Challenger Disaster

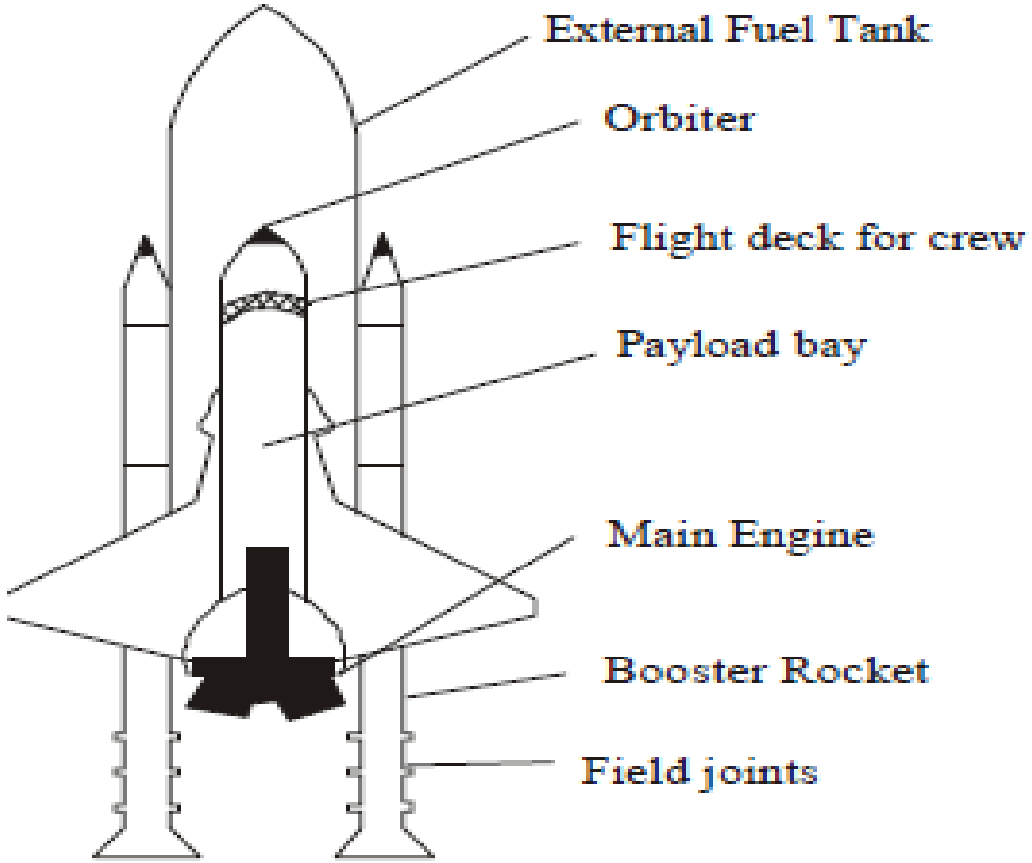
