August 16, 1999

ALPHA MAGENTIC SPECTROMETER (AMS)
TECHNICAL INTERCHANGE MEETING
MINUTES

August 2, 1999

PURPOSE:

Provide a technical overview of the AMS project to representatives from the ISS system and payload safety community, and identify potential safety-related challenges.

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SIGNIFICANT DISCUSSION POINTS:

1. AMS Mission Manager, Jim Bates, provided an overview of the AMS project:

a) The AMS-01 was successfully flown on STS-91 and operated as planned. The AMS-02 Project Team is essentially the same personnel as those for AMS-01.

b) AMS-01 employed a permanent magnet. As proposed for the Space Station, AMS-02 uses a unique state-of-the-art super-conducting magnet. The experiment is a precision spectrometer designed to search for anti-matter and dark matter.

c) This project is being developed at the direction of NASA Administrator, D. Goldin, by inter-agency agreement with the Department of Energy.

d) The Principal Investigator team, lead by Nobel Laureate, Dr. Samuel Ting, includes 13 countries.

e) On STS-91, AMS Detector tracked incoming particles (for energy, momentum, type, etc.).

f) Technical considerations – Similar magnet configuration between AMS-01 and AMS-02. Both have:
   - Same inner radius
   - Dipole moment = 0 (near zero)
   - B @ 2.0 M $\leq$ 60 G (AMS-01 was ~3 gauss at 2.3 meters from the center of the magnet)

2. LM Project Manager, Ken Bollweg, provided a detailed technical briefing on current AMS-02 configuration and planning:

a) AMS consists of:

- Superconducting Magnet System – More powerful than the AMS-01 permanent magnet
  - ➢ warm vacuum case (proposed to be provided by NASA and Lockheed Martin as an integral structural component of the USS-02)
  - ➢ thermally isolated suspension system between warm vacuum case and cold mass
  - ➢ superfluid helium (SFHe) vessel (~2600 liters)
  - ➢ cooling coils around the magnet coil support structures
  - ➢ vapor cooled shields (VCSs) and numerous MLI layers surround the cold mass which consists of the magnet coils, their support structures, and the SFHe vessel
  - ➢ one of the VCSs will have an active cryocooler system on it
  - ➢ power leads are activated when the magnet is energized/de-energized
  - ➢ 20 racetrack coils help to shape the field and minimize the dipole moment
  - ➢ 2 dipole coils provide the main field inside the magnet
  - ➢ external Power Supply Unit (PSU) with a controller is used to energize/de-energize the magnet

- Tracker – *May be the only re-use item* from AMS-01 (same silicon wafer structure, ladders, etc.); tracks x, y, and z positions of particles. There are now five honeycomb planes instead of six on STS-91. They are made of carbon fiber. Three center planes have silicon wafers on two sides for a total of eight silicon tracker planes. All the tracker planes will be fully populated with the wafers.

- The Anti-Coincidence Counter (ACC) system is essentially the same design as STS-91.

- The Time of Flight (TOF) system is essentially the same design as STS-91.

- New components – Include the Syncotron Radiation Detector (SRD) at the top of the experiment. A Transition Radiation Detector (TRD) which uses Xenon to be mixed with Freon (CF4). Current plans are to use the same Xenon tanks as certified for the ISS Plasma Contacter Unit. A Ring-Imaging Cherenkov Counter, (RICH) is under the magnet. An Electronic Calorimeter (ECAL) is at the bottom of the experiment.

- AMS Project Team is already working with JSC Structures Working Group to define verification/certification requirements for the entire AMS Payload. Pressure systems design and test requirements are already included in all applications.

- Mounting Interface to ISS – Payload Attach System (PAS) utilizing a capture claw around a capture bar.

- AMS Project Team is already working with Space Station Payloads Office (OZ) to define integration requirements on ISS.

- Unique Support Structure (USS-02) – cannot use the same as for AMS-01 because AMS-02 is much heavier (13,500 lb up mass) and larger. ISS PAS interface capabilities have also been significantly reduced which will no longer allow use of the original USS. The USS-02 will be of similar design as the original USS. AMS-02 down mass is TBD with time since SFHe and TRD Xenon/Freon gas are consumed.

