Back Up

STS-125/HST MOD FLIGHT READINESS STATEMENT

The Mission Operations’ flight preparation process plan, documented in Mission Operations Directorate Certification of Flight Readiness, DA8-020, and governed by NSTS 08117, requirements and procedures for Certification of Flight Readiness, have been satisfied. Required products and other responsibilities for Mission Operations (NSTS 08117, Section 8, Paragraph 8.5.7) have been or will be produced or completed. The Mission Operations’ flight preparation process plan documented in Mission Operations Directorate International Space Station Certification of Flight Readiness, JSC 28140, and governed by SSP 50108, Certification of Flight Readiness Process Document, International Space Station Program, have been satisfied. Required products and other responsibilities for Mission Operations (SSP 50108, Appendix H, figures H.3.2-1 and H.3.2-2) have been or will be produced or completed. All areas are ready. The Mission Operations is prepared to sign the certificate of flight readiness for STS-125/HST MOD Flight Readiness Review.

Paul S. Hill
Mission Operations Director
Mission Operations Directorate
Flight Director Office

DA8/Ceccacci, Knight, Dye - 125/HST SM4 SSP FRR DA8 Charts 4/20/09
STS-125/HST SM4 Overview Timeline with 1 OA Burn
11+2 Day (5 EVAs) - Launch: 12 May 2009, GMT 17:31

Mission Operations Directorate
Flight Director Office

"Pre-decisional: Internal Use Only"

DA8/Ceccacci, Knight, Dye - 125/HST SM4 SSP FRR DA8 Charts 4/20/09

Mission Operations Directorate
Flight Director Office

"Pre-decisional: Internal Use Only"

DA8/Ceccacci, Knight, Dye - 125/HST SM4 SSP FRR DA8 Charts 4/20/09
STIS Trainer (Fastener Capture Plate)

STS-125/HST SM4 Mission Overview
**Nose Cap Survey**

**New Operations – T0 Surveys (STBD)**

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**Mission Operations Directorate**
**Flight Director Office**

DA8/Ceccacci, Knight, Dye - 125/HST SM4 SSP FRR DA8 Charts 4/20/09
New Operations – RPM Replacement Surveys

Mission Operations Directorate
Flight Director Office

“Pre-decisional: Internal Use Only”

New Operations – T0 Surveys (Port)
New Operations – RPM Replacement TPS Surveys

Port OMS POD

New Operations – T-0 Surveys

Mission Operations Directorate
Flight Director Office

Mission Operations Directorate
Flight Director Office
New Operations – T-0 Surveys

Special Topics – MMOD Mitigation Plan: ATL

- ZLV-XVV (Used for the majority of the mission)
  - No Ku optimization
  - No wing fwd to avoid poor S-bd periods
  - No wing fwd to provide stars for non-mnvr IMU alignments

- Biased –ZLV –XVV (HST)
  - 25 deg yaw bias requirement from HST to checkout new Rate Sensing Units (RSU) post EVA #2
  - Required for the entire crew sleep period

- EVA Sun Protect
  - Required during each EVA
    » protect HST aft shroud and ORUs from direct sunlight
    » Maintains PLB to earth as much as possible
    » Secondary objective to minimize EVA and Orbiter MMOD exposure
  - In each orbit
    » About 45 min of biased –ZLV –XVV
    » About 25 min in a Belly sun inertial
    » About 25 min mnvr back to LVLH
Special Topics – MMOD Mitigation Plan: ATL

- Water Dumps
  - When HST present must use –ZLV
    » HST requirement
    » Only option is +YVV
  - When HST not berthed, used a better MMOD attitude
    » Mostly bay into velocity vector (protects underside)

- Rendezvous (+XLV –ZVV)
  - Standard profile
  - better than –ZLV for MMOD

- TPS Inspection
  - Not constrained for MMOD
    » Optimized for lighting and Ku comm
    » Highest risk attitude

- HST Battery Charge
  - HST requirement to point –XSI
    » MMOD optimized by keeping the PLB in the orbit plane

