Alpha Magnetic Spectrometer – 02
Phase II Ground Safety Review

Ground Operations

September, 2008

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Outline

• Operations Timeline
• Operations Flow Diagram
• Ground Operations
  – Off-Line, Non-Payload Tests
  – Off-Line Payload Processing: SSPF
  – On-Line Payload Processing:
    • SSPF
    • Canister Ops
    • Pad / PCR Ops
    • Abort
• Launch Commit and Go / No Go Criteria
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Ground Operations - Timeline

Parallel, Off-Line, Non-Payload Tests:
- POPIT2
  - MLP Launch Commit Criteria Tests
  - Flight Specific MLP Data Transmission Tests
- OPF Orbiter Side-Side Test

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Processing and Test Flow Diagram

A
STS Pre-Integration (Pre-Mate)

1
POPIT-2
MLP @ Pad

2
Pin-out Checkout

3
SIT - IVT

4
SIT – End-to-End
On STS in OPF

B
ISS IVT

C
ISS – End-to-End
SSPF ELC RS

D
STS IVT

E
STS Pre-Launch Ops
Pad

F
Joint SIMs
POCCs / HOSC / MILA / LCC / MCC / MOD

JSC / KSC / MSFC

Integrated P/L & STS

Off-Line Assembly & Check-out SSPF # 7
Final Assembly ELC RS

Integrated P/L

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Parallel Off-Line Non-Payload Tests

A. STS Pre-Mate Verifications
   • To be worked in parallel with payload processing
   • Utilize flight spare Class I stand-alone components:
     – Pad Operations Preliminary Interface Test (POPIT) 2
     – STS Interface Test (SIT) \{OPF Orbiter Sill-Side Test\}

Blue Dashed Line on Flow Diagram
Parallel Off-Line Non-Payload Tests

1. POPIT-2: Empty, flight specific MLP at the pad
   a. Repeat POPIT for 1553 & RS-422 using J-Crate Flight Spare Unit
   b. Perform LCC and KSC POCC Verifications (1553 & RS-422)
      i. P/L Critical Health Data → Launch Control Center P/L Console
      ii. P/L ↔ KSC POCC
   c. T0 P/L Power Services: 120VDC and 110 VAC
      i. Verify pin-out from MLP Room 10 A to T0
      ii. Power out and abort simulations verifying monitor and control of power services
Parallel Off-Line Non-Payload Tests

2. Pin-out verifications prior to STS Interface Test (SIT)

3. STS Interface Test (SIT) – Interface Verification Testing (IVT)
   a. J-Crate (P/L Computer) ↔ DDRS-02 (P/L AFD Data Recorder)
   b. J-Crate FEU → Ku-Band
   c. J-Crate FEU ↔ S-Band
   d. J-Crate FEU ↔ T0
   e. DDRS-02 (playback) → Ku-Band

4. STS Interface Test (SIT) – End-to-End; all the way to JSC POCC
   • Can be part of joint STS and AMS-02 Simulation (F)
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STS Interface Test (SIT) Schematic

Ku-Band Option 1:
End-to-end RF / STS Ku to MILA to TDRSS to WSTF to JSC POCC, complete test of Ch. 2 format & transmission

Ku-Band Option 2:
Hardware “short-cut” / STS Ku cap to C&T lab patch to split off Ku Ch 2 to DDRS-02 as well as bit sync.

S-Band Option A:
End-to-end RF / STS S-Band to MILA to TDRSS to WSTF to JSC POCC, complete test of format & transmission

S-Band Option B:
Hardware “short-cut” / STS S-band to C&T lab PSP/PDI patch to route NASCOM blocks to JSC / LRDL / FEP.

