THE CHALLENGER CASE STUDY

- The Space Shuttle Challenger disaster is well known to us.
- Happened on January 28, 1986.
- Seven astronauts killed as it exploded just over a minute into the flight.
- Next few slides is to give a deep thought into certain facts revolving around it.

The Challenger on the morning of its final launch. (1) The External Tank. (2) The Solid Rocket Boosters.

KEY DATES

- 1974 - Morton-Thiokol awarded contract to build solid rocket boosters.
- 1976 - NASA accepts Morton-Thiokol's booster design.
- 1977 - Morton-Thiokol discovers joint rotation problem.
- November 1981 - O-ring erosion discovered after second shuttle flight.
- January 24, 1985 - shuttle flight that exhibited the worst O-ring blow-by.
- July 1985 - Thiokol orders new steel billets for new field joint design.
- August 19, 1985 - NASA Level I management briefed on booster problem.
- January 27, 1986 - night teleconference to discuss effects of cold temperature on booster performance.
- January 28, 1986 - *Challenger explodes 72 seconds after liftoff*

KEY ISSUES

HOW DOES THE IMPLIED SOCIAL CONTRACT OF PROFESSIONALS APPLY TO THIS CASE?

WHAT PROFESSIONAL RESPONSIBILITIES WERE NEGLECTED, IF ANY?

SHOULD NASA HAVE DONE ANYTHING DIFFERENTLY IN THEIR LAUNCH DECISION PROCEDURE?

BACKGROUND

- NASA managers were anxious to launch challenger due to
  - •Competition from European Space Agency to prove the space transportation system ‘s cost effectiveness and potential for commercialization
  - • scheduling backlogs
  - •Political pressure : As President Reagan had to give state of union address and it was mainly about education were he was expected to mention shuttle.

- Shuttle rocket boosters (SRBs) are the key elements that produce enough thrust to overcome earth’s gravitational pull and achieve orbit. Its attached each side of fuel tank. Its drawback was that once ignited it cannot be turned off or controlled. The joints where booster segments are joined together is known as field joints. Each joint is sealed by two O- rings, the bottom ring known as the primary O-ring, and the top known as the secondary O-ring . The purpose of the O-rings is to prevent hot combustion gasses from escaping from the inside of the motor.

LAUNCH DELAYS

- The first delay of the Challenger mission was because of a weather front expected to move into the area, bringing rain and cold temperatures.
- The second launch delay was caused by a defective micro switch in the hatch locking mechanism and by problems in removing the hatch handle.
- It was convinced that there were cold weather problems with the solid rocket motors. Almost half of the shuttle flights had experienced O-ring erosion in the booster field joints.

