A Successful failure

THE RESCUE OF APOLLO 13

A lot happened in 1970, The Beatles split-up, the world lost two rock legends Jimi Hendrix and Janis Joplin, the world's first jumbo-jet, the Boeing 747 had its first commercial flight and the Concord made its first supersonic flight. There was also the Nuclear Non-Proliferation Treaty that went into effect after ratification by 43 nations, both the United States and South Vietnam invaded Cambodia, the first computer chess tournament took place and George Gray invented Liquid Crystal Display (LCD). For six days in April that year, the world anxiously waited for news of the safe return to earth of Apollo 13 astronauts, Commander Jim Lovell, Command Module Pilot Jack Swigert and Lunar Module Pilot Fred Haise.
In 2015, OMEGA introduced the OMEGA Speedmaster "Apollo 13 Silver Snoopy Award", a watch that pays homage to that unforgettable mission 45 years before, celebrating the teamwork, quick thinking, ingenuity and courage that brought them home safely.

Photos: © NASA

Deke Slayton (in black shirt, left of center) director of flight crew operations, and Chester M. Lee shake hands in Mission Control, while Rocco Petrone watches Apollo 13 commander Jim Lovell on the screen

Jim Lovell leads Jack Swigert and Fred Haise to the Transfer van

GO FOR LAUNCH

At 2:13 pm EST on the 11th of April 1970, Apollo 13, which was to be the third lunar landing, lifted off from launch pad 39A at Kennedy Space Centre. Just five-and-a-half minutes later, John Swigert, Fred Haise and James Lovell felt a small vibration. Next the centre engine of the S-II stage shut down two minutes early, causing the remaining four engines to burn 34 seconds longer than planned. This meant the S-IVB third stage had to burn nine seconds longer to put Apollo 13 into orbit.

The mission had already experienced a number of hiccups. Just days before launch, backup lunar module pilot, Charles Duke had inadvertently exposed the rest of the crew to German measles. Command Module Pilot Ken Mattingly, who had no immunity to measles, was replaced by backup command module pilot, John Swigert. Ground tests before launch had also indicated the possibility of a poorly insulated supercritical helium tank in the lunar module (LM) decent stage, so the flight plan had to be modified to enter the LM three hours earlier to take an on-board readout of helium tank pressure.

Despite these hiccups, the first two days of the mission ran smoothly, and the crew ran into only a couple of minor surprises. At 46 hours, 43 minutes Joe Kerwin, the capsule communicator, or Capcom, on duty said, "The spacecraft is in real good shape as far as we are concerned. We're bored to tears down here." It was a belief shared by the crew on a 49-minute TV broadcast a few hours later, where they showed the world how comfortably they lived and worked in weightlessness. At 55 hours, 46 minutes, Lovell ended the broadcast saying, "This is the crew of Apollo 13 wishing everybody there a nice evening, and we're just about ready to close out our inspection of Aquarius and get back for a pleasant evening in Odyssey. Good night."

A BIG BANG

At 46:40 the crew routinely switched on the fans in the oxygen tanks briefly. A few seconds later the quantity indicator for tank number two went off the high end of the scale, where it stayed. The tanks were stirred twice more during the next few hours; and at 55:53, after a master alarm had indicated low pressure in a hydrogen tank, the Mission Control Center (MCC) directed the crew to switch on all tank stirrers and heaters.

Nine minutes later, oxygen tank No. 2 blew up, causing the No. 1 tank to fail as well. The spacecraft carried two oxygen tanks, each holding 145 kilograms of supercritical oxygen, which provided the oxygen for the command module atmosphere and (with two tanks of hydrogen) three fuel cells which were the crafts primary source of electrical power. The chemical reaction in the cells also produced water, supplying not only the crew's drinking water, but also circulated through cooling plates to remove heat from certain critical electronic components. Now, the command module's normal supply of electricity, light and water was lost. At 9:08pm, as they heard a sharp bang and felt a vibration, Swigert saw a warning light come on and uttered those famous words, "Houston, we've had a problem here." Then Lovell came on and told the ground that it was a main B bus undervolt. The warning lights indicated the loss of two of three fuel cells – the spacecraft's primary source of electricity. As the warning lights continued to blink, one oxygen tank appeared to be completely empty and there were indications that the oxygen in the second tank was rapidly depleting.

