

# **Space Shuttle Program – Mission Evaluation Room**

## **STS-135 MISSION SUMMARY REPORT**

### **Pre-Launch**

The objectives of the STS-135 mission include docking with the International Space Station (ISS), installation of the Multi-Purpose Logistics Module (MPLM) and performance of one Extravehicular Activity (EVA).

During prelaunch operations, two lightning strikes occurred near the vehicle. One strike hit the water tower and the second hit occurred on a nearby beach. After a review of Orbiter telemetry and Modular Auxiliary Data System (MADS) data for both strikes, no impacts to the vehicle were identified. The Ultra-High Frequency (UHF) communications system was active at the time of the strikes. The UHF system did respond to the electrical energy during the strike timeframe and the system did recover, which is typical of an Amplitude Modulation (AM) receiver.

### **Flight Day 1**

The launch countdown was stopped at T-31 sec by the automatic system. The problem was corrected and after a 2 min 18 sec hold, the launch countdown resumed.

The STS-135 mission was launched at 189/15:29:03.996 [Greenwich Mean Time (GMT)] on July 8, 2011, on the thirty-third and final Space Shuttle Program (SSP) mission of the Atlantis vehicle and the thirty-seventh and final mission to the ISS.

The Backup Flight System (BFS) quantities in the left Reaction Control System (RCS) fuel and oxidizer tanks were erratic during ascent. This signature has been seen on previous missions. The measurement returned to a nominal condition and did not impact ascent operations.

The Reusable Solid Rocket Booster (RSRB) separation was visible. A nominal Orbital Maneuvering System (OMS) assist maneuver was performed following RSRB separation. Ignition occurred at 189/15:31:17 GMT [00/00:02:13 Mission Elapsed Time (MET)], and the maneuver was 83.2 sec in duration.

Main Engine Cutoff (MECO) occurred at 189/15:37:28 GMT (00/00:08:24 MET). The External Tank (ET) separated from the Orbiter at 189/15:37:49 GMT (00/00:08:21 MET).

A nominal OMS-2 maneuver was performed at 189/16:06:49.1 GMT (00/00:37:45 MET). The maneuver was 64.4 sec in duration and the Differential Velocity ( $\Delta V$ ) was 97.0 ft/sec. The resulting orbit was 85.2 by 123.9 nautical miles (nmi).

The payload bay doors were opened at 189/17:03:20 GMT (00/01:34:16 MET). The Ku-Band antenna was deployed and the self-test was completed with satisfactory results.

The Shuttle Remote Manipulator System (SRMS) on-orbit initialization was completed at 189/18:28 GMT (00/02:59 MET) and the power-up was completed at 189/22:06 GMT (00/06:37 MET). The SRMS checkout was completed at 189/22:58 GMT (00/07:29 MET). The SRMS was returned to the Pre-cradle position at 189/23:06 GMT (00/07:37 MET). No anomalies were noted during any of the SRMS activities.

The Nominal Correction (NC) 1 OMS-3 was performed at 189/19:08:38.0 GMT (00/3:39:34 MET) with the cutoff 94.1 sec later at 189/19:10:12.1 GMT (0/3:41:08 MET). The maneuver was a dual OMS engine, straight-feed firing with a  $\Delta V$  of 144.6 ft/sec. The resulting orbit was 120.9 by 168.7 nmi, and the engine performance was nominal.

## **Flight Day 2**

The main activities for Flight Day (FD) 2 included the Orbiter Boom Sensor System (OBSS) unberthing, the survey of the Thermal Protection System (TPS), the Orbiter Docking System (ODS) ring extension and the rendezvous tools checkout.

The NC 2 OMS-4 maneuver was a right-engine firing that occurred at 190/10:18:07 GMT (00/18:49:03 MET) with the engine cutoff 11.0 sec later at 190/10:18:18 GMT (00/18:49:14 MET). The resulting  $\Delta V$  was 8.3 ft/sec and the resulting orbit was 121.2 by 172.8 nmi. Engine performance was nominal.

