

# *Challenger Space Shuttle Disaster*

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## Abstract

This case study dives into the events surrounding the catastrophic series of events that unfolded on January 28<sup>th</sup>, 1986. That morning, The NASA Space Shuttle Challenger took off setting for space. The shuttle carrying seven astronauts on board, suffered a major failure within one of its rocket boosters. This failure, taking place about 73 seconds into liftoff, involved one of the O-rings sealing the rocket booster tanks carrying fuel for the shuttle's propulsion system. Ultimately this failure led to the explosion of the rocket, killing all seven members on board. The events taking place leading up to the event and how they were allowed to unfold is discussed below.

## Introduction

January 28<sup>th</sup>, 1986, was the date that NASA's space shuttle Challenger, set to take off for the limitless sky.[3] The team was set to take off on this tragic morning. The team on board, consisted of seven NASA astronauts, all of which were killed within the destruction of the space shuttle itself. During launch, about just one-minute after take-off, Challenger as a whole ignites and explodes, scattering debris throughout the sky. Imaged to the right, is a famous image of the explosion itself, as you can see in [Figure 1](#), after the main fuel tank itself explodes, the rocket boosters positioned on the sides of the tank continued firing and shooting towards the sky, after majority of the shuttle was scattered through the sky as a free-falling debris shower. The main failure of the shuttle was attributed to a failure in the joint between two segments on the right solid rocket booster.[9]

As mentioned above, sadly all seven astronauts on board, were killed immediately within the shuttle explosion, which is a better fate to meet than that of their counterparts on board space shuttle Columbia. Columbia was another space shuttle disaster that happened under the eye of NASA. In this



*Figure 1.* Pictured above is a screenshot from the live broadcast by CNN, of The Challenger Space Shuttle, on the day of the incident. The trail of the shuttle, followed by the explosion then led to the two rocket boosters to continue firing towards space by their themselves.[4]

incident, a piece of the shuttle falls off, causing damage to the wing of the space craft. This damage to the wing led to the disintegration of the shuttle on re-entry to the atmosphere. Sadly, in this tragedy the astronauts survived long enough to realize exactly what was going on, whereas in Challenger there simply was not enough time for their brains to even send signals of pain to their nervous system.

The scaling of this catastrophe was massive, as in there was no brushing this under the rug for NASA in any way. President John F. Kennedy launched the Space Program in 1961 and garnered tons of public attention to what is beyond our blue skies. With the interest of the general population, being very high. Many people followed these NASA projects, keeping up with launch dates so they could go and spectate some of the largest engineering marvels at the time. This flight was also housing a civilian teacher, who applied and became an astronaut, as NASA was looking to garner more attention to the space program.[8] This woman was a wife, mother of two young children, and an everyday classroom teacher. People were infatuated with her ability to become an astronaut as she became a symbol across the country drawing attention in from every angle.[8] This meant millions of citizens, including classrooms across the nation were tuned in to the live feed of this National Project in its entirety from start to finish. I remember stories my father, an established Mechanical Engineer himself, of his elementary teachers rolling the big TV into the classroom for the big launch day. Kids across the nation watching in awe as the space shuttle ignites and explodes into a fireball, scattering debris across the sky leaving everyone spectating speechless.

**Engineering Analysis**

NASA following the incident assembled a team/commission in order to inspect and investigate the explosion of the Challenger Space Shuttle. NASA later produced these documents to the public, which entailed the analysis of what exactly happened on board Challenger that late morning. Their investigation points to a certain failure, involving the Solid Rocket Motor on the right side of the shuttle. [9] More specifically, the explosion was caused from the destruction of the O-ring seals, used to prevent hot gasses from leaking through the joint during propellant burns by the rocket motor. In regard to the investigation NASA said, “In arriving at this conclusion, the Commission reviewed in detail all available

data, reports, and records; directed and supervised numerous tests, analyses, and experiments by NASA, civilian contractors, and various government agencies; and then developed specific failure scenarios and the range of most probable causative factors. The sections that follow discuss the results of the investigation.” [9]