Thirteen minutes after the explosion, Lovell looked out of the left-hand window and saw the final evidence pointing toward potential catastrophe. "We are venting something out into the... into space," he reported to Houston. Capcom Jack Lousma replied, "Roger, we copy you venting." Lovell said, "It's a gas of some sort." It was oxygen gas escaping at a high rate from the second, and last, oxygen tank.

The pressure in the No. 1 oxygen tank continued to drop, passing 300 pounds per square inch, heading toward 200 pounds per square inch mark. Once it hit that mark, the crew and ground controllers knew that they would lose all oxygen, which meant that the last fuel cell also would die.

One hour and 29 seconds after the bang, Lousma, on instruction from Flight Director Glynn Lunney, said, "It is slowly going to zero, and we are starting to think about the LM lifeboat." Swigert replied, "That's what we have been thinking about too."

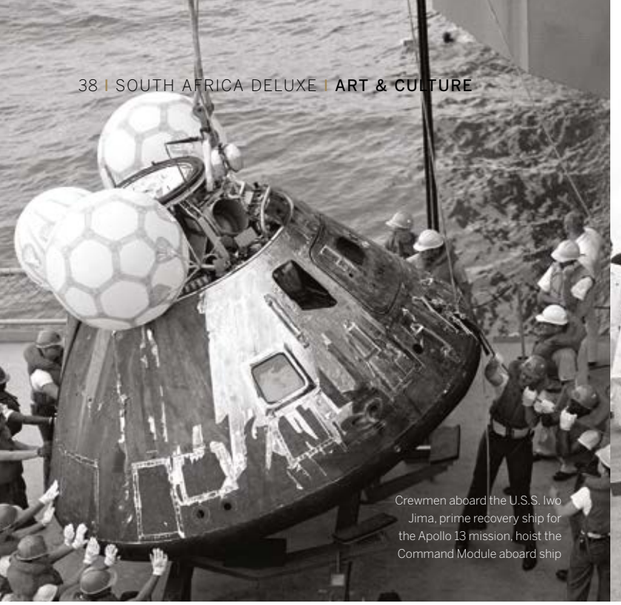
A FORMIDABLE TASK

There was so much to be done in such a short space of time, including completely new procedures being written and tested in the simulator before being passed up to the crew. Navigation was going to be a major challenge – how, when and at what altitude should the crew burn the LM descent engine to ensure a quick return home.

With just 15 minutes of power left in the CM, Lousma instructed the crew to move into the LM. Haise and Lovell floated quickly through the tunnel, while Swigert remained to perform the final tasks in the CM. The LM was built for a 45-hour lifetime and now needed to be stretched to 90. Of major concern was whether there would be enough power, oxygen, and water to return the team home safely. There were 2,181 ampere hours in the LM batteries. Ground controllers carefully worked out a procedure where the CM batteries were charged with LM power. All noncritical systems were turned off and energy consumption was

"The spacecraft is in real good shape as far as we are concerned. We're bored to tears down here."

Speedmaster



Crewmen aboard the U.S.S. Iwo Jima, prime recovery ship for the Apollo 13 mission, hoist the Command Module aboard ship

Commander Philip Eldredge Jerauld (at microphone), offers a prayer of thanks for the safe return of the Apollo 13 crew members

reduced to just one fifth, this meant there was 20 percent of LM electrical power left when Aquarius was jettisoned. During the mission, one of the CM batteries vented with such force, it dropped off the line for a moment. Had that battery failed, there would not have been enough power to return the ship to earth.

There was sufficient oxygen in the full LM descent tank, and there were two ascent-engine oxygen tanks and two backpacks of oxygen that would have been used on the lunar surface. Two emergency bottles housing six or seven pounds of oxygen in them were also on board.

Of greatest concern was water supply. Calculations showed the crew would run out of water approximately five hours before Earth re-entry, however data from Apollo 11's LM showed that its mechanisms could survive seven or eight hours in space without water cooling. In order to conserve water, the crew cut down their intake to six ounces each per day, a fifth of their normal intake, and used fruit juices, and ate hot dogs and other wet-pack foods when they ate. The crew became dehydrated throughout the flight and set a record that stood up throughout the Apollo missions. Lovell lost 14 pounds, and the crew lost a total of 31.5 pounds, nearly 50 percent more than any other crew. Through conservation they managed to return with 28.2 pounds of water, about 9 percent of the total.