The OBSS was unberthed by the SRMS at 190/11:05 GMT (00/19:35 MET). The TPS surveys were being analyzed.

During the setup for the TPS surveys, the crew reported an issue with the in-cabin cable between the Laser Camera Computer (LCC) and the Orbiter Patch Panel (OPP). The crew reported that moving the cable caused communications between the LCC and the LCS to drop out. The crew secured the cable and operations continued. A spare cable is available in the event that the condition of the original cable worsens.

The starboard-survey of the TPS began at 190/12:21 GMT (00/20:52 MET) and was completed at 190/13:31:10 GMT (00/22:02 MET). The nose-cap survey began at 190/13:53 GMT (00/22:24 MET) and was completed at 190/14:24 GMT (00/22:55 MET). The port-survey began at 190/14:28 GMT (00/22:59 MET) and was completed at 190/16:09 GMT (01/00:40 MET).

The ODS was powered on at 190/18:57:06 GMT (01/03:28:02 MET). The ring extension was completed in 3 min 38 sec at 190/19:00:44 GMT (01/03:31:40 MET). The power was on the ODS for 7 min 02 sec and the ODS performed nominally.

The NC 3 maneuver was a +X RCS firing that occurred at 190/19:47:01 GMT (01/04:17:57 MET). The firing duration was 5.6 sec with a  $\Delta V$  of 1.3 ft/sec. The resulting orbit was 121.7 by 173.5 nmi.

Wing Leading Edge Impact Detection System (WLEIDS) sensor 1080 failed to respond correctly to multiple programming and diagnostic commands when preparing for Port Wing Group 1 Micrometeoroid/Orbital Debris (MM/OD) monitoring during the NC 3 maneuver. Further attempts to recover communications with the sensor were ultimately successful.

All imagery from the FD 2 surveys was downlinked. The Reinforced Carbon-Carbon (RCC) and TPS Damage Assessment Teams (DATs) were reviewing the imagery.

### **Flight Day 3**

The main activities on FD 3 include rendezvous and docking with the ISS, and OBSS Handoff.

A simultaneous supply and waste-water dump was started at 191/08:03:04 GMT (01/16:34:00 MET) and completed at 191/08:37:30 GMT (01/17:08:26 MET). A total of 137.5 lb of supply water and 55 lb of wastewater were dumped.

When activating General Purpose Computer (GPC) 3 during the Group-B power-up prior to rendezvous, GPC 3 joined the common set then subsequently went to Halt. GPC 3 will not be used for the rendezvous. An Initial Program Load (IPL) will be reloaded to regain GPC 3.

The crew switched the Ku-Band System to Communications (COMM) mode at 191/09:46:16 GMT (01/18:17:12 MET) and the system operated nominally. The crew switched the system to RADAR mode for rendezvous at 191/11:44:48 GMT (01/20:15:44 MET) and detected the ISS at a range of 144,000 ft. The Ku-Band RADAR mode operated as expected.

The Nominal Height (NH) OMS -5 maneuver, a dual-engine firing, was completed satisfactorily. Ignition occurred at 191/10:08:06 GMT (01/18:39:02 MET). The firing duration was 38.3 sec with a  $\Delta V$  of 60.0 ft/sec. The resulting orbit was 122.5 by 207.4 nmi.

The NC 4 OMS-6 maneuver, a dual-engine firing, was completed satisfactorily. Ignition occurred at 191/10:55:27 GMT (01/19:26:23 MET). The firing duration was 89.8 sec with a  $\Delta V$  of 143.7 ft/sec. The resulting orbit was 203.2 by 207.9 nmi.

The OMS-7 Terminal Initiation (TI) maneuver was completed using the left engine. Ignition occurred at 191/12:29:04 GMT (01/21:00:00 MET). The duration of the maneuver was 8.5 sec with a  $\Delta V$  of 9.0 ft/sec, and the Orbiter was placed into a 206.8 by 210.6 nmi orbit. Engine performance was nominal.

