Online Ethics Center
FOR ENGINEERING AND SCIENCE

Early Evidence of a Temperature Effect

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Description

Part Two of Seven Discussions Concerning the Challenger Disaster

Body

The final flight readiness assessment chart read as follows:

Conclusion: STS-51C consistent with erosion data base. Low temperature enhanced probability of blow-by.

STS-51C experienced worst case temperature change in Florida history. STS-51E could exhibit same behavior. Condition is acceptable.

STS-51E field joints are acceptable for flight.

These conclusions were accepted and the flight was certified ready for launch.

Later, I met with Arnie Thompson to discuss the blow-by scenario and the effect of cold temperature on O-ring resiliency, which is the ability of the seal to restore itself to a round shape when the squeeze on the seal is removed. Arnie proposed that subscale lab tests be conducted which would provide us with assessment data. The resiliency testing was performed in March and showed that low temperature was a problem. The results indicated that the seals would lift off their sealing surfaces for several seconds at 75 degrees Fahrenheit and in excess of 10 minutes at 50 degrees Fahrenheit. This data was discused with Morton Thiokol engineering management

but was thought to be too sensitive by them to release.

Another post flight inspection occurred in June 1985 at Morton Thiokol in Utah. This time a nozzle joint from Flight 51B, which flew on April 29, 1985, was found to have a primary seal eroded in three places over a 1.3 inch length up to a maximum depth of 0.171 inches, and the secondary seal in the same joint was eroded 0.032 inches. It was postulated that this primary seal had never sealed during the full two minutes of flight.

My former concerns now escalated because if this same scenario happened in a field joint, the secondary seal could also be compromised especially during a low temperature launch. A Flight Readiness Review presentation was prepared for Flight 51F, which was scheduled for launch on July 29, 1985. The presentation was given to NASA at MSFC on July 1, 1985, with an additional presentation on the overall status of the booster seals given the next day. The preliminary results of the O-ring resilience testing in March were presented for the first time during this meeting. All O-ring test samples were 0.280 inch diameter and compressed to 0.040 inches with a decompression distance of 0.030 inches at a 2-inch-per-minute rate as compared with a flight rate of approximately 3.2 inches per minute. The results showed that the seals did not lose contact at 100 degrees Fahrenheit; lost contact for 2.4 seconds at 75 degrees, and lost contact in excess of 10 minutes at 50 degrees. Test results also indicated that a 0.295-inch diameter seal lost contact for 2 to 3 seconds at 50 degrees, which meant that the 0.295-inch diameter seal performance at 50 degrees was similar to the performance of a 0.28-inch diameter seal at 75 degrees. Everyone on the program for the first time was now aware of the influence of low temperature on the joint seals.

My concern increased once again due to the lack of attention being given to this problem.

Discussion Question

The bench tests showed that temperature can adversely affect the resiliency, and therefore the effectiveness, of the O-rings, yet management at Thiokol and NASA shows no interest in planning a design change. What general courses of action are reasonable for an engineer in this sort of situation?

Answer 1: Contact a professional society.

It depends on the society and the services that they offer members. If the society has an advice service this may be a good idea, but you have not taken the problem far enough within your company to warrant asking them to mediate for you with the Morton Thiokol management.

Answer 2: Gather knowledge of problem.

In light of the test results you have just obtained what is the information you want and how would you go about getting it?

Answer 3: Perform more experiments.

What information would they give you? It might help if it gave you information you need to improve the seal performance, but it may simply delay the need for action.

Answer 4: Take concerns to supervisor.

Yes, if your supervisor's intervention is needed to start work on fixing the erosion problem. Depending on the company's normal procedures, it may be enough to notify your supervisor of what you are doing and why you are doing it.

Continue to Being Asked to Soften the Urgency of the O-ring Problem

Resource Type

Case Study / Scenario

Topics

Catastrophes, Hazards, Disasters
Lab and Workplace Safety
Engineer/Client Relationships
Social Responsibility

Discipline(s)

Aerospace Engineering
Mechanical Engineering
Engineering