Note:
MILA functionality and associated KSC support is a KSC STS programmatic issue, without which this portion of the test is TBD.
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Ground Operations
KSC Flow: Off-Line

- Arrive at Space Station Processing Facility (SSPF)
- Re-Assemble Lower USS to Upper USS
- Set-up and test CGSE and EGSE, including facility interfaces
- Top-off SFHe
- Power up/checkout Avionics and charge Cryomagnet (via Test Connector Panel / Interface Panel A)
- Integrate remainder of AMS-02 hardware
  - Handrails
  - PAS
  - Remove Test Connector Panel
  - Re-Route Integration Cables and Terminate at EVA Connector Panel
KSC Flow: On-Line

- Remove AMS-02 from Payload Support Structure (PSS)
- Transfer AMS-02 to ELC Rotation Stand
- Install Grapple Fixtures (PSS exclusion)
KSC Flow: On-Line (continued)

B. ISS Interface Verification Test (SSPF ELC)

With Integrated Payload – KSC PRCU Check-out

- Functional Interface Test (FIT)
  - EBCS Camera Alignment
  - PAS / UMA Functional Fits
  - ISS Data (PRCU) and Power (PEPSE) Testing (via UMA)
    a. 1553 & HRDL to PRCU
    b. To HOSC
    c. To JSC POCC
- Can be used to support joint SIMs (F)
- Power up / checkout avionics, no Magnet Charge

Return P/L to PSS and monitor until Canister Operations
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Payload Component Locations
KSC Flow: On-Line (continued)

• Load into canister and transport to Canister Rotation Facility (CRF) – will require On-Board Pump (SFHe), possibly data connections

• Rotate canister in CRF

• Transport to Pad for Vertical Installation in Payload Change-out Room (PCR) using Payload Ground Handling Mechanism (PGHM)

• In parallel with canister operations, the P/L CGSE (subset) will be transferred from the SSPF to the pad
KSC Flow: On-Line (continued)

- Mate STS ROEU ODA/PDA Interface
- Install P/L GSE vent lines
- STS Interface Verification Test (IVT)
- End-to-End P/L Tests in STS
- Remainder P/L CGSE connection
- Continued GSE payload servicing, including SFHe top-off
- Payload close-out and GSE disconnected
- Continued payload monitoring until 120 VDC power-off
KSC Flow: On-Line (continued)

D. STS Mated Interface Verification Test / Functional Test:

*With Integrated Payload in Shuttle PLB at Pad: Check-out*

1. 1553 & RS422 command and monitor

2. Fully functional check-out except magnet charge and thermal control systems (not possible in 1g)

3. Including DDRS-02 on AFD
KSC Flow: On-Line (continued)

E. PAD OPERATIONS

Installation at L-22 days through L-9 minutes:

- L-88 hours:
  - Complete Top-off SFHe
  - Disconnect and remove TRD Gas Bottle
  - Close SFHe Tank Vent Valve
  - Cap P/L Vent Lines
  - Activate/checkout AMS-02 avionics subsystems and thermally condition payload
    - Approximately 1000 ~ 1500 W for J-Crate, Cryo-valves, Cryo-coolers, CAB critical functions, and SFHe On-Board Pump
    - Maximum of 2 kW (peak) for calibration and contingency based upon thermal load in maximum flow / minimum temperature purged PLB
    - Thermal monitoring & considerations may drive subsystem power cycling
  - Payload GSE interface disconnect
E. PAD OPERATIONS (continued)

- L-80 hours PLB door close
- At L-30 minutes:
  - Deactivate On-Board Pump (110 VAC)
  - Power down Cryo-coolers
  - Power down all equipment with the exception of J-Crate and necessary CAB functions to monitor of cryogenics system health (limited to 120W)
- LCC: Monitor health status of cryogenic systems until L-9 min: GO / NO GO Call from AMS-02 based on Cryogenic System Health
- At L-9 minutes: 120 VDC Payload Power-Down
  - STS AFD Standard Switch Panel (SSP) provided 28 VDC is on
E. PAD OPERATIONS

⇒ No magnet charging possible on STS:

