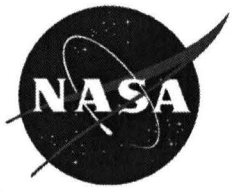
National Aeronautics and Space Administration



Teaching Notes for NASA Case Study SCSC-T-0113

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

Overview

This study focuses on STS-80 and the jammed airlock hatch that occurred in orbit. While attempting her first spacewalk, mission specialist Tamara Jernigan discovered the outer airlock hatch was jammed. Fellow astronaut Thomas Jones also attempted to open the hatch and was unsuccessful. Several hours troubleshooting were attempted, but a definitive cause could not be determined. Some engineers believed the problem was because of a misalignment with the hatch and the body of the orbiter. Others believed the issue was within the hatch itself. Because the linking mechanism was on the external portion of the hatch, it was not possible for astronauts to directly troubleshoot the anomaly.

The Mission Management Team was forced to cancel the two secondary objective EVAs, because they did not want to risk damage to the hatch or its seals. Upon post-landing inspection, a faulty actuator was found to be the origin of the malfunction. Within the actuator's gearbox, a loose screw was found lodged between a planetary gear and a ring gear. This was believed to have been caused by improper thread inserts used to keep the screws in place. Gearbox schematics clearly indicated that locking thread inserts would need to be used with the screws, but non-locking thread inserts were used instead. As a result, all orbiters were re-fitted with the proper thread inserts and engineering drawings were updated to include torque specifications.

The shuttle orbiter's airlock hatch was an entry point for astronauts on their way to or from the unpressurized payload bay. The airlock served as a depressurizing/pressurizing chamber for astronauts ending or beginning an EVA. The size of a small closet, the airlock had room for two fully dressed astronauts.

Learning Objectives

- To learn the basic mission goals, failures, and successes of STS-80.
- To use analytical concepts to "step into the shoes" of mission management and determine whether or not to continue with certain mission objectives.

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- To understand the importance of cohesion between engineering teams and hardware manufacturing.
- To use lessons learned to identify areas of improvement for next generation space transportation.
- To determine best engineering practices based on presented material.

Classroom Management

For use in class discussions, group activities, and/or open-ended research, with focus on critical areas of case material. Instructors are encouraged to develop additional questions or areas of interest to use as supplemental material with the included discussion questions and activities.

Class Discussion

Students can be separated into 3-4 person groups (depending on class size) to work on formulating an answer to the assigned **Decision Time** question.

After allowing students to read the Case Study Epilogue, utilize the following questions in a full class discussion:

- What was your recommendation and what factors contributed to your decision?
- Do you feel that the complexity of the hatch's design led to the astronaut's inability to repair the hatch on orbit? Why or why not?
- How can lessons learned from STS-80's jammed hatch apply to future NASA vehicles?

Group Activity

The following concept can be used for a group activity:

- Epicyclic (Planetary) Gear Train:
    - Using a simple Epicyclic gear train, have students determine the gear ratio between sun, planet and ring gears.
    - Use additional information to determine the efficiency of the gear system
    - Use additional information to calculate output torque produced by the system.
    - Use additional information to calculate angular velocity between each gear and the system as a whole.

Note: Introduce students to general principles and concepts of epicyclic gearing prior to or in conjunction with group activity. Ensure students are given the proper formulas to complete calculations.

Open-Ended Research

Boeing engineer Albert Curry suggested that in order to allow for easier on-orbit troubleshooting with future hatch malfunctions, a simpler hatch design should be developed. Complete a thorough literature review of the space shuttle airlock and hatches. Afterwards, develop a conceptual design for a new set of airlock hatches which could be used for future spaceflight. A research paper or report should be required.

References

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