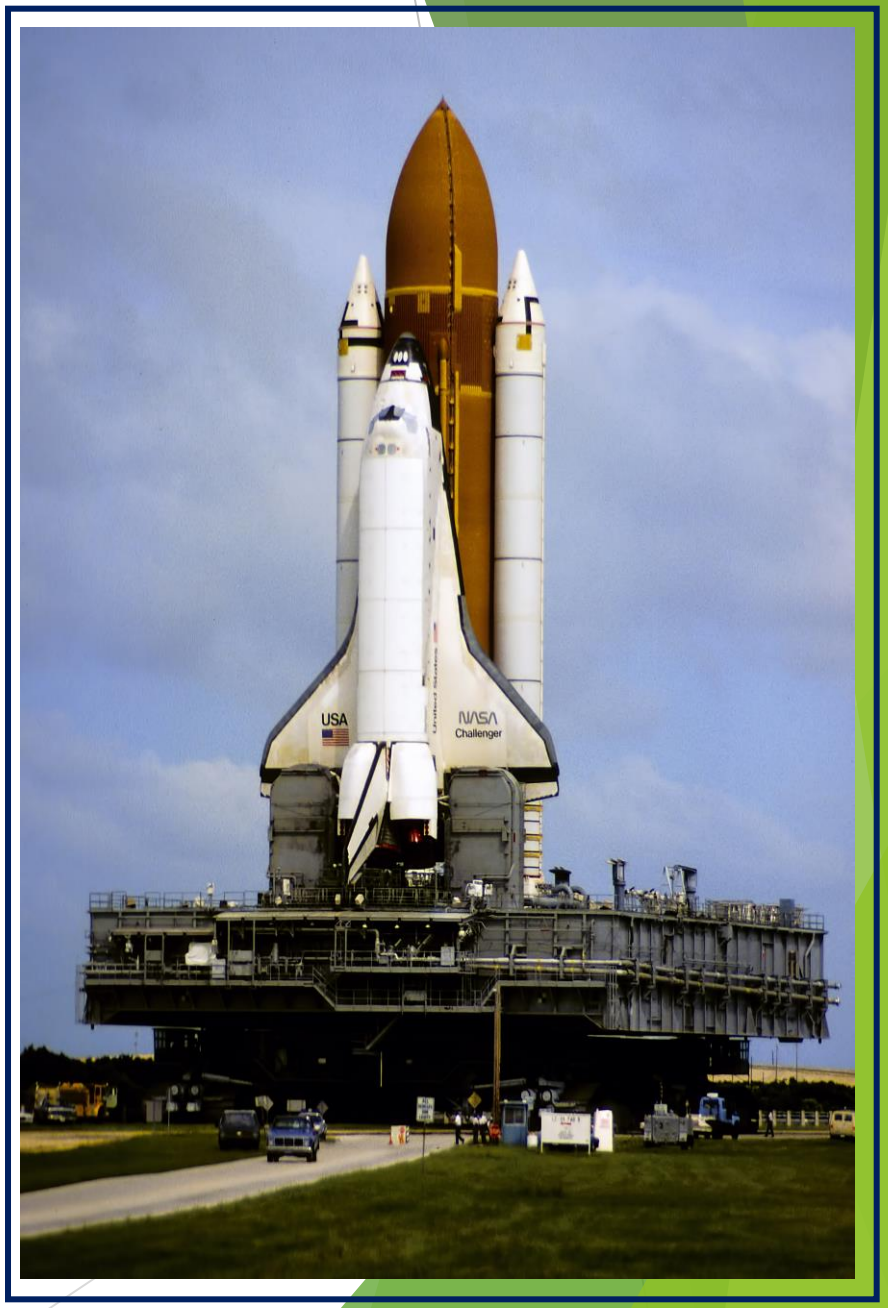
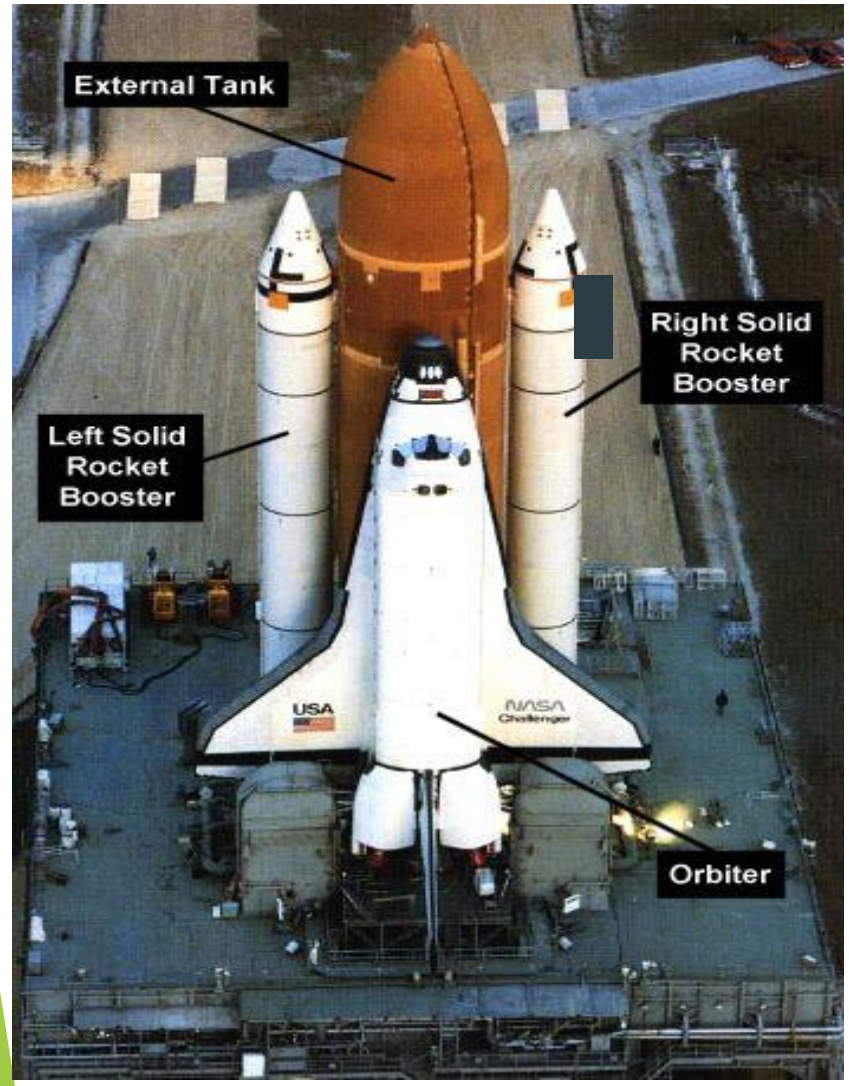