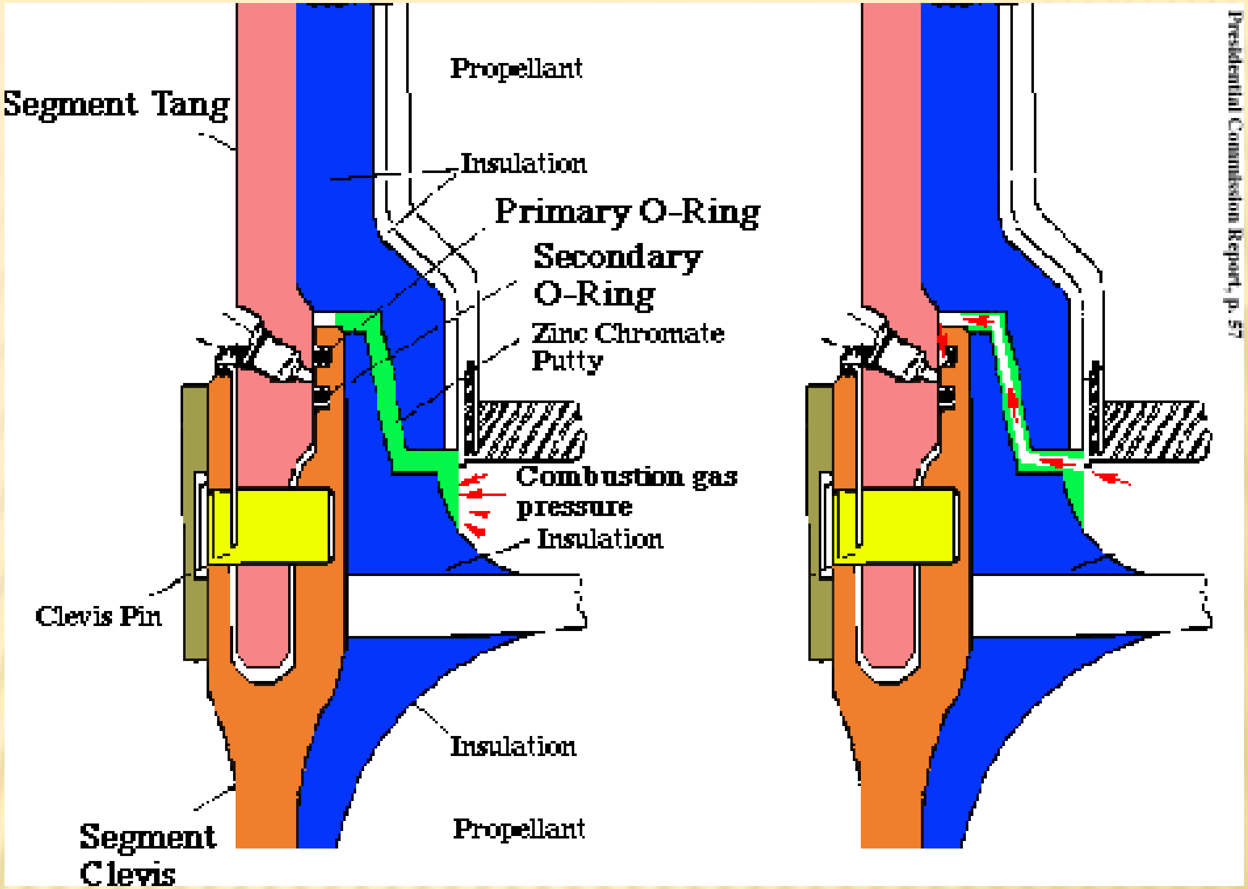
ENGINEERING DESIGN

- Increasing O-ring compression in order to decrease Joint Rotation was taken for analysis where Joint rotation is the opening of gap between the tank and clevis which was caused due to ballooning of cylinder and changes were made in the design.

- A new problem was deducted after the flight of the second shuttle mission. Examination of the booster field joints revealed that the O-rings were eroding during flight. Study was conducted about the effects of O-ring resiliency at low temperatures . New steel billets were ordered for the redesign of the tank.

outside

inside



The Solid Rocket Boosters

BEFORE LAUNCH

- Engineers gave a presentation to convince that the cold weather would exaggerate the problems of joint rotation and delayed O-ring seating. The lowest temperature experienced by the O-rings in previous mission was 53°F,.So they asked to delay the launch as O-ring erosion was found at this temperature.
- The managers seemed to believe the O-rings could be eroded up to one third of their diameter and still seat properly, regardless of the temperature. The new recommendation stated that launch was recommended, even though the engineers had no part in writing the new recommendation.

THE LAUNCH

- During the night, temperatures dropped to as low as 8°F. In order to keep the water pipes in the launch platform from freezing, safety showers and fire hoses had been turned on. Some of this water had accumulated, and ice had formed all over the platform.
- The ice inspection team thought the situation was of great concern, but the launch director decided to go ahead with the countdown.

- The key personal who had to authorize the launch were not aware of the teleconference about the solid rocket boosters that had taken place the night before.
- Eight hundredths of a second after ignition, the shuttle lifted off. Engineering cameras focused on the right-hand booster showed about nine smoke puffs coming from the booster aft field joint. Before the shuttle cleared the tower, oxides from the burnt propellant temporarily sealed the field joint before flames could escape. Fifty-nine seconds into the flight, *Challenger experienced the most violent* wind shear ever encountered on a shuttle mission. The glassy oxides that sealed the field joint were shattered by the stresses of the wind shear, and within seconds flames from the field joint burned through the external fuel tank. Hundreds of tons of propellant ignited, tearing apart the shuttle. One hundred seconds into the flight, the last bit of telemetry data was transmitted from the *Challenger*

ISSUES FOR DISCUSSION

The Challenger disaster has several issues which are relevant to engineers.

- One of the most important issues deals with engineers who are placed in management positions. It is important that these managers not ignore their own engineering experience, or the expertise of their subordinate engineers.

- Another issue is the fact that managers encouraged launching due to the fact that there was insufficient low temperature data. Since there was not enough data available to make an informed decision, this was not, in their opinion, grounds for stopping a launch. This was a reversal in the thinking that went on in the early years of the space program, which discouraged launching until all the facts were known about a particular problem.

- The first canon in the ASME Code of Ethics urges engineers to "hold paramount the safety, health and welfare of the public in the performance of their professional duties." Every major engineering code of ethics reminds engineers of the importance of their responsibility to keep the safety and well being of the public at the top of their list of priorities. Although company loyalty is important, it must not be allowed to override the engineer's obligation to the public.