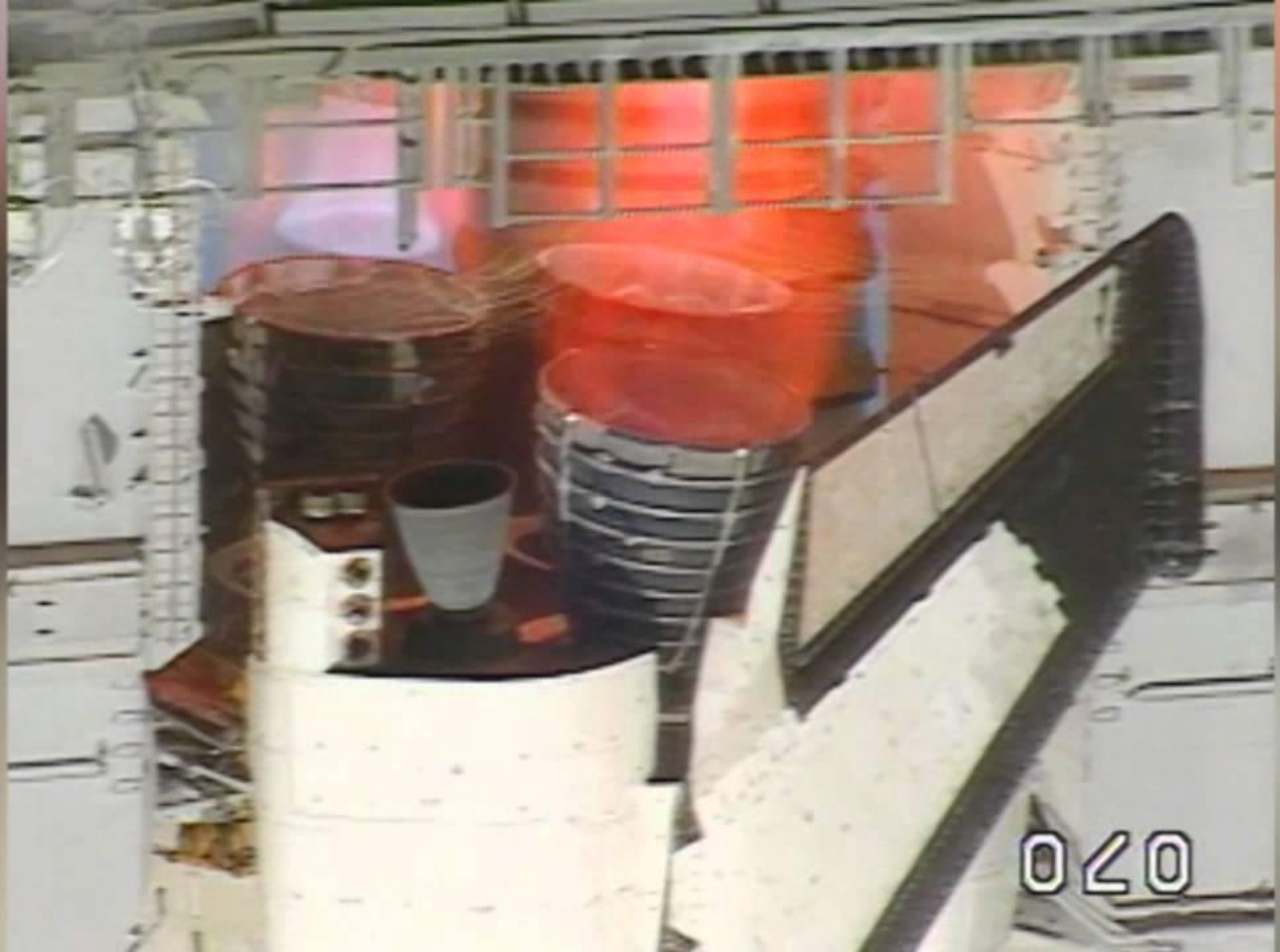
070

1
00:00:01,030 --> 00:00:03,160
NARRATOR (Voice Over B-Roll): Millions of people watched the roaring engines,

2
00:00:03,160 --> 00:00:09,650
and thundering rush of fire and twin pillars of smoke that made up the unique signature of a space shuttle laun

3
00:00:09,650 --> 00:00:14,680
They saw four large machines work together precisely to send astronauts, satellites,

4
00:00:14,680 --> 00:00:18,730
observatories and space station sections into orbit.

5
00:00:18,730 --> 00:00:23,660
The four elements, when combined ahead of a launch, were called a shuttle stack.

6
00:00:23,660 --> 00:00:32,230
They included the shuttle itself, also known as the orbiter, plus a pair of solid rocket boosters and a single exte

7
00:00:32,230 --> 00:00:39,220
The external tank, or ET, is the familiar orange structure that dominates most images of the shuttle at liftoff.