The crew needed to ensure that carbon dioxide in the LM was safely removed. They had four cartridges from the LM and four from the backpacks, counting backups. The LM was designed to support two men for two days, not three men for four days, so the challenge they faced was to marry the square lithium hydroxide canisters from the CM to the round openings in the LM environmental system. When carbon dioxide built up to dangerous levels, mission control managed to devise a way to attach the CM canisters to the LM system using plastic bags, cardboard and to tape all materials carried on board.

HOMEWARD BOUND

The LM navigation system was not designed to help the crew get back to Earth. The team would need to take the LM out of the lunar-landing-trajectory, and set it onto a free-return-to-Earth-trajectory. To correct the course, ground control computed a 35-second burn and fired it five hours after the explosion. Then, as they approached the moon, another burn was computed; this time a long five-minute burn to speed up the return home. This took place two hours after rounding the far side of the moon.

The crew had transferred the CM navigational platform alignment to the LM, however verifying the alignment proved difficult. The debris from the explosion meant it was impossible to sight a suitable navigation star which would be used by the Alignment Optical Telescope (AOT) and an on-board computer to verify the guidance platform's alignment. Ground control again stepped in with an alternate procedure in which the crew would use the sun as an alignment star. Lovell rotated the spacecraft to the requested altitude and found that when he looked through the AOT, the sun was just where it was expected to be. With the alignment less than half a degree off, ground control and the crew knew it was safe to perform the five minute burn. This burn succeeded in reducing the total time of their voyage to approximately 142 hours.

The cold meant that it was virtually impossible to sleep, particularly so when the electrical systems were turned off removing an important source of heat. The temperature dropped to 38 degrees Fahrenheit and condensation formed on all the walls. Procedures were needed to power up the CM after its long, cold sleep. The remarkable flight controllers at mission control wrote documents to address this in just three days – something that would normally have taken three months. The walls, ceiling floor, wire harnesses and panels of the CM were covered with droplets of water at the start of power-up, and it was suspected that conditions behind the panels were the same. There was concern over short-circuits, but because safeguards were built into the CM after the disastrous Apollo 1 fire, no arcing took place.

The service module was shed by the crew four hours before landing. It was kept until then, because there were fears of what the cold of space might do to the un-sheltered CM heat shield.

The emergency procedures sent through by ground control, and enacted by the crew resulted in effective conservation of expendable resources. The electrical power reserves in the LM were enough to allow the use of that power in the CM allowing some of the early CM activities to be done at a slower pace. When the CM splashed down within a mile of the recovery carrier, it had approximately 20 percent of its battery power remaining. The astronauts were taken aboard the U.S.S. Iwo Jima on 17th April 1970 and were flown to Hawaii for an emotional reunion with their families.

WHAT WENT WRONG?

The Apollo 13 Accident Review Board conducted an extensive investigation to better understand the cause of the explosion. Improvements performed on the CM in 1965 included raising the permissible voltage to the heaters in the oxygen tank from 28 to 65 volts DC. Unfortunately, the thermostatic switches on these heaters weren't modified to suit this change. During the final test on the launch pads, the heaters were on for a long period, subjecting the wiring around the heaters to temperatures of 1000 degrees Fahrenheit. Subsequent tests have shown this exposure to severely degrade Teflon insulation, so when the thermostatic switches started to open while powered by 65 volts DC they were probably welded shut. Additional warning signs during testing went unheeded and the tank, damaged from eight hours of overheating was a potential bomb the next time it was filled with oxygen. Despite the failure to land on the moon, its primary mission, Apollo 13's flight was classified as a "successful failure" because of the experience gained in rescuing the crew.

OMEGA'S CONTRIBUTION TO THE SUCCESSFUL RESCUE

In about 1962, NASA purchased a number of commercially available watches for evaluation. After extensive testing aimed at discovering which of the watches would be most reliable in the conditions likely to be experienced in space, the Omega Speedmaster Professional triumphed, beginning a relationship with astronauts and space agencies across the world, which has endured for more than half a century.

The Omega Speedmaster Professional didn't just tell time, it also incorporated a chronograph (stopwatch) via the large third hand on the watch dial. The three interior dials provided a second-hand, a minute elapsed counter and an hour elapsed counter, both of which related to the chronograph function. The outside of the dial included a fixed bezel incremented to act as a Tachymeter (to measure miles per hour) in conjunction with the stopwatch function, hence the title "Speedmaster".