- STS Flight APCU power supplied to prime PDS side “B” has no connectivity to the CAB
- Magnet charging on Pad via T0 is operationally controlled
  - Monitored with positive feedback until L-9 minutes
  - Multiple non-stored commands required to initiate
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Ground Operations

AMS-02 in PLB (CGSE access)
SFHe On-Board Pump

- Pre-Launch only
- T0 110 VAC interface and ground safety being worked with STS Program and KSC
- Rotating parts analysis complete
Pre-Launch Configuration
Payload Data Interface Panel 2 (PDIP#2)

- Low rate data (1553) is routed through T0 umbilical to MLP GSE computers from Shuttle PDIP2 with the “AMS-02 1553” switch in the “T0” position, and program provided jumper installed on PDIP2 front panel “J4” connector.
- High rate data (RS422) is routed through T0 umbilical to MLP GSE computers from Shuttle PDIP2 via payload provided cable installed between PDIP2 front panel “J103” and “J105” connectors.
Pre-Launch Standard Switch Panel Configuration

- S16 - ON
- S18 - ON
- CB4 Closed
Digital Data Recorder System-02 (DDRS-02)

- Will be used on Aft Flight Deck in STS end-to-end tests
- Stowed for launch
Mission Abort

• In the event of a flight abort, P/L Baroswitch Electronics automatically closes vent valve when PLB pressure exceeds 15 – 20 millibars (mission success only)

• If possible, upon landing, services should be applied via the T0 Umbilical to perform the following:
  – Allow internal Electronics to Monitor SFHe tank pressure
  – Operate vent valve and on-board pump
  – Not a safety concern, but rather a refurbishment concern (don’t want to rupture burst disks)
  – Initial projection from KSC for nominal landing indicates ~ 10 hrs.

⇒ Endurance & Mission Success for turn-around
Launch Scrub Turnaround Scenario

This scenario can be repeated up to 96 hours from first launch attempt (L₁).
Typically, a maximum of four launch attempts are made prior to re-servicing, so one day may be maintained at AMS Nominal Ops without attempting a launch.
Launch Scrub Recycle Turnaround Scenario

- We really aren't going to launch, let's De-Tank the Shuttle
- AMS Power Cryocoolers and Vacuum Pump on
- PLBD Open
- PCR Access, Attach Cryo GSE and perform Top-off
- L-88 hours

$$T_s$$
- $$T_s + 1$$ hr
- $$T_s + 2$$ days
- $$T_s + 2$$ days
- $$T_s + 9$$ days

Return to Pre-launch Activity Timeline
Hurricane Plan

Power down – safe without services.
• Including roll-back to VAB if necessary
• No safety requirements driving KSC reconnection – endurance and mission success only

Mission assurance concerns at 96 hours.
Safety Launch Commit Criteria – 1 of 2

Loss of vacuum case seal immediately prior to launch possibly results in over-pressurization of the SFHe Tank during ascent, venting into and over-pressurizing the PLB and damaging the Aft Bulkhead

• Worst case leak in VC requires 23 minutes to generate sufficient He to burst disks, releasing gas into PLB
• For PLB over-pressurization to present a hazard to the Orbiter, the over-pressurization must occur between L+30 seconds and L+1 minute
• Monitor Cryo-system health / status until L-9 minutes, ensuring insufficient time to release gas, thus preventing launch with hazard potential
  – Compared to trend data established over the lifetime of the experiment to indicate occurrence, and make the GO / NO GO Call
  – Minimum of three measurements of temperature and pressure within the SFHe Tank will provide this data on redundant paths
Safety Launch Commit Criteria – 2 of 2

Ensure MLP GSE Power Supplies are powered off, ensuring dead-faced T0 Connections

Payload Go / No Go Criteria

- The only payload mission success Go / No Go Criteria that has been defined relates to the operability of ISS Bus A prior to PLB door closure.
  - Because this bus is required for magnet charging, verification that this bus is operational must be made prior to launch.
  - EVA Connector Panel connections can be swapped to rectify lack of ISS Bus A prior to launch.
Backup Slides