Professional Ethics & Human Values

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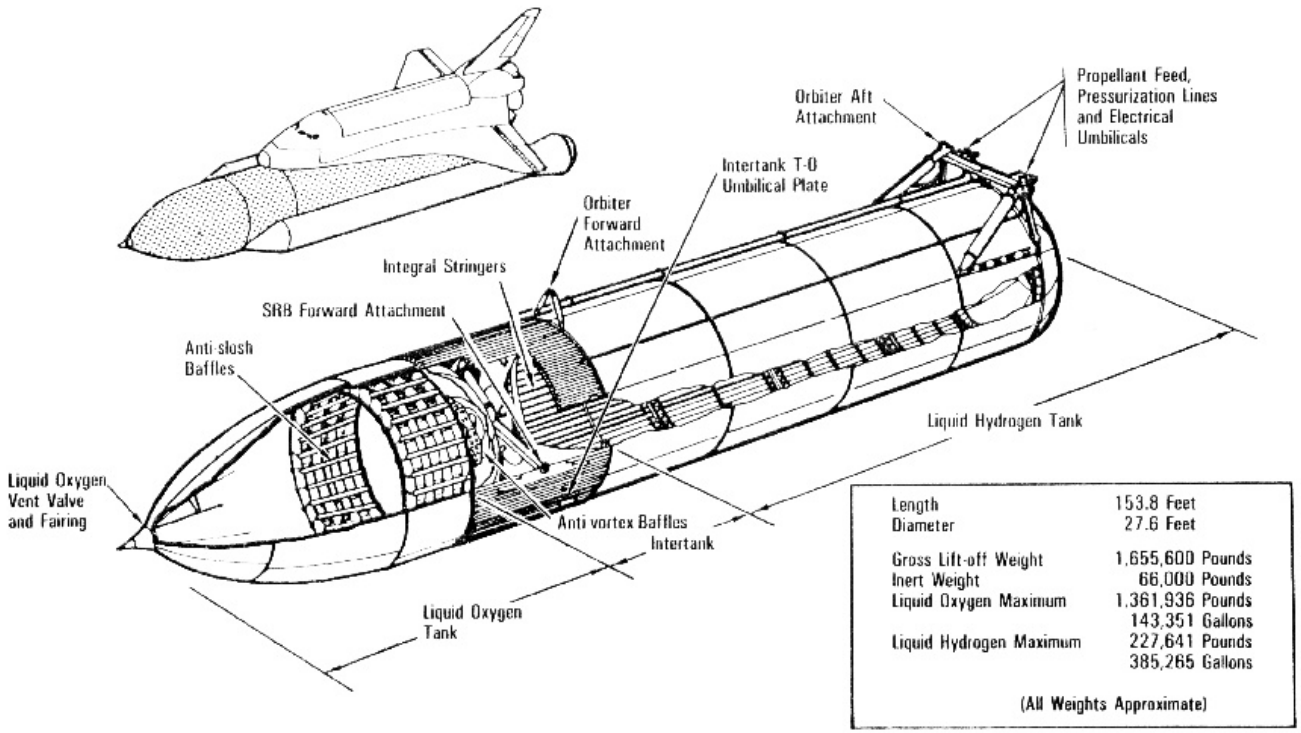
THE CHALLENGER DISASTER
A CASE-STUDY IN ENGINEERING ETHICS