The Midcourse Correction (MC) 1 maneuver was an +X RCS firing using two thrusters. Ignition occurred at 191/12:49:04 GMT (01/21:20:01 MET). The  $\Delta V$  delivered was 0.24 ft/sec and the resulting orbit was 206.3 by 210.2 nmi. The MC 2 maneuver was a multi-axis RCS firing using 11 primary thrusters. Ignition occurred at 191/13:21:54 GMT (01/21:52:51 MET). The  $\Delta V$  delivered was 0.8 ft/sec and the resulting orbit was 206.3 by 210.3 nmi. The Out-of Plane null maneuver was not required. MC 3 maneuver was a multi-axis RCS firing using seven primary thrusters. Ignition was at 191/13:38:54 GMT (01/22:09:51 MET) and the  $\Delta V$  delivered was 0.8 ft/sec. The MC 4 maneuver was a multi-axis RCS firing using nine primary thrusters. The ignition occurred at 191/13:48:54 GMT (01/22:19:51 MET). The  $\Delta V$  delivered was 1.6 ft/sec and the resulting orbit was 207.2 by 212 nmi.

The Rendezvous Pitch Maneuver (RPM) began at 191/14:05:20 GMT (01/22:36:16 MET) and was completed satisfactorily.

The crew returned the Ku-Band to COMM mode at 191/14:49:40 GMT (01/23:20:36 MET) at a range of 197 ft.

The ODS was powered on at 191/14:35:46 GMT (01/22:36:17 MET). Atlantis made initial contact with the ISS at 191/15:07:15 GMT (01/23:38:12 MET). The hook-drive command was initiated at 191/15:15:47 GMT (01/23:46:44 MET). The hard-mate was completed at 191/15:18:08 GMT (01/23:49:05 MET), and the ODS was powered off at 191/15:19:39 GMT (01/23:50:36 MET).

The hatch was opened at 191/16:34 GMT (02/01:04:57 MET).

The OBSS was grappled and unberthed by the SSRMS following release of the starboard Manipulator Release Latches (MRLs) at 191/19:17 GMT (02/03:48 MET). The OBSS was maneuvered to the OBSS Handoff position where it was grappled by the SRMS at 191/19:42 (02/04:13 MET). The SRMS was then moved to the MPLM Viewing position.

The crew filled and transferred one Contingency Water Container (CWC). CWC no. 1 was filled with 93 lb of water at 191/19:26:19 GMT (02/03:57:15 MET).

After docking, the Orbiter had issues synchronizing data with the ISS through the Orbiter Interface Unit (OIU). The ground exchanged the data bus being used to transfer data from the ISS and this resolved the issue.

The WLEIDS sensor 1111 prematurely dropped out of the On-Orbit Monitoring (OOM) mode twice. All attempts to reset and reprogram the unit were unsuccessful. No further attempts will be made to recover the unit.

The RCC DAT completed their review of the FD 2 imagery and recommended clearing the RCC, which the Mission Management Team (MMT) accepted. The Orbiter Project

Office (OPO) accepted the TPS DAT recommendation that no Focused Inspection would be required.

#### **Flight Day 4**

The main activities for FD 4 will include the installation and ingress of the MPLM.

Prior to unberthing the MPLM by the Space Station Remote Manipulator System (SSRMS) at 192/09:37:39 GMT (02/18:08:35 MET), the Payload Retention Latch Assembly (PRLA) System-A microswitch did not indicate OPEN. The PRLA System-B microswitch did indicate OPEN and the System-A motor ran for single-motor time, which provided confidence that the latch was indeed open.

GPC 3 was successfully recovered after reloading the IPL.

The crew filled and transferred three CWCs. CWC no. 2 was filled with 94 lb of water at 192/10:10:37 GMT (02/18:41:33 MET). CWC no. 3 was filled with 94 lb of water at 192/11:34:01 GMT (02/20:04:57 MET). CWC no. 4 was filled with 97 lb of water at 192/13:30:04 GMT (02/22:01:00 MET).

The crew ingressed the MPLM at 192/16:26 GMT (03/00:57 MET).