Fig. 3.2 a Challenger



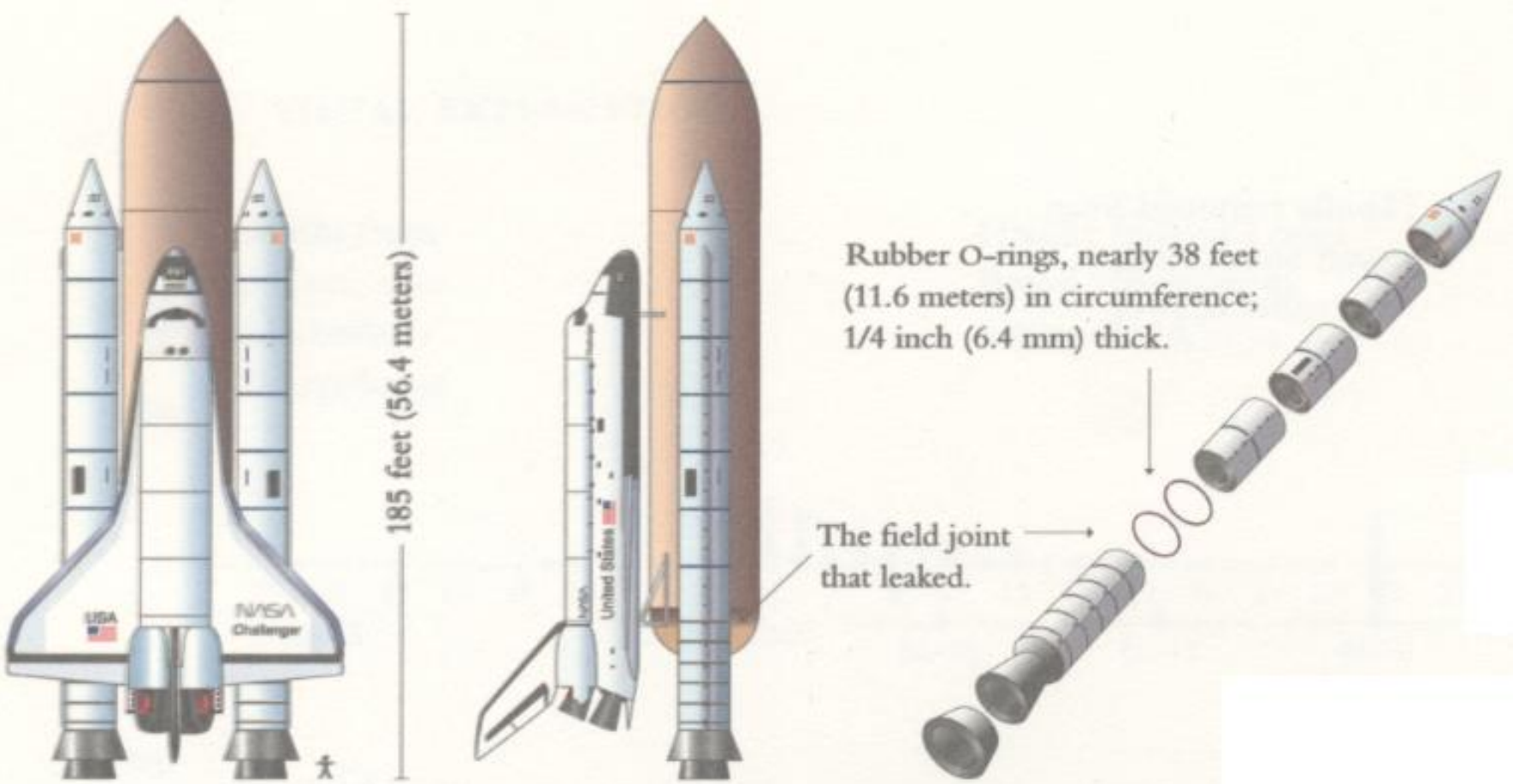
Basic shuttle design



The orbiter of the Challenger had three main engines fuelled by liquid hydrogen. The fuel was carried in an external fuel tank which was jettisoned when empty. During lift-off, the main engines fire for about nine minutes, although initially the thrust was provided by the two booster rockets. These booster rockets are of the solid fuel type, each burning a million pound load of aluminum, potassium chloride, and iron oxide.

The casing of each booster rocket is about 150 feet long and 12 feet in diameter. This consists of cylindrical segments that are assembled at the launch site. There are