National Aeronautics and Space Administration

NASA Case Study SCSC-R-0113

So Close Yet So Far: The Jammed Airlock Hatch of STS-80

Overview

STS-80 was the last shuttle launch of 1996, serving as the shuttle program's 80th mission and Columbia's 21st flight. The mission consisted of a five-person crew: Kenneth Cockrell, Kent Rominger, Tamara Jernigan, Thomas Jones, and veteran astronaut Franklin Story Musgrave.

Figure 1: STS-80 Crew (from bottom left): Kent. V. Rominger, F. Story Musgrave, Kenneth D. Cockrell, Tamara E. Jernigan, and Thomas D. Jones. NASA Image

The primary mission objectives were to successfully deploy and retrieve two free-flying research satellites: the Orbiting Retrievable Far and Extreme Ultraviolet Spectrometer – Shuttle Pallet Satellite II (ORFEUS–SPAS II) and the free-flying Wake Shield Facility (WSF). The ORFEUS-SPAS II was to observe the nature, structure, and evolution of stars and galaxies. The WSF was flown to test the development of thin film materials in the vacuum of space. Another key component to the mission, although not a primary objective, was the evaluation of tools that would be used to construct and maintain the International Space Station (ISS). Two extravehicular activities (EVAs) were scheduled for that purpose. Shortly after EVA preparations began, the astronauts were presented with the challenge of a lifetime. The outer airlock hatch of the orbiter was jammed closed, preventing entry to the payload bay where astronauts were to perform their tool evaluations.

Mission Challenges

One of the major challenges for STS-80 occurred before Columbia even lifted off from the launch pad. STS-80 was originally scheduled to launch October 31, 1996. However, when Columbia's solid rocket boosters (SRBs) were used for Atlantis' STS-79 launch September 16, 1996, delays with STS-80 became

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inevitable. Engineers switched the SRBs because of nozzle erosion and possible faulty new adhesive used on Atlantis' original boosters.

Additional threats posed by Hurricane Fran created further launch delays. A new launch date of November 4th was made, and then pushed back to November 15th when the STS-79 SRBs required further nozzle erosion testing. On November 13th, poor weather conditions resulted in a scrub of the Atlas IIA launch from Cape Canaveral Air Force Station and subsequently forced another delay with STS-80. After weeks of schedule changes, STS-80 successfully launched from the Kennedy Space Center on November 19, 1996 at 2:55:47 p.m. EST.

Space Jam

Following the successful deployment of the ORFEUS-SPAS II and WSF satellites, preparations began for the two EVAs. After almost two hours of preparation, Tamara Jernigan attempted to open the outer hatch of the airlock only to discover the hatch was jammed. After several attempts, Tamara asked her EVA partner, Thomas Jones, to try to open the jammed device. Tom recalled that when he attempted to open the hatch:

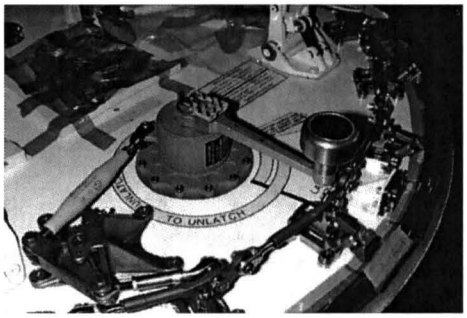

Figure 2: View of outer airlock handle and actuator assembly. NASA Image

"It smacked solidly into some obstacle at the 30-degree mark. After several grunting attempts to force the handle around, I could see...We were nowhere near turning the handle the one full circle required to retract the metal rollers that held the hatch against its seals. There was nothing obvious in the way, yet the handle felt like it was jamming against a hard metal stop [2]."

The airlock and airlock hatches permit EVA flight crew members to transfer from the middeck crew compartment into the payload bay, in their extravehicular mobility units (EMUs), without depressurizing the orbiter crew cabin [3]. After several unsuccessful attempts to open the hatch, EVA 1 was put on hold in order to allow time to determine the cause of the malfunction.