The DAT presented a status of the tile and blanket imagery analysis to the MMT in support of the recommendation that a Focused Inspection is not required. The MMT subsequently accepted that recommendation.

The MMT also made the decision to add a day to the mission making the mission duration now 13+0+2 days.

#### **Flight Day 5**

The main activity for FD 5 is the one, and only, planned EVA.

The crew filled and transferred CWC no. 5 with 93.9 lb of water at 193/11:52 GMT (03/20:23 MET).

The EVA began with the hatch opening at 193/13:21:44 GMT (03/21:52:40 MET). The planned EVA activities, which were completed, included installing the Contingency Operations Large Adapter Plate Assembly (LAPA) Tool (COLTS), removing the Pump Module (PM) from the External Stowage Platform (ESP) 2 and installing the PM on the Lightweight Multi-Purpose Experiment Support Structure (MPES) Carrier (LMC), installing the Robotics Refueling Mission (RRM) on the Enhanced ORU Temporary Platform (EOTP), and installing the Materials International Space Station Experiment (MISSE) Optical Reflector Materials Experiment (ORMATE). The get-ahead tasks completed were the Pressurized Mating Adapter (PMA) 3 cover installation, clearing of the Functional Cargo Block (FCB) Power and Data Grapple Fixture (PDGF) grounding

wire, installation of a gap-spanner on Laboratory nadir handrails, and retrieval of the Large Cutter from the Airlock (A/L) Tool Box. The hatch was closed at 193/20:05:42 GMT (04/04:36:38 MET). The duration of the EVA was 6 hr 31 min.

The Nitrogen (N<sub>2</sub>) repressurization was initiated at 193/15:37 GMT (04/04:36:38 MET) and terminated at 193/18:29:39 GMT (04/03:00:35 MET). A total of 26.7 lb of N<sub>2</sub> was transferred.

Both Inertial Measurement Units (IMUs) were aligned, and drift compensations were uplinked. The largest drift compensation was one-half sigma for the Z axis on IMU 3.

## **Flight Day 6**

The main activities on FD 6 were Middeck and MPLM transfer, and a Public Affairs Office (PAO) event.

The crew filled and transferred one CWC. CWC no. 6 was started 194/08:59:58 GMT (04/17:30:54 MET) and terminated at 194/10:37:48 GMT (04/19:08:44 MET) with 96.2 lb of water.

A N<sub>2</sub> repressurization was initiated at 194/14:20:47 GMT (04/22:51:43 MET) and terminated at 194/18:10:44 GMT (05/02:41:40 MET). A total of 29 lb of N<sub>2</sub> was transferred.

## **Flight Day 7**

The main activities for FD 7 were the Removal and Replacement (R&R) of the Treadmill with Vibration Isolation and Stabilization (TVIS) Gyro, MPLM transfer, PAO Events and crew off duty.

The crew filled and transferred two CWCs. CWC no. 7 was started at 195/08:48:56 GMT (05/17:19:52 MET) and terminated at 195/09:42:41 GMT (05/18:13:37 MET) with 94.2 lb of water. CWC no. 8 started at 195/09:51:42 GMT (05/18:22:38 MET) and terminated at 195/10:45:36 GMT (05/19:16:32 MET) with 93.2 lb of water.

A N<sub>2</sub> repressurization was initiated at 195/08:56:41 GMT (05/17:27:37 MET) and terminated at 195/12:17:44 GMT (05/20:48:40 MET). A total of approximately 33 lb of N<sub>2</sub> was transferred.

At 195/22:07:18 GMT (06/06:38:14 MET), the crew was awakened by a Master Alarm that was annunciated by a GPC 4 failure. GPC 4 was assigned as the Primary Avionics Software System (PASS) Systems Management (SM) GPC at the time of the failure. The crew was asked to re-assign GPC 2 as the PASS SM GPC which returned the Data Processing System (DPS) to a stable configuration.

## Flight Day 8

The main activities for FD 8 were MPLM transfer, data downloads from GPCs 1 and 4, and IPL reload of GPC 4.