four-field joints and they use seals consisting of pairs of O-rings made of vulcanized rubber. The O-rings work with a putty barrier made of zinc chromate.

Challenger Model



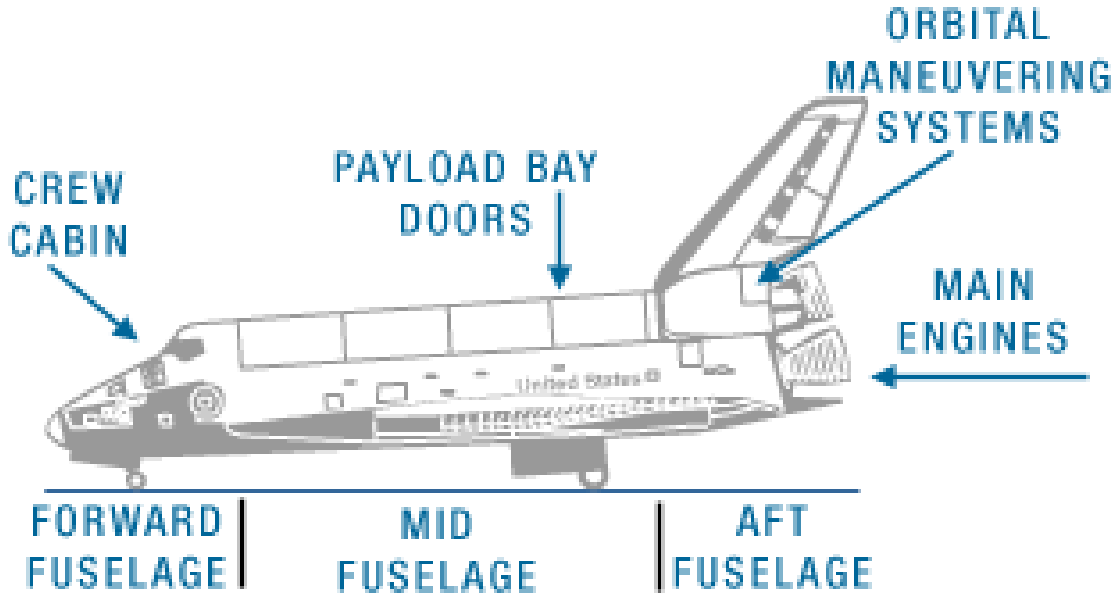
The shuttle consists of an *orbiter* (which carries the crew and has powerful engines in the back), a large liquid-fuel *tank* for the orbiter engines, and 2 solid-fuel *booster rockets* mounted on the sides of the central tank.

1. Orbiter

- Length 37.2m
- Height 17.25m
- Mass 68.5tonnes
- Payload:32,000kg
- Crew: 7 max

- The primary component:

A reusable, winged craft containing the crew and payload that actually travels into space and returns to land on a runway.