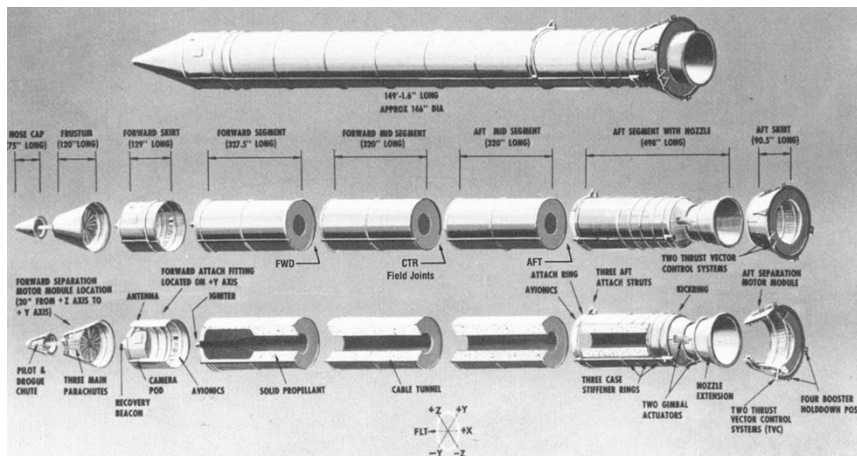


Figure 2. Image showing a single Rocket Booster in an exploded view, that was on board the Challenger Space Shuttle.[7]

When anyone mentions Challenger, it is often followed by a comment on O-rings or negligibility, the negligibility aspect shall be discussed later as the whole event was avoidable in its entirety. An O-ring is a versatile sealing mechanism used in a wide range of applications. NASA proceeded to use a subcontractor for many parts on their shuttles, for the O-ring a company called Morton Thiokol was used.[8] Engineers from MT were tasked with and proceeded to develop and manufacture massive 13-foot O-rings for the rocket boosters attached to The Challenger Shuttle.[8] These O-rings were used throughout the design of the rocket boosters, at varying sizes. The rocket boosters can be thought of as towers of metal tanks full of propellant to be used by the rocket motor for propulsion to space.[8] The propellant stored in

these rockets, is highly explosive. As this propellant heats up, the O-rings inside these rocket boosters prevent the high-temperature gases from escaping and leaking out and

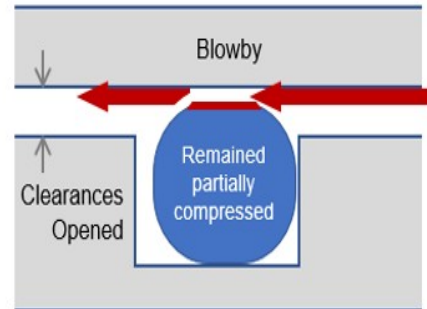
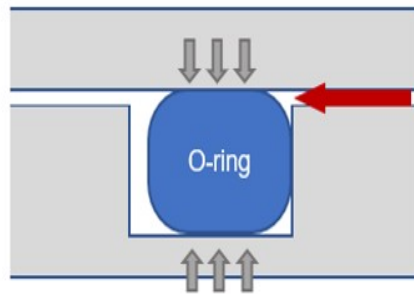
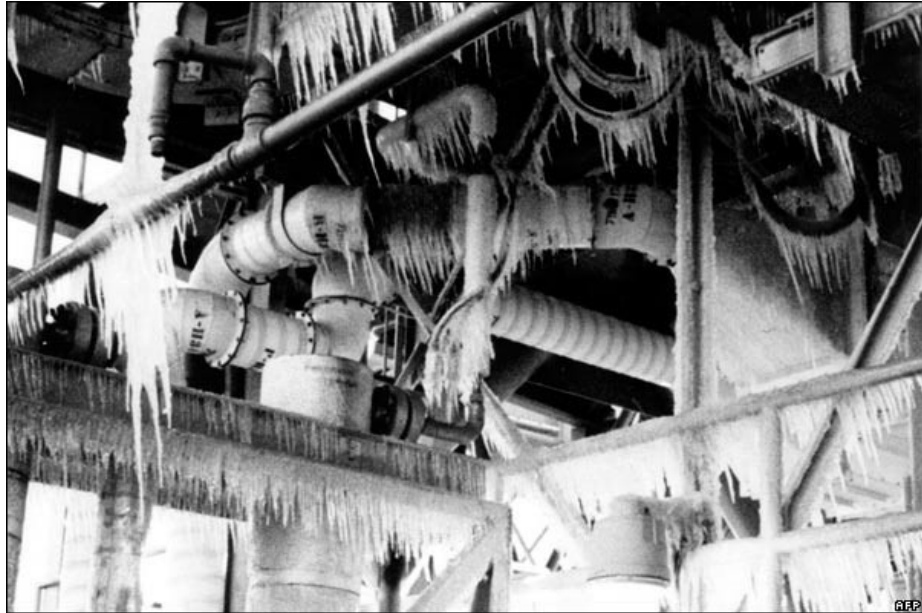


Figure 3. Example of how an O-ring seals a chamber and how potential blowby occurs.[10]

through to another tank.[8] During the flight, these O-rings faced erosion and became damaged in the elements they were facing, leading to blow-by.[sim]. Blow by is the leakage of gas from chamber to chamber, which is what caused the explosion of Challenger, an example of blow by can be seen above in [Figure 3](#). During the investigation it was also found that certain SRB field joints, which secured these O-rings in place, preventing blow-by, differed on Challenger, than the ones planned to be installed. The ones planned to be installed upon Challenger, could have potentially sealed these O-rings in place, securing it enough, to prevent the blow-by, allowing for Challenger to make a safe flight.