- Inertial Attitudes
  - No MMOD optimization to EOM inertial attitudes
  - +X RCS and OMS burns performed heads up (small improvement)
  - No MMOD optimization for grapple or release
  - Crew conference performed in good MMOD inertial attitude with good Ku comm
Special Topics - OA: STS-400 Increased Rendezvous Cost

- STS-400 insertion apogee is 297 nmi
  - STS-400 apogee and STS-125 post-OA apogee (optimized for STS-125 deorbit) are not aligned
  - STS-400 has to perform retrograde burns to lower apogee to match STS-125, and then raise another part of the orbit to match STS-125 apogee

Special Topics - OA: Integrated STS-400 Propellant Cost

Phase Angle vs Propellant Margin

- Launch @ OA + 4 Days (FD2)
- Launch @ OA + 5 Days (FD2)
- Launch @ OA + 4 Days (FD3)
- Launch @ OA + 5 Days (FD3)
**Special Topics - OA: Elliptical Rendezvous Cost Variation**

For an assumed STS-400 launch 4-5 days after the OA, rendezvous cost as a function of phase angle is shown in the plots below:

- Rendezvous cost keeps increasing as 400 launch slips
- Have to assume launch window could be any part of this plot – 125 reboost or variation in OA TIG and DV will have drastic effect on phase angle
- Rendezvous cost increases ~50-100 fps for 1 day scrub

**Planar Open**

Launch OA + 4 Days

Launch OA + 5 Days

**Special Topics - OA: 125 Disposal**

- Orbiter disposal is an agency priority based on international agreements
  
  **Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines**
  
  “Whenever possible spacecraft or orbital stages that are terminating their operational phases in orbits that pass through the LEO region, or have the potential to interfere with the LEO region, should be de-orbited … If a spacecraft or orbital stage is to be disposed of by re-entry into the atmosphere, debris that survives to reach the surface of the Earth should not pose an undue risk to people or property. This may be accomplished by limiting the amount of surviving debris or confining the debris to uninhabited regions, such as broad ocean areas.”

- Performing the OA will place some limitations on STS-125 disposal operations, in the event of an STS-400 call-up
  
  - Analysis based on Oct 14 launch date
  
  - 24 hour period analyzed beginning 2 hours after planned Atlantis release

- Two factors required for good disposal opportunity (how we determine TIG)
  
  - Available ΔV for disposal burn results in trajectory steep enough to produce small enough debris footprint
    
    » Near apogee, not enough prop available to even capture
    
    » 30-35 min of 93 min orbit acceptable from propellant standpoint
  
  - Location of disposal footprint adheres to rules regarding distance from land masses.
Special Topics– Orbit Adjust Strategy

STS-125 Pre-OA OCT14 (no Orbit Adjust)
Disposal Footprints Colored by Orbit Rev of Deorbit Burn

STS-125 OCT14: 300x160 nmi Orbit
Disposal Footprints Colored by Deorbit Time
Items of Interest

EVA Task Replanning Guidelines (FR125_A2-36)

- Pre-flight agreed to plan that minimizes “real-time” discussion and allows next day planning process to be initiated without delay (which is mandatory to in support of 5 “back-to-back” EVAs)
- Developed to support Minimum Mission Success criteria as well as Mission priorities
- Provides EVA re-planning guidelines in support of:
  - Reduced EVA capability (mission timeline) in the scenario where the 5 planned EVAs cannot be accomplished
  - Also provides re-planning guidelines in the event of a science instrument or battery failure (assumes nominal 5 EVAs are available)
- Philosophy:
  - Minimize changes to the planned EVAs as much as possible and focus on what can be accomplished in the nominal timeline
  - Although failures may change relative priorities, it’s important to retain the big picture and utilize procedures/timelines that have been extensively choreographed, trained and have become second nature to the crew, which provides the maximum efficiency and highest probability of successfully completing all mission objectives
  - Contingency system workarounds will be incorporated as required resulting in possible loss of EVA mission objectives to accommodate keeping EVAs within ~ 7 hour duration