- Radiator Panels – Wake radiator panels dissipate heat; ram radiator panels may also serve as debris shields.

- M/OD Shielding – to protect science and pressure vessels. Debris would have to penetrate vacuum case, dozens of MLI layers, and vapor cooled shields to get to SFHe vessel. TRD gas supply vessels are located on lower wake side to minimize possibility of impact.

b) Ascent/Descent – 3 launches/landings planned, including a possible precursor flight. Magnet is not energized on ascent, descent, or during ISS payload berthing operations. Checkout of magnet system and physics detectors is currently planned on ascent to Station. Additional helium is consumed each time magnet is turned on/off.

c) Major Operational Safety Concern: "Quenching"

- Part of the magnet (conductor) becomes resistive.
- Propagates causing the entire magnet to become resistive.
- Rapid heat buildup, vents helium gas from cooling coils around the magnet coil support structures
- ~1500 liters of helium (out of 2600 liters total volume) are required to re-cool the magnet back down to superconducting temperature
- Project aiming for conservative design to minimize quench probability.

d) Helium Gas Venting Rate – Needs to be determined for both normal and contingency operations. There's always a parasitic heat load, so AMS will vent some helium gas continuously. Question is "how much?" Will need to determine cumulative effect of the venting in the Shuttle payload bay and on ISS.

- Per PSRP Chair, Skip Larsen, SSP is still trying to determine acceptable leak rate into cargo bay (via ICD).
- One option discussed: close proximity vent in the cargo bay.
- AMS Project team also is working this issue with the Environmental Contamination Group.

e) Power – 2kW power consumption from ISS:
- Including ramp up, operation (instrumentation-e.g., heavy heat loads to dissipate), and ramp down. Requires 4-8 hours to ramp up (from 0 to 450 amps) and down.
- Commanding via 1553 bus to shut down.
- Running AMS could result in power decrement to other systems.

f) Servicing – No plans to service on-orbit.
- Possibility of contingency ops; ORUs <TBD>.
- NASA currently has no "tanker" to refill AMS, but AMS may be designed to accommodate on-orbit resupply.

g) ISS Attached Payloads Operational Envelope – Currently exceeds proposed EVR envelope by ~14"; vacuum vessel has the most protusion.

h) Operating Environment – ISS environment is relatively warm; concern re: getting AMS too hot.

i) Cryogenic Schemes – Option 2 has four vapor cooled shields with cryocooler on fourth (VCS4). (Note: Super-fluid helium tends to migrate to warmer components and to wet all surfaces.)

j) Ground Safety – AMS team coordinating with Ground Safety Review Panel/Paul Kirkpatrick.

3. AMS ISSUES IN WORK

- Worst-case flow rate needs to be identified.
- Team is seeking ideas on helium venting.
- Per EA/Bob Wren, team needs to show why overboard helium vent lines may not be needed.
- Per PSRP Chair, Dave O'Brien, investigate possible vacuum case leaks; uphill leaks are major concern for rapid helium venting.
- Keep-out zones around attached and energized AMS need to be determined.
- EMU gauss limit is being revisited.
- Per S&MA Deputy Manager, Dean Hanks, concern is whether AMS could withstand impacts from having the Prop Module at one end and the SM at the other. [Team is studying this.]
- Per SRP Chair, Gregg Baumer, AMS team should postulate failures and look at the results (e.g. quenching, torque impact on ISS, etc.).

Meeting Adjourned *(see post-TIM decision next page)*

NOTE:
Following this TIM, a decision was made by OE management that the AMS will be reviewed at the Payload Safety Review Panel. Integrated safety issues related to potential impacts from the integration and operation of this payload onto ISS will be elevated to the Safety Review Panel (SRP) via the Integrated Experiment Hazard Assessment (IEHA) developed by Boeing. The process for assuring that

integrated safety concerns are elevated to the SRP is being defined and will be agreed upon by OE management and all the PSRP and SRP Chairs. No impact is anticipated to the Payload Developer.