### **How Could This Happen?**

The event that took place, claiming the lives of seven astronauts, was seen by many as completely avoidable after the investigation unfolded. Multiple people in higher positions at NASA were made aware multiple times of warnings within Challenger's rocket boosters. This can be seen as pure negligence



from people in positions of high-power setting dates for engineers projects, yet not understanding the full effects of what they are doing. Typically, in Cape Canaveral where the shuttle was launched from, the temperature in the morning around late January time-frame would average around fifty degrees Fahrenheit.[H] However the morning of launch, temperatures would drop below freezing, reaching as low as twenty degrees at its coldest and around thirty-six degrees at the time of launch.[H] Many images from that morning that show icicles forming off the edges of the launch tower and shuttle itself, some growing to lengths of over two feet. Cold weather was known to inhibit the effectiveness of these O-rings, limiting performance, as this was seen on previous Challenger flights in colder weather.[8] In colder weather tests and flights, the O-rings would undergo serious damage raising concern around the performance on the rocket boosters aboard Challenger in cold weather specifically.

An engineer with over a 25-years' experience in aerospace engineering made multiple attempts at stopping the launch of Challenger that morning.[1] His name was Roger Boisjoly, his numerous attempts and warnings of disaster involving the NASA shuttle were ignored by many high-up managers at NASA, who were focused on hitting a deadline instead of practicality.[1] His warnings however were not the only message NASA received about concerns revolving around Challenger's launch. The main focus turns to a meeting held the morning of launch with the engineering team. They discussed the idea not to launch, which the engineers favored as

Figure 4. The above image shows the icicles found on the Challenger shuttle and launch pad. [8]

they were aware of the concerns surrounding the O-rings in cold temperature, just as the NASA managers were.[1] Yet the NASA managers decided to ignore and override the engineers' warnings, proceeding with the launch anyways. This is where many began to see this event as completely avoidable as the main failure was noticed and was labeled as an area of concern and is discussed more in the NSPE violations section of the report.

### **NSPE Ethical Analysis**

The National Society of Professional Engineers, or the NSPE, is an organization created in 1934 with one crucial goal. The overall goal of the NSPE taken directly from their website is to, "create an

inclusive, nontechnical organization dedicated to the interests of licensed professional engineers, regardless of practice area, that would protect engineers (and the public) from unqualified practitioners, build public recognition for the profession, and stand against unethical practices and inadequate compensation.”[6] With that being said, the NSPE has come together to set up a list of rules/guidelines to uphold the morals and ethics within the engineering world.

Focusing mainly on the fundamental canons of the NSPE code of ethics. NASA faced a lot of scrutiny following the investigation. These managers had blood on their hands as this catastrophic event was for the most part avoidable. The first canon states that it is crucial to hold the safety and welfare of the public to a paramount standard. However, NASA managers, given many warnings about the launch of Challenger proceeded to ignore and bypass these warnings. This also flows into how they stepped outside their realm of competence bypassing these recommendations from the engineering team. The engineers of MT who manufactured the O-rings however held their standards as they proceeded to send multiple warnings about the effectiveness of the O-rings when working in cold temperatures. Like the other warnings, they were of no use and in the end ignored by the NASA management team. Overall, these managers at NASA did not heed many warnings that potentially could have saved multiple lives, disregarding multiple canons of ethics leading to widespread distrust in the space program.

### **Conclusion**

Overall, the events that unfolded the morning of January 28<sup>th</sup>, 1986, were undoubtedly hard to watch for viewers around the world. Classrooms, students, astronaut-idolizers, space-nerds, tuned in to watch the next big step of the United States Space Program take place. Bright smiles and faces of anticipation quickly faded around 73 seconds into the launch, as the shuttle combusts and explodes into a fireball. The explosion instantly killing all seven astronauts on board, was caused by a faulty O-ring, which lost much of its durability when being utilized in a cold-temperature atmosphere, as well as discrepancies within the design and installation of certain SRB field joints. Sadly, the event as a whole was widely seen as avoidable, had the management team at NASA heed many specific warnings surrounding Challenger and its vulnerability in cold weather, now looked on as a major learning event.

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