125/HST SM4 EVA Glove Usage Plan

- Modified/Turtle Skin EMU gloves will be used for all EVAs with the following exceptions:
  - EVA 3
    » In support of ACS Task, EV1 (Grunsfeld) will wear non-modified gloves (no Overgloves during the EVA) to accomplish repair
      • Complex task requires maximum dexterity/tactile feeling
        – Poor visibility and lighting
        – Releasing and capturing a large amount of non-captive fasteners (36 fasteners)
        – Using manual screwdriver to “feel” initial release of fasteners in order not to strip them
        – Fine alignment required to not damage hardware/tools
        – Interfacing with several 1/4 turn fasteners
  - EVA 4
    » Currently EV3 has planned to wear Modified/Turtle Skin gloves for the STIS repair task
      • On EVA 2, EV3 (Mass) will determine if the Modified glove will provide the required dexterity/tactile feeling to support the STIS repair task
        – If EV3 feels that the modified gloves will hinder the STIS repair efforts, he will switch to the non-modified gloves (no Overgloves) on EVA 4 to increase the probability of a successful STIS repair
        – STIS Complex task (117 fasteners) comparable to ACS repair
Items of Interest

125/HST SM4 EVA Glove Usage Plan (cont.)

- **Risk Mitigation**
  - Exceptions identified are supported / in sync with the philosophy identified in XA-08-001
    - "Overglove Use Policy During US EVA"
      - Crew in Orbiter Payload Bay
      - New Flight Hardware
      - Required task dexterity
      - Etc.
  - Known "sharp edges" on HST Hardware clearly identified and warnings included in EVA procedures
  - Unknowns HST
    - Only ~ 14% of EVA (5) time on exterior of telescope
    - Only ~ 2.5% of EVA (5) time on HST Handrails (MMOD)
      - EVA 3 – EV1/FF ~ 8.5 ft translation on -V2 bottom handrail (see backup)
      - EVA 4 – EV3/FF ~ 8.5 ft translation on -V2 bottom handrail, ~ 20 ft translation on +V3 top and right side handrail (see backup)
  - Standard glove inspections during EVA and post EVA
    - If unexpected damage occurred, the location/cause could be quickly identified and that marked as a Warning/ KOZ
      - Due to task locations, most of worksites on HST are never revisited

125/HST SM4 EVA Glove Usage Plan (cont.)

- **Risk Mitigation (cont.)**
  - Detailed "Translation by Translation" and Task review performed at 125/HST Flight Techniques so the "community" could fully understood the HST EVA compliment and differences from ISS
    - XA and EVA safety part of the discussions and agreements
Items of Interest -125/HST SM4 EVA Glove Usage Plan

- **EVA 1**
  - Grunsfeld (EV1) – Modified/Turtle Skin
  - Feustel (EV2) – Modified/Turtle Skin
- **EVA 2**
  - Massamino (EV3) – Modified/Turtle Skin
  - Good (EV4) – Modified/Turtle Skin
- **EVA 3**
  - Grunsfeld (EV1) – Un-Modified (No-Overgloves)
  - Feustel (EV2) – Modified/Turtle Skin
- **EVA 4**
  - Massamino (EV3) – Modified Turtle Skin**
  - Good (EV4) – Modified/Turtle Skin
- **EVA 5**
  - Grunsfeld (EV1) – Modified/Turtle Skin
  - Feustel (EV2) – Modified/Turtle Skin

**To be determined during EVA 2**

Items of Interest -125/HST SM4 EMU Glove Manifest

<table>
<thead>
<tr>
<th></th>
<th>Prime</th>
<th>Backup</th>
<th>Contingency</th>
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<tr>
<td>Grunsfeld</td>
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<td>Non-modified</td>
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<td>Feustel</td>
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<td>Non-modified</td>
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</table>
**EVA 3 (HST Handrails Used for COS & ACS Tasks)**

- V2

*Note:* Circled handrails are used by RMS EV to open/close aft shroud doors

Translation distance ~8.5 ft (green line)