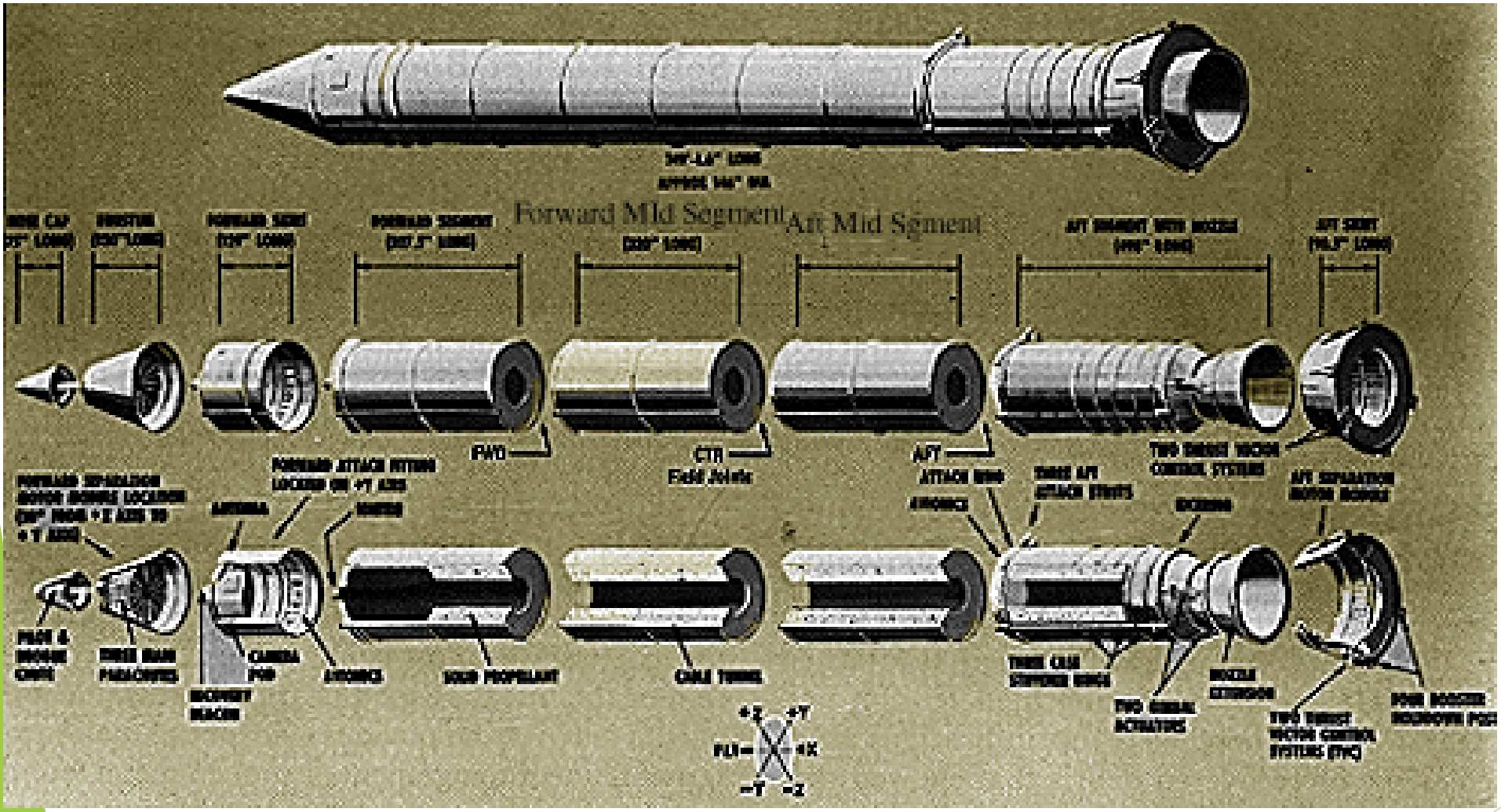


3. Solid rocket boosters

- Without the SRBs, the shuttle cannot produce enough thrust to overcome the earth's gravitational pull.
- An SRB is attached to each side of the external fuel tank.
- Each booster is 149 feet long (45m) and 12 feet (3.6m) in diameter.
- Before ignition, each booster weighs 2 million pounds (900 tonnes, 150 elephants).