"We were in a surreal situation: Just an eighth of an inch of aluminum separated us from the experience of a lifetime [2]"

-Tom Jones, STS-80 Mission Specialist

The Mission Management Team (MMT) chair, Loren Shriver, and engineering analysis teams at Johnson Space Center, Kennedy Space Center, and Rockwell were tasked with finding possible cause and solution scenarios. During this time, astronauts used the orbiter's remote manipulator system (RMS) to provide video of the outer hatch mechanism's movement, while attempting to open the hatch. Preliminary assessments suggested a simple hatch misalignment with the orbiter structure (caused by either a problem

during installation or a small deflection of the orbiter structure on orbit); continued attempts could free the jammed hatch.
Engineers determined that if, however, the hatch was forced open and could not be resealed, per emergency contingency plans, the ORFEUS-SPAS II must be left in space. This would be the only way for both astronauts to re-enter the earth's atmosphere while still in the airlock. Astronauts were told that a decision regarding the EVAs would be made and relayed to them the following morning.

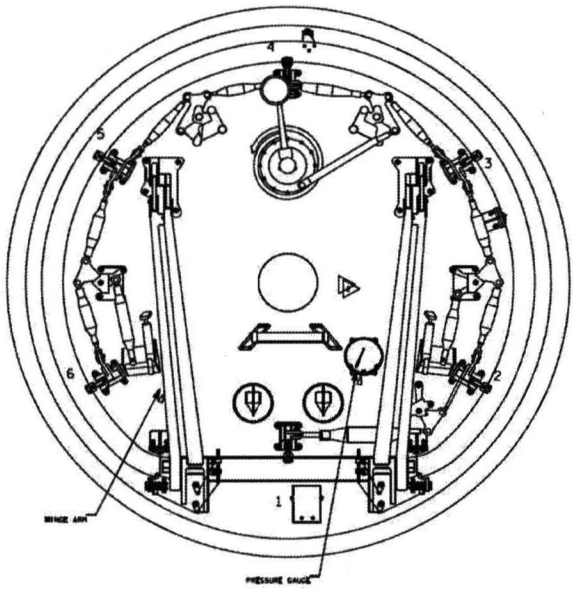

Figure 3: Schematic of aft view of outer airlock hatch. NASA Image

Airlock and Airlock Hatch

The airlock is 83 inches long with an inside diameter of 63 inches and can accommodate two fully-suited crew members at one time. It consists of two D-shaped pressure-sealing hatches. For Columbia, the inner airlock hatch is mounted to the front side of the airlock and opened into the middeck. The outer hatch is mounted to the aft bulkhead of the crew module. Both hatches have dual pressure seals to maintain pressure integrity and open in the direction of the primary pressure source: the crew cabin. Each hatch has six interconnected latches with a gearbox and actuator. Latches are interconnected with push/pull rods, as well as a bell crank for pivoting the rods [3]. The gearbox allows the crew to open or close the hatch during transfers and EVA operations. The gearbox and the latches are mounted on the low-pressure side of each hatch, and a gearbox handle is installed on both sides to permit operation from either side of the hatch.

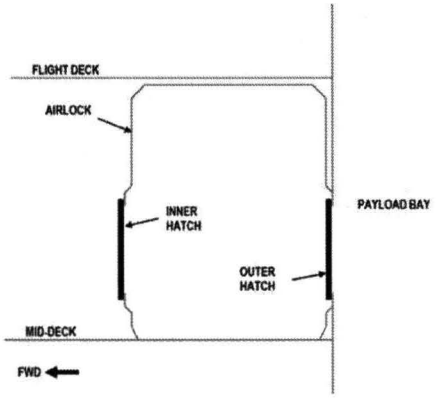

Figure 4: Illustration of the inner and outer hatch positions within the airlock . NASA Image

The airlock can be depressurized by venting the inside pressure overboard utilizing controls within the airlock. The airlock can be re-pressurized by equalizing the airlock's and crew cabin's pressure. This can be done using controls from the crew cabin middeck or from inside the airlock. Pressure leak checks are normally completed prior to launch. The airlock is also fitted with a four inch diameter window (one in each hatch) which can be used for crew monitoring [3]. Fully latching and unlatching the hatch requires a minimum rotation of 440-degrees with a maximum 30-pound force applied to the actuator via the hatch crank handle.

Decision Time

You are a member of the Mission Management Team and must make a decision as to whether or not to cancel the two extravehicular activities. Engineers have been unable to determine the issue from video survey obtained by the orbiter's remote manipulator system. Because the linking mechanism is on the external portion of the hatch, it is not possible for astronauts to directly troubleshoot the anomaly.

- Would you recommend continuing with the EVAs? Why or why not?

References

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