**EVA 4 (HST Handrails Used for STIS Task)**

+ V2

*Note:* Circled handrails are used by RMS EV to open/close aft shroud doors

Translation distance ~8.5 ft (green line)
**Items of Interest**

**PPCO2 Management**
- **STS-125/HST LiOH Plan** is to perform dual can change outs except Pre-sleep on FD1, FD3, FD4, FD5, FD6, FD7 and FD8 (which are single can)
  - Same protocol as performed on STS-109 where peak was 5.7 MM/Hg FD4 pre-sleep
  - Predicted Levels (Predictions assume 7hrs of crew exercise a day)
    - Max Peak is 6.2 MM/HG pre-sleep on FD9
    - Between 5 – 6.1 MM/HG prior to post sleep LiOH change out on FD4 – FD8
  - Same protocol as performed on STS-109 where peak was 5.7 MM/Hg FD4 pre-sleep
  - Predicted level assume LiOH change out 1 Hr before Pre-sleep and 1 hour after crew wake.
- **Plan** is to give the crew a heads up when the PPCO2 is ≥ 5.0 MM/Hg and give them an option to change out the LiOH at the time
  - Follows same philosophy used on STS-124 (captured in FR 125_A2-78)
- **Changes to LiOH change out plan/PPCO2 management** will be determined based on actual PPCO2 levels/rates that are seen during the mission
  - Later or earlier change outs may be requested
**Items of Interest**

**Loss Of Ku Plan**

- A Contingency Plan has been developed in support of Loss of Ku
  - Provides operations plan to support Loss of KU capabilities
  - Best effort to maximize available capability
  - Which include:
    » TPS Inspections
      - Record data per nominal plan (DTV Tape, IDC Laptop, Digital stills)
      - Crewmember assigned to watch LDRI/ITVC data (via monitor) and log GMT if they notice a possible defect/something off nominal in scans
      - Update TFL to support SSV during inspection activities
        - Current priority goes to HST data (since nominally KU available)
      - Utilize S-Band FM system for imagery data dumps over MILA or Dryden (possibly ESTL if ground track supports)
        - ~ 1 hr 15 minutes avail/day with MILA/Dryden
        - Highest priority goes to the areas the crew identified during the OBSS scans
    » SSR dump management
    » MFX/760 Activation on A/G 2
      - Limited capability
      - Does support some WLES operations
Flight Director Mission Staffing

- All STS-125/HST SM4 and STS-400/LON Flight Directors are certified per Flight Director Certification Guide (DA8-00010), Final, dated September 24, 2007
- Additional certified Flight Directors are available to support Team 4, and EMCC as required
- MOD Work Guidelines are met
- Flight-specific certifications are expected to be complete by April 24, 2008

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<tr>
<th>STS-125/HST SM4 Shuttle Flight Directors</th>
<th>STS-400/LON Shuttle Flight Directors</th>
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<tbody>
<tr>
<td>Tony Ceccacci</td>
<td>Lead/Orbit 1</td>
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<tr>
<td>Rick LaBrode</td>
<td>Orbit 2</td>
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<tr>
<td>Paul Dye</td>
<td>Mike Sarafin</td>
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<td>Norman Knight</td>
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<td>Norman Knight</td>
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<td>Ascent/Entry</td>
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CSCS Support – 125/HST

- STS-125/HST CSCS documentation is located on the DA8 STS-125/HST Flight Techniques page
  - Documentation Includes:
    » STS-125/HST SM4 Group C+ Powerdown /Powerup
      • Delta from RTF version to provide Orbiter Attitude Hold
    » STS-125/HST SM4 Star Of Opportunity Align
      • Power up and Power Down of Star Trackers to support IMU Align.
- STS-125/HST FDF & LON support
  - STS-125/HST Rendezvous Book
    » STS-400/LON Rendezvous and Release Procedures
    » STS-125/HST SM4 Disposal Timeline
      • Updated/Simplified from RTF version to support Orbiter Disposal (no unmanned undocking, no sep burns, etc.)
      • Will include and be synced up with actions prior to and post separation with 400
      • 28.5 deg Inclination required Disposal burn targeting update
        – Pacific Ocean with "debris footprint" North of Hawaii
  - STS-125/HST EVA Checklist will include Rescue EVA timelines