A N<sub>2</sub> repressurization was initiated at 196/07:42:02 GMT (06/16:12:58 MET) and terminated at 196/10:30:04 GMT (06/19:01:00 MET). A total of approximately 20 lb of N<sub>2</sub> was transferred.

The crew filled and transferred three CWCs. CWC no. 9 was started at 196/07:45 GMT (06/16:16 MET) and terminated at 196/08:36 GMT (06/17:07 MET) with 95.3 lb of water. CWC no. 10 was started at 196/09:00 GMT (06/17:31 MET) and terminated at 196/09:54 GMT (06/18:25 MET) with 97.1 lb of water. CWC no. 11 was started at 196/14:54 GMT (06/23:25 MET) and terminated at 196/15:46 GMT (07/00:17 MET) with 93.7 lb of water.

Data downloads from GPCs 1 and 4 were performed. Analysis of the data is in work. GPC 4 was recovered after an IPL reload. GPC 4 was subsequently put into the “freeze-dry” state.

The crew reported that one of the latches of the Atmospheric Revitalization System (ARS) Lithium Hydroxide (LiOH) Service Door would not release when the pinch tabs were pressed. The effect of this failure is that the LiOH canisters could not be changed out. An In-Flight Maintenance (IFM) procedure was developed to open the door. The procedure was uplinked for the crew to perform on FD 9.

## Flight Day 9

The main activities on FD 9 were the MPLM transfer and the ARS LiOH Service Door IFM.

The crew performed the IFM to open the ARS LiOH Service Door and the door was successfully opened. The crew reported that one of the latches had become completely unthreaded from the rod on the aft-most release. The crew removed that latch and spring. The door was operational using the remaining pull latch.

A N<sub>2</sub> repressurization was initiated at 197/09:59 GMT (07/18:30 MET) and terminated at 197/12:30 GMT (07/21:01 MET). A total of approximately 19 lb of N<sub>2</sub> was transferred.

The crew filled and transferred three CWCs. CWC no. 12 was started at 197/10:00 GMT (07/18:31 MET) and terminated at 197/10:51 GMT (07/19:22 MET) with 93.7 lb of water. CWC no. 13 was started at 197/10:52 GMT (07/19:23 MET) and terminated at 197/11:45 GMT (07/20:16 MET) with 94.6 lb of water. CWC no. 14 was started at 197/12:15 GMT (07/20:46 MET) and terminated at 197/13:09 GMT (07/21:40 MET) with 93.3 lb of water.

GPC 4 was added to the Guidance Navigation and Control (GNC) redundant set in order to give it some run time. It operated nominally for several hours after which it was returned to the “freeze-dry” state. Analysis of the data downloaded from GPCs 1 and 4 was completed. While the data was insufficient to definitively isolate the root cause of the GPC 4 issue, evidence was consistent with a transient failure condition.

## **Flight Day 10**

The main activities on FD 10 were MPLM transfer, a PAO event and crew off-duty.

An Oxygen (O<sub>2</sub>) repressurization was initiated at 198/05:20 GMT (08/13:51 MET) and terminated at 198/06:13 GMT (08/14:44 MET). A total of approximately 16 lb of O<sub>2</sub> was transferred.

The crew filled and transferred five Payload Water Reservoirs (PWRs). PWR no. 1 was started at 198/05:23 GMT (08/13:54 MET) and terminated at 198/05:43 GMT (08/14:14 MET) with 20.1 lb of water. PWR no. 2 was started at 198/05:49 GMT (08/14:20 MET) and was terminated during a Loss Of Signal (LOS) with 17.9 lb of water. PWR no. 3 was started at 198/06:27 GMT (08/14:58 MET) and terminated at 198/06:48 GMT (08/15:19 MET) with 19.9 lb of water. PWR no. 4 was started at 198/06:49 GMT (08/15:20 MET) and terminated at 198/07:15 GMT (08/15:46 MET) with 19.9 lb of water. PWR no. 5 was started at 198/07:16 GMT (08/15:47 MET) and terminated at 198/07:30 GMT (08/16:01 MET) with 14.2 lb of water.