8
00:00:39,220 --> 00:00:44,540
At more than 15-stories tall, it is the largest single part of a shuttle stack.

9
00:00:44,540 --> 00:00:50,110
It gets its signature orange color from the foam insulation sprayed on the tank's aluminum structure.

10
00:00:50,110 --> 00:00:56,650
The insulation helps the tank act as a thermos bottle to keep the super cold propellants from evaporating too q

11
00:00:56,650 --> 00:01:04,450
It also helps prevent ice from forming on the tank's exterior and promotes the right aerodynamic shape for laun

12
00:01:04,450 --> 00:01:12,070
The main job of the tank is to hold about 535,000 gallons of super cold liquid hydrogen and liquid oxygen.

13
00:01:12,070 --> 00:01:17,340

The lower portion of the tank holds the liquid hydrogen, which is the fuel for the engines.

14
00:01:17,340 --> 00:01:23,580
The second-coldest known chemical, it is stored in the tank at minus 423 degrees Fahrenheit.

15
00:01:23,580 --> 00:01:29,620
The upper part of the tank holds liquid oxygen, chilled to minus 297 degrees.

16
00:01:29,620 --> 00:01:34,780
During the space shuttle fleet's 30 years of operation, the tank, like the shuttle itself,

17
00:01:34,780 --> 00:01:39,110
has undergone numerous upgrades and weight-saving improvements.

18
00:01:39,110 --> 00:01:46,820
For example, designers quickly saved six hundred pounds by not painting the tank white after the first two miss

19
00:01:46,820 --> 00:01:51,470
Following a few revisions to designs and materials, the latest version of the tank,

20
00:01:51,470 --> 00:01:59,380
known as the Super Lightweight tank, is 17,000 pounds lighter than the first one Columbia used in 1981.

21
00:01:59,380 --> 00:02:06,310
The tank also received extra attention after 2003's Columbia accident, which was blamed in part on

22
00:02:06,310 --> 00:02:13,730
a piece of the insulating foam on the tank breaking off, striking the left wing and creating a hole in the shuttle's

23
00:02:13,730 --> 00:02:18,940
Engineers implemented changes to the foam and the way it is applied and refined before the next launch.

24
00:02:18,940 --> 00:02:24,350
Some foam was removed altogether to eliminate risk further.

25
00:02:24,350 --> 00:02:32,840
The twin solid rocket boosters, or SRBs, are bolted to either side of the tank, with the shuttle itself riding piggyb

26
00:02:32,840 --> 00:02:37,760
This approach was revolutionary in rocket design when it debuted in 1981.

27
00:02:37,760 --> 00:02:43,030
Until then, rockets were built by stacking one stage on the top of another and then casting off

28
00:02:43,030 --> 00:02:49,000
the stages one at a time until a small spacecraft was left on its own in orbit.

29
00:02:49,000 --> 00:02:57,440
Until the space shuttle's first mission in 1981, no astronaut had ridden into orbit on the strength of a solid-fuele

30
00:02:57,440 --> 00:03:04,700
The SRBs hold their own fuel, a mixture of powdered aluminum and a chemical called ammonium perchlorate.

31
00:03:04,700 --> 00:03:13,540
When dry, the combination feels like a pencil eraser. The fuel is the "solid" in the solid rocket booster's name.

32
00:03:13,540 --> 00:03:20,270
The 15-story-tall boosters work much simpler than liquid-fueled rockets that require complex engines and pump

33
00:03:20,270 --> 00:03:24,490
They produce nearly 7 million pounds of thrust.

34
00:03:24,490 --> 00:03:29,510
The solid rocket boosters do not ignite until the shuttle's main engines are up and running.

35
00:03:29,510 --> 00:03:35,160
At liftoff, flames shoot down through the inside of the booster to ignite the fuel.

36
00:03:35,160 --> 00:03:45,240
Once ignited, the boosters cannot be turned off. A pair of boosters combines to burn nine tons of fuel every sec

37
00:03:45,240 --> 00:03:54,560
The boosters accelerate the 4.5 million-pound shuttle stack to 3,000 miles per hour and 24 miles high in two m

38
00:03:54,560 --> 00:04:02,410

By then, most of the fuel is used up and the boosters fall away, leaving the shuttle's own main engines to reach

39
00:04:02,410 --> 00:04:09,790
The boosters parachute safely into the ocean where they're recovered and reused on later launches.

40
00:04:09,790 --> 00:04:13,340
After the shuttle engines shut down and the orbiter is on its way,

41
00:04:13,340 --> 00:04:19,280
the external tank falls away and safely burns up in the atmosphere over the ocean.

42
00:04:19,280 --> 00:04:26,700
NASA's shuttle fleet performed unprecedented work in orbit during its career, whether deploying spacecraft to