National Aeronautics and Space Administration

Lessons from Challenger

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Pre-Launch

- Launch day temperatures as low as 22 °F at Kennedy Space Center.
- Thiokol engineers had concerns about launching due to the effect of low temperature on O-rings.
- NASA Program personnel pressured Thiokol to agree to the launch.

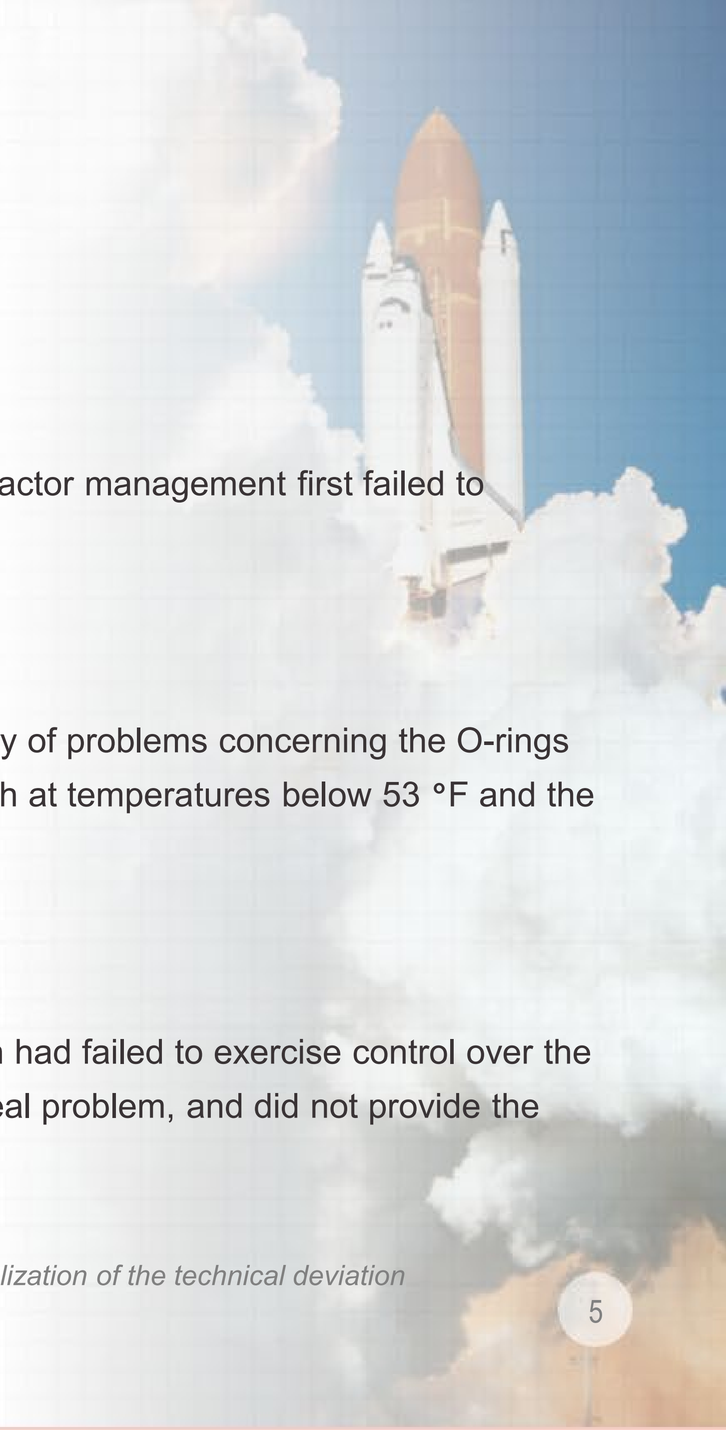
Summary of Accident

- Escaping gases were seen from lowest Solid Rocket Booster (SRB) joint at liftoff.
- O-ring resealed during ascent.
- Vibrations and crosswinds caused a catastrophic loss of sealing.
- SRB support structure failed, leading to tank rupture, vehicle loss, and loss of all 7 crew members at 73 seconds into flight.

Lost Opportunities to Recognize and Eliminate the Problem

1. NASA's performance specification did not include the known weather conditions that occur in Florida during the winter months.
2. A new joint design was accepted without sufficient certification and testing.
3. Failure to accept recommendations to redesign the clevis joint.
4. Establishing the upper limit of erosion tolerated in flight on the basis of a “computer program model” instead of recognizing the erosion itself as a failure of the joint.
5. Completing four years of shuttle flights with continuing joint/seal problems without designing, testing, and incorporating a new type of field joint and nozzle joint as well.
6. NASA's permitting Thiokol to continue making Solid Rocket Motors (SRMs) without conducting full-scale tests as had been requested by NASA 14 months previously.
7. Acceptance of joint failures as being within “their experience base.” In other words, if it broke before and the size of the recent break was no bigger than those before, then there was no problem. Even when the erosion surpassed all previous experience, NASA then went on and expanded its “experience base.”

Contributing Factors



Normalization of Deviance

The space shuttle's SRB problem began with the faulty design of its joint and increased as both NASA and contractor management first failed to recognize it as a problem, then failed to fix it, and finally treated it as an acceptable flight risk*.

Organizational Silence

The decision to launch Challenger was flawed. Those who made that decision were unaware of the recent history of problems concerning the O-rings and the joint and were unaware of the initial written recommendation of the contractor advising against the launch at temperatures below 53 °F and the continuing opposition of the engineers at Thiokol after management reversed its position.

Silent Safety Organization

There were serious ongoing weaknesses in the shuttle Safety, Reliability, and Quality Assurance Program, which had failed to exercise control over the problem tracking systems, had not critiqued the engineering analysis advanced as an explanation of the SRM seal problem, and did not provide the independent perspective required by senior NASA managers at Flight Readiness Reviews.

**Boston College sociology professor Diane Vaughan, author of the book "The Challenger Launch Decision," referred to this as, "The normalization of the technical deviation of the booster joints …"*

Lessons Learned

- **We cannot become complacent.**
- **We cannot be silent when we see something we feel is unsafe.**
- **We must allow people to come forward with their concerns without fear of repercussion.**

Learn More

- **Challenger Case Study**: SMA-OV-WBT-120
- **Risk Leadership:** SMA-HQ-WBT-220
- **Leaders Making Tough Decisions:** SMA-CORE-WBT-LMTD
- **Organizational Silence:** SMA-OV-WBT-131, expected release February 2021

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Thank You