The crew filled and transferred one Iodine-treated CWC-I. CWC-I no. 1 was started at 198/12:25 GMT (08/20:56 MET) and terminated at 198/12:26 GMT (08/20:57 MET) with 36 lb of water.

GPC 4 was reassigned as the SM GPC.

## **Flight Day 11**

The main activities on FD 11 were the MPLM uninstall and return to the payload bay, the hatch closure and the Rendezvous Tools Checkout.

The crew filled and transferred five Iodine-treated CWC-I's. CWC-I no. 2 was started at 199/05:23 GMT (09/13:54 MET) and terminated at 199/05:33 GMT (09/14:04 MET) with 36.4 lb of water. CWC no. 3 was started at 199/05:37 GMT (09/14:08 MET) and terminated at 199/05:48 GMT (09/14:19 MET) with 37.4 lb of water. CWC no. 4 was started at 199/05:52 GMT (09/14:23 MET) and terminated at 199/06:03 GMT (09/14:34 MET) with 38.3 lb of water. CWC no. 5 was started at 199/07:25 GMT (09/15:56 MET) and terminated at 199/07:36 GMT (09/16:07 MET) with 38.3 lb of water. CWC no. 6 was started at 199/07:44 GMT (09/16:15 MET) and terminated at 199/07:56 GMT (09/16:27 MET) with 40.1 lb of water.



An O<sub>2</sub> repressurization was initiated at 199/05:28 GMT (09/13:59 MET) and terminated at 199/06:20 GMT (09/14:51 MET). A total of approximately 14 lb of O<sub>2</sub> was transferred.

The MPLM uninstall and return to the payload bay with the SSRMS was completed at 199/11:48:29 GMT (09/20:19:25 MET).

The hatch between the ISS and the Orbiter was closed at approximately 199/13:59 GMT (09/22:30 MET) and the vestibule was leak-checked successfully.

The OBSS was maneuvered to the Undock position at 199/14:39 GMT (09/23:10 MET).

Rendezvous Tools Checkout was nominal.

## **Flight Day 12**

The main activities on FD 12 were the undocking, the flyaround and the RCC surveys.

The Orbiter resumed attitude control with the Digital Autopilot (DAP) in the automatic-mode at 200/04:56:30 GMT (10/13:27:56 MET) and the maneuver to the undocking attitude was initiated at 200/04:57:29 GMT (10/13:28:25 MET). The maneuver was completed satisfactorily in approximately 33 min. The DAP was commanded to Free Drift at 200/06:25:04 GMT (10/14:56:00 MET) for the undocking.

The command to undock from the ISS was initiated at 200/06:25:45 GMT (10/14:56:41 MET). The total drive time was approximately 2 min and 15 sec. Hook Groups 1 and 2 operated nominally. The ODS performed nominally for undocking. Physical separation occurred at 200/06:27:57 GMT (10/14:58:53 MET).

The fly-around the ISS was initiated with RCS +X pulse of the L1A and R1A thrusters at 200/07:27:40 GMT (10/15:58:36 MET).

Prior to the separation 1 maneuver, the Ku-Band was taken to the RADAR mode at 200/07:44:13 GMT (10/16:15:09 MET) and locked on to the ISS at an approximate range of 558 ft. The Ku-Band was configured back to the Communications (COMM) mode at 200/08:15:27 GMT (10/16:46:23 MET) at a range of approximately 4535 ft.

The separation 1 maneuver was initiated with RCS +X pulse for 6.32 sec using thrusters L1A and R1A at 200/07:50:32.68 GMT (10/16:21:29 MET). The separation 2 maneuver was performed at 200/08:18:43.3 GMT (10/16:49:39 MET). This was a 42.72 sec RCS -X maneuver using thrusters F2F and F3F.

A simultaneous supply-water and waste-water dump was started at 200/09:03:17 GMT (10/17:34:13 MET) and completed at 200/09:53 GMT (10/18:24 MET). A total of 134.8 lb of supply water and 108 lb of waste water were dumped.