  80% of the total vehicle mass, 83% of total thrust

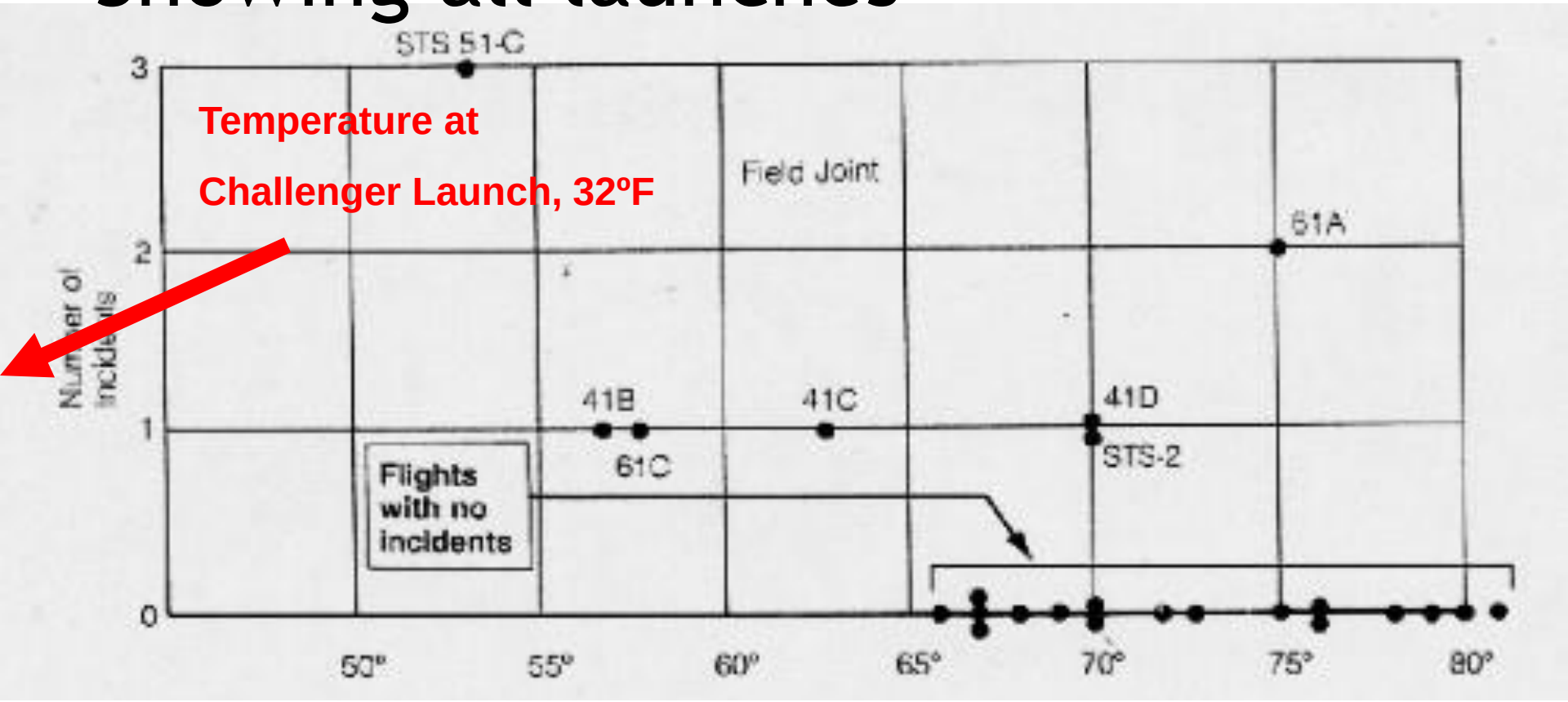
Solid rocket boosters



Warning

- Roger Boisjoly, a Thiokol engineer had gone on record the night before the launch.
- In a teleconference with NASA he stated:
- “If we launch tomorrow we will kill those seven astronauts”
- He was ignored.

Chart by Rogers Commission Showing all launches



Further details

Pressure to launch

NASA managers were anxious to launch the Challenger for several reasons, including economic considerations, political pressures, and scheduling backlogs.

