Almost to the Moon and Back: How NASA Compromised to Bring Apollo 13 Safely Home

> Kylie Miles-Kroening Junior Division Individual Paper Word Count: 2,409

"Houston, we've had a problem here."¹ Those are the words of Jack Swigert, Apollo 13's command module pilot, when he felt a shudder aboard the spacecraft. Apollo 13 had suffered a terrible explosion on their spacecraft, endangering the lives of the crew members. The public was in shock, and NASA was afraid. How could they get the crew home? Would they be able to? Apollo 13 matters in American history because it was a failed space mission that turned into a huge conflict, helped NASA compromise together on how to bring the crew home safely, and improved future space missions.

Apollo 13 was the third mission attempt to go to the moon.² All around, the Cold War was raging, and with that came the Space Race. The United States and the Soviet Union were each trying to prove their greatness in space exploration, going head to head to see who could win. NASA (National Aeronautics and Space Administration) was fresh into the Apollo program. After successfully putting man on the moon with Apollo 11 and 12, NASA was ready to give it a third go. They were determined to continue their success in all of their space missions. Apollo 13 was to land at the Fra Mauro uplands once at the moon.³ There, they would collect samples of the moon's bedrock to help researchers understand more about the moon's structure.

The original crew of Apollo 13 included Jim Lovell, Fred Haise, and Tom Mattingly.⁴ Tom Mattingly, however, was exposed to German measles by backup crew member Charles Duke. When Mattingly was not allowed to go, he was replaced by Jack Swigert, another member of

¹ Dunbar, Brian. "Apollo 13." NASA, NASA, 29 Mar. 2017,

www.nasa.gov/mission_pages/apollo/missions/apollo13.html.

² Dunbar, Brian. "Apollo 13." NASA, NASA, 29 Mar. 2017,

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³ Christopher, John. *The Apollo Story*. History Press, 2009.

⁴ Christopher, John. *The Apollo Story*. History Press, 2009.

the backup crew. James A. Lovell Jr. (Jim Lovell) was the mission commander, Fred W. Haise Jr. was the lunar module pilot, and John L. Swigert Jr. (Jack Swigert) would fill in for Tom Mattingly as command module pilot on the Apollo 13 mission. Swigert joined the main crew only a few days before the mission began. This may as well have been the first bad sign for Apollo 13, and there were more to come.

Lift off was April 11th, 1970. Since Apollo 11 and 12 went so well, the public thought Apollo 13 would go the same. Mission Control felt that way as well. However, NASA's lunar missions weren't exactly the media's top story anymore. Mission Control (in Houston, Texas), along with chief flight director Gene Kranz, were ready to go. Lift off occurred at 1:13 p.m. at Kennedy Space Center in Florida.⁵ Lift off went fine, but soon into the mission the crew ran into a conflict. The spacecraft's second stage engine had failed. Mission Control was able to fix this problem by having the crew burn the other engines for about thirty-four seconds longer. Once this error was fixed, everyone at Mission Control thought that the rest of Apollo 13's flight would go smoothly.

The crew was now ready to drop the Saturn V