The starboard RCC survey began at 200/10:49 GMT (10/19:20 MET) and was completed at 200/11:55 GMT (10/20:26 MET). The nose-cap survey was initiated at 200/12:28 GMT (10/20:59 MET) and was completed at 200/12:58 GMT (10/21:29 MET). The port RCC survey was initiated at 200/13:21 GMT (10/21:52 MET) and was completed at 200/14:16 GMT (10/22:47 MET).

The OBSS was returned to the starboard Manipulator Positioning Mechanisms (MPMs) and latched down at 200/14:48 GMT (10/23:19 MET). The SRMS was cradled, latched and powered down at 200/15:16 GMT (10/23:47 MET).

All imagery from the surveys was downlinked. The RCC Damage Assessment Team (DAT) began their review of the imagery.

### **Flight Day 13**

The main activities on FD 13 were the Flight Control System (FCS) checkout, the RCS Hotfire, the deployment of the Pico-Satellite Solar Cell (PSSC) experiment, PAO event and cabin stow.

The separation 3 maneuver was initiated with a RCS +X pulse for 25.9 sec using thrusters L1A and R1A at 201/05:04:06.2 GMT (11/13:35:02 MET).

The FCS checkout was initiated at 201/05:07:13 GMT (11/13:38:09 MET). Auxiliary Power Unit (APU) 1 was started at 201/05:16:36 GMT (11/13:47:32 MET) and ran for 4 min 26 sec, and used 14 lb of fuel. The APU and the Hydraulic/Water Spray Boiler (HYD/WSB) systems operated nominally throughout the FCS checkout. The FCS checkout procedure was completed nominally and all Flight Control surfaces responded as expected.

The RCS hot-fire procedure was initiated at 201/06:04:25 GMT (11/14:35:21 MET) and terminated at 201/06:12:53 GMT (11/14:43:49 MET). All 38 RCS thrusters were fired at least once. The hot-fire was completed nominally and no anomalies were observed.

The PSSC experiment was deployed at 201/07:49:04 GMT (11/16:20:00 MET) and was the 180<sup>th</sup> successful payload deployment from a Shuttle payload bay.

The port MPMs were stowed at 201/08:05 GMT (11/16:36 MET). The starboard MPMs were stowed at 201/08:07 GMT (11/16:38 MET).

The Ku-band antenna was stowed nominally using dual-motors at 201/15:32:34 GMT (12/00:03:30 MET).

The RCC DAT completed analysis of the imagery and they will recommend to the MMT that the RCC be cleared for entry, which the MMT accepted.

### **Deorbit and Landing Operations**

The STS-135 mission was successfully completed with a landing at Kennedy Space Center (KSC), Florida on July 21, 2011.

The Ku-band antenna was stowed nominally using dual-motors during the previous day at 201/15:32:34 GMT (12/00:03:30 MET).

Both Payload Bay Doors (PLBDs) were closed nominally by 202/06:16:35 GMT (12/14:47:31 MET) in preparation for landing.

The deorbit maneuver for the first landing opportunity at KSC, a dual-engine straight-feed firing, was performed on orbit 200 at 202/08:49:04.2 GMT (12/17:20:00 MET). The maneuver was 198.2 sec in duration with a  $\Delta V$  of 333.1 ft/sec. The orbit after the deorbit maneuver was 25.5 by 209.6 nmi.

Entry interface occurred at 202/09:25:13 GMT (12/17:56:09 MET).

The main landing gear touchdown occurred on KSC runway 15 at 202/09:56:58 GMT (12/18:27:54 MET). The drag chute was deployed at 202/09:57:03.6 GMT. The nose gear touchdown occurred at 202/09:57:12 GMT. Drag chute jettison occurred at 202/09:57:35 GMT. Wheels stop occurred at 202/09:57:53 GMT. The rollout was normal in all respects.

The last APU was shut down at 202/10:18:01.505 GMT.

The flight duration was 12 days 18 hr 27 min 04 sec.

David S. Moyer

**David S. Moyer**  
**STS-135 Lead MER Manager**