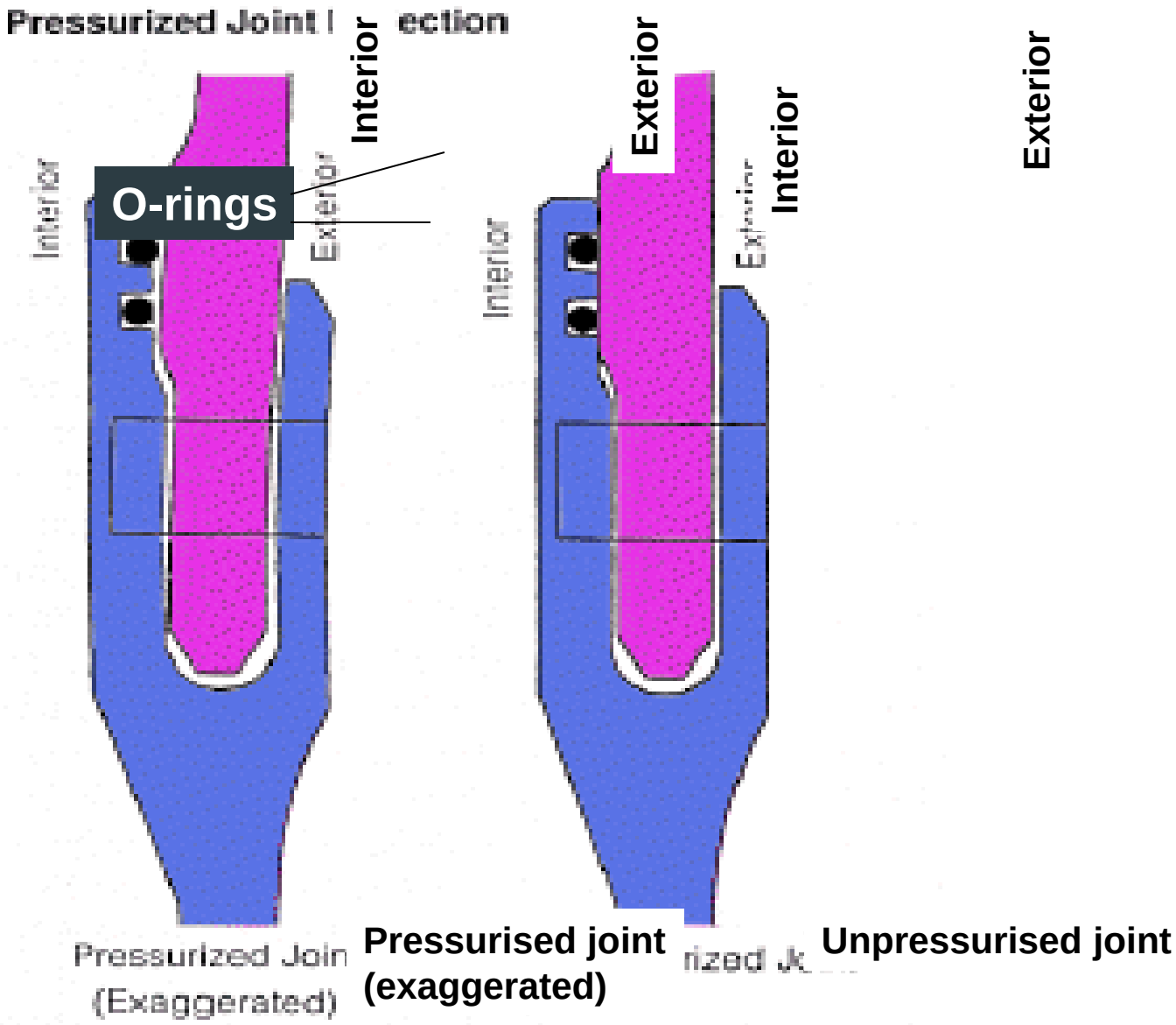
- Unforeseen competition from the European Space Agency put NASA in a position in which it would have to fly the shuttle dependably on a very ambitious schedule to prove the Space Transportation System's cost effectiveness and potential for commercialization.
- This prompted NASA to schedule a record number of missions in 1986 to make a case for its budget requests.