When NASA issued its astronauts with the standard Speedmaster Professional manual-wind timepiece, it was intended to be worn for intra and extra-vehicular activities, including the moonwalks on all the missions. They would be worn conventionally inside a pressurised environment however during EVAs the watch would be worn on the outside of their pressure suits, and thus the Velcro strap was designed to accommodate the change in wrist dimension.

Edward H. White, the first American to walk in space, wore a Speedmaster during his Gemini 4 spacewalk and in July of 1969, the Speedmaster became the first watch worn on the moon. In 1970, in perhaps its most important contribution, Jack Swigert used his Speedmaster to accurately time the critical mid-course correction burns using the Lunar Module's Reaction Control System, allowing for the crew's safe return. In recognition of this, Omega was awarded the Snoopy Award by the Apollo 13. ■ Lindsay Grubb

Photos: © NASA

Crew
Commander James A. Lovell
Jr.Lunar Module Pilot Fred W. Haise Jr.
Command Module Pilot John L. Swigert Jr.

Backup Crew
Commander John W. Young
Lunar Module Pilot Charles M. Duke Jr.
Command Module Pilot John L. Swigert Jr.

Payload
Odyssey (CM-109) Aquarius (LM-7)

Prelaunch Milestones
June 13, 1969 - S-IVB on dock at Kennedy
June 29, 1969 - S-II on dock at Kennedy
June 16, 1969 - S-IC on dock at Kennedy
July 7, 1969 - S-IU on dock at Kennedy

Launch
April 11, 1970; 1:13 p.m. CST
Launch Pad 39A
Saturn-V AS-508
High Bay 1
Mobile Launcher Platform-3
Firing Room 1

Orbit Altitude
118.99 miles

Inclination
32.547 degrees

Earth Orbits
1.5

Duration
Five days, 22 hours,
54 minutes, 41 seconds

Distance
622,268 miles

Landing
April 17, 1970, Pacific Ocean

Recovery Ship
USS Iwo Jima

For more information on this mission visit www.nasa.gov
All facts in this feature courtesy of NASA.

The Omega Speedmaster Apollo 13 Silver Snoopy Award, pays homage to the unforgettable Apollo 13 mission, and celebrates the teamwork, quick thinking, ingenuity and courage that brought Commander Jim Lovell, Command Module Pilot Jack Swigert and Lunar Module Pilot Fred Haise home safely.

Marking the 45th Anniversary of Nasa's "Successful Failure"

THE SPEEDMASTER APOLLO 13 SILVER SNOOPY AWARD

Photos:© NASA, OMEGA

The dial of the Speedmaster Apollo 13 Silver Snoopy Award, is inspired by the black and white comic strips printed in newspapers, and is at once recognisable as the inverse of its legendary predecessor. The white dial contrasts the black varnished Moonwatch-style hands and the polished black ceramic bezel, which features a Super-LumiNova tachymeter scale. Super-LumiNova is also found on the central hour, minute and chronograph seconds hands. The luminescent material was used to make the indexes, and their glow is enhanced by the black varnish that fills the indexes' top cavities.

The timepiece, bears two inscriptions that decorate the dial. Fourteen small squares between zero and 14 seconds on the dial come together to form a long comic strip, with the words "What could you do in 14 seconds?" written underneath in reference to the 14-second mid-course correction that the Apollo 13 astronauts timed with their on-board back-up timing device: the OMEGA Speedmaster. At the centre of the dial is the quote: "Failure is not an option." These inspiring words were spoken by actor Ed Harris who played Apollo 13

Flight Director Gene Kranz in the 1995 film about the historic mission, Apollo 13. A small image of a sleeping Snoopy painted on the dial with Super-LumiNova is positioned in the small seconds sub-dial at 9 o'clock and it appears as if he is dreaming of the token phrase that is often used in association with the mission.

Each of the enamelled casebacks with its 925 silver medallion, are slightly different as they are partially crafted by hand, meaning that no two pieces are exactly alike. The 42 mm stainless steel timepiece is presented on a black-coated, nylon fabric strap with white stitching and a fold-over clasp.

The timepiece is powered by the Omega calibre 1861, and is limited to 1,970 pieces. The timepiece is kept in a special presentation box that includes a certificate of authenticity, a 925 silver Snoopy pin and a newspaper with unique stories about the mission and behind-the-scenes information about Snoopy's relation to NASA. The Omega Speedmaster Apollo 13 Silver Snoopy Award, is offered with a full two-year warranty and is water resistant to 5 bar (50 metres / 167 feet). ■ **Lindsay Grubb**

Photos: © OMEGA