Shuttle Components

- Orbiter
- Liquid Rocket Booster
- Solid Rocket Booster

SHUTTLE COMPONENTS



Lightweight External Tank

CHRONOLOGY OF THE RELATED EVENTS

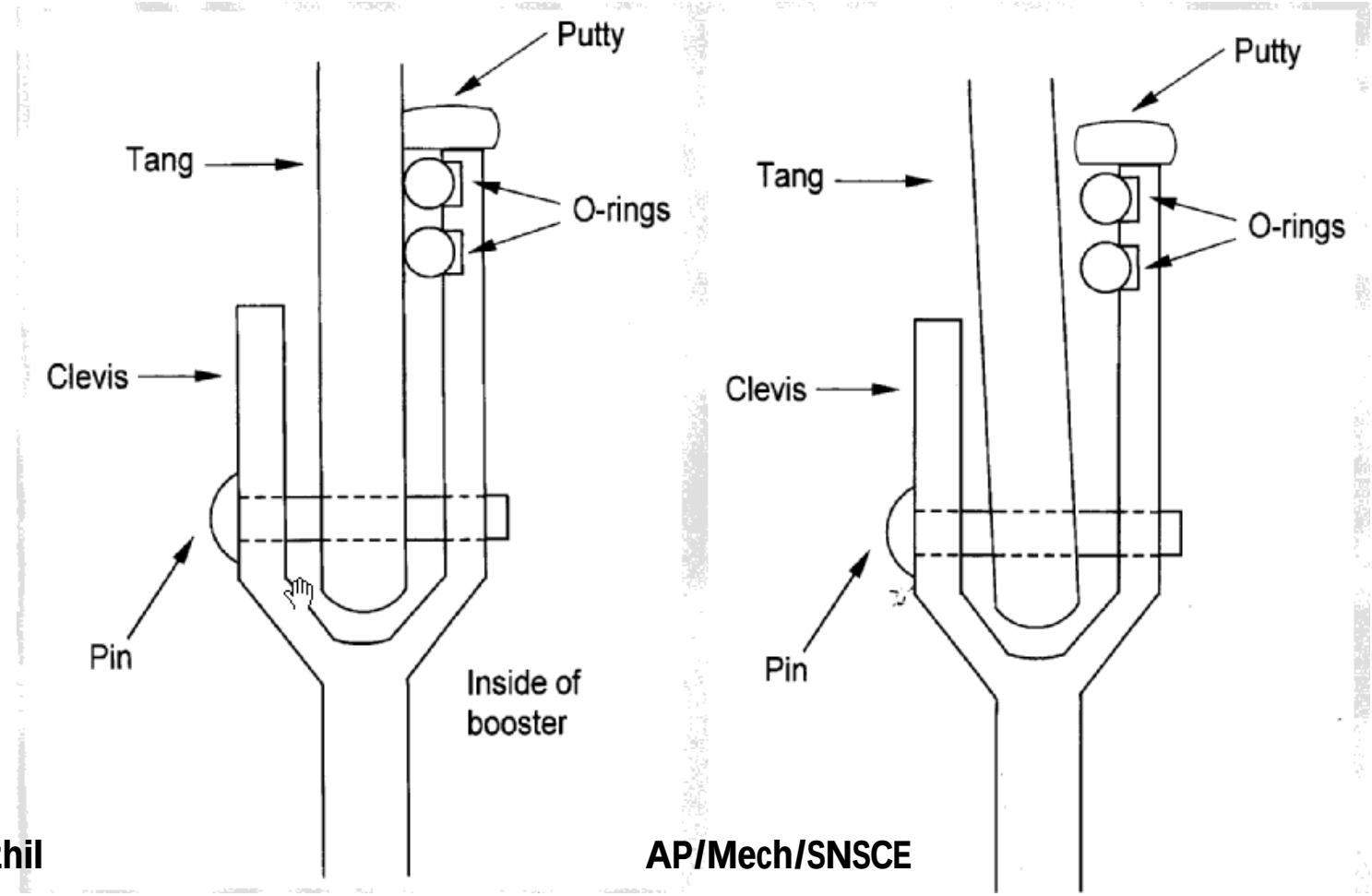
1974

- NASA contracts Morton Thiokol

1976

- NASA accepts the design based on the Titan missiles
- The joints are sealed by
  - Two synthetic rubber O-rings,
  - 177 clevis pins,
  - Heat shield putty

THE CAUSE OF THE DISASTER



EARLY PROBLEMS

1977

- Tests at Thiokol show O-ring leakage
- Joint is made stronger by changing sizes

1981

- Post-launch investigation showed O-ring erosion due to hot gages.

EARLY PROBLEMS

January of 1985 launch

- First cold-weather launch
- Post-launch investigation showed joint failure
- Tests showed O-rings inability to fill the gap due to joint rotation at lower temperatures

EARLY PROBLEMS

July 1985

- Thiokol redesigns the joints w/o O-rings – The design was not ready for Challenger launch

POLITICAL CLIMATE

Congress is unhappy with NASA

Competition with Russians to be the first to observe Halley's comet.

Pressure to launch before President Reagan's State of the Union Address

DAYS BEFORE LAUNCH

First launch attempt postponed

The next launch date was set and was to be attended by Vice President Bush.

The temperature at launch: 29 degrees F.

DAYS BEFORE LAUNCH

NASA starts an investigation of the effect of low temperatures on the O-ring seals

Organization involved

- NASA
- Marshall Space Flight Center
- Morton Thiokol

ENGINEERING INVESTIGATION BEFORE LAUNCH

Players at NASA

- Larry Mulloy: SRB Project Manager at Marshall

Players at Thiokol

- Roger Boisjoly: A SRB engineer
- Arnie Johnson: A SRB engineer
- Joe Kilminster: SRB engineering manager
- Alan McDonald: SRB engineering director
- Bob Lund: Vice president for engineering
- Jerald Mason: General manager

ENGINEERING INVESTIGATION BEFORE LAUNCH

Boisjoly and Johnson recommend the launch to be postponed.

Bob Lund, the VP for engineering agrees and makes a similar recommendation.

INVESTIGATION BEFORE LAUNCH

Larry Mulloy, the NASA manager of SRB asks Joe Kilminister, the SRB manager at Thiokol, for his opinion.

Kilminister agrees with other Thiokol engineers and recommends a launch delay.

INVESTIGATION BEFORE LAUNCH

After discussion with Mason

Lund reverses his decision regarding launch!

Thiokol recommend the launch to proceed

THE LAUNCH IN JANUARY 1986

The overnight temperatures drop to 8 F

The temperature of SRB at launch is 28 F

There is an immediate blow-by of hot gas at launch. The seal fails quickly over an arc of 70 degrees.

THE LAUNCH IN JANUARY 1986

The by-products of combustion forms a glassy oxide that reseals the joint.

The brittle oxide is shattered

Hot gases quickly burn through the liquid rocket booster

THE AFTERMATH

Causes of the accident are attributed to

- Inability of the O-rings to expand and seal at low temperatures.
- Heat shield putty did not perform at low temperatures
- Fits and seating of the O-ring was affected by low temperature.

THE AFTERMATH

After all the testimonials

- Biosjoly is taken off the project and subtly harassed by Thiokol management.