Further details

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 blowby.
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.

Pressurised Joint deflection on Solid Rocket Booster



Pressurised joint (exaggerated)

Unpressurised joint

Moral/Normative Issues

1. *The crew had no escape mechanism. Douglas, the engineer, designed an abort module to allow the separation of the orbiter, triggered by a field-joint leak. But such a 'safe exit' was rejected as too expensive, and because of an accompanying reduction in payload.*

2. *The crew were not informed of the problems existing in the field joints. The principle of informed consent was not followed.*

3. *Engineers gave warning signals on safety. But the management group prevailed over and ignored the warning.*

Conceptual Issues

1. NASA counted that the probability of failure of the craft was one in one lakh launches. But it was expected that only the 100000th launch will fail.
2. There were 700 criticality-1 items, which included the field joints. A failure in any one of them would have caused the tragedy. No back-up or stand-bye had been provided for these criticality-1 components.

Factual/Descriptive Issues

1. Field joints gave way in earlier flights. But the authorities felt the risk is not high.
2. NASA has disregarded warnings about the bad weather, at the time of launch, because they wanted to complete the project, prove their supremacy, get the funding from Government continued and get an applaud from the President of USA.
3. The inability of the Rockwell Engineers (manufacturer) to prove that the lift-off was unsafe.

This was interpreted by the NASA, as an approval by Rockwell to launch.

Field Joint Leakage

- On many of the previous flights the rings have been found to have charred and eroded. In freezing temperature, the rings and the putty packing are less pliable. From the past data gathered, at
- temperature less than 65 °F the O-rings failure was certain.
- But these data were not deliberated at that conference as the launch time was fast approaching.

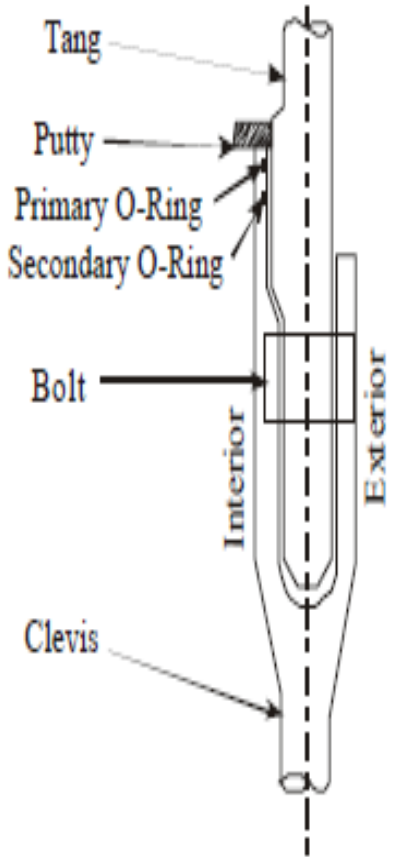


Fig. 3.2 b Field joint before ignition

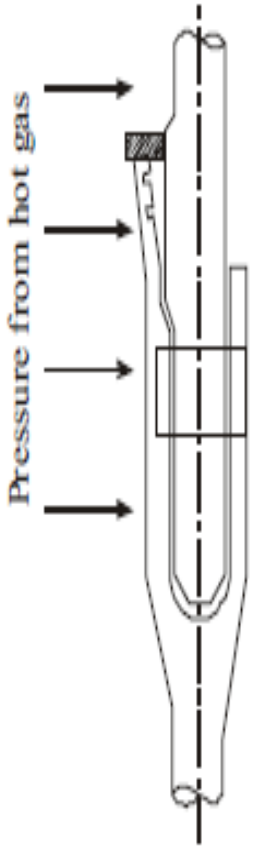


Fig. 3.2 c Field joint after ignition

What really happended

- At 11.38 a.m. the rockets along with Challenger rose up the sky. The cameras recorded smoke
- coming out of one of the filed joints on the right booster rocket. Soon there was a flame that hit the
- external fuel tank. At 76 seconds into the flight, the Challenger at a height of 10 miles was totally
- engulfed in a fireball. The crew cabin fell into the ocean killing all the seven aboard.
- Some of the factual issues, conceptual issues and moral/normative issues in the space shuttle
- challenger incident, are highlighted hereunder for further study.