassing the orifice in the GSE was made, but had no effect. De-mate of the QD revealed no obvious problems. The GHC was R&R'd. Subsequently, the leak check procedure was unsuccessfully repeated as the same flow through leakage was seen. The AHC poppet was R&R'd. This was followed by a He pressurization/He mass spec of the AHC, which passed. The GN2 tank was then serviced for flight.

IPR #133V-0053: Right OMS He Fill QD (MD515): Post OMS/RCS He tank stage 1 pressurization, when the GSE feeding the Right OMS He tank was isolated and vented, the tank also vented down indicating the AHC poppet was stuck open. Console bypassed the GSE orifice and was able to get the poppet closed. The AHC/GHC were demated to determine cause of the stuck poppet and half of a GHC O-ring was found stuck inside the AHC. The vehicle He tank was vented, the GHC was R&R'd, and the AHC poppet was R&R'd. This was followed by a He pressurization/He mass spec of the AHC, which passed. The He tank was then serviced for flight.

E. Miscellaneous (i.e. catch all category)

BOOSTER:

Updates to Integrated Hazard Report (IHR) IMPS-03 - At the 09/23/10 PRCB, the Space Shuttle Program approved updates to IHR IMPS-03 and associated Orbiter CILs and Hazard Reports. This update was processed to document the increase in risk due to the possibility of purge gas entering the LH2 or LO2 MPS manifolds due to failure of the relief valves which are part of the inboard fill & drain valves for each system. The probability of this failure occurring and the amount of gas that may relieve into the manifold are both believed to be small but cannot be accurately quantified, resulting in a change in the risk category from “controlled” to “accepted”. This issue was previously accepted by the PRCB via a special safety issue briefing for STS-129 through STS-132. The only procedural change resulting from these updates is an Operations and Maintenance Instruction deviation to pre-tanking operations processed by KSC. This deviation closes the GN2 Drain Assist Purge Shutoff Valve to improve the overall risk posture by providing additional redundancy against GN2 entering the LO2 fill line during tanking. There are no changes to Booster procedures as a result of these updates and no further discussion of the issue is anticipated.

E. Miscellaneous (i.e. catch all category)

BOOSTER, cont.:

Equipment Replacements/Additions

STS-133 is the 39th flight of OV-103
 Inclination: 51.6 degrees
 Launch PAD: 39A/MLP 3
 External Tank: S/N 137 (Super Light Weight Tank)
 RSRM Set: RSRM-112: Left Side (A), Right Side (B)
 SRB Assembly: BI-144
 Orbiter Software: OI-34

SSME Hardware¹

Position Number	1(C)	2(L)	3(R)
Engine Number	2044	2048	2058
Engine Type	Block II	Block II	Block II
Last Hotfire	STS-129	STS-129	STS-129
Powerhead	6010	6021	6023
Main Injector	4029	6015	6022
MCC	6007	6012	6027
Nozzle	(5001)	4025	5011
Controller	AF56	AF63	AF49
HPFTP	8114	8030	(8121)
HPFTP R/L Deg. R	1860	1860	1860
LPFTP	2133	6102R1	(4208R1)
HPOTP	8219	8217	8218
HPOTP R/L Deg. R	1660	1660	1660
LPOTP	6007	(6008)	2528

NOTE: Items in parentheses have been changed out since the last hot-fire of the SSME.

SPACE TRANSPORTATION VEHICLE DIVISION FLIGHT READINESS REVIEW
FRR DELTA DATA PACK
STS-133 (OV-103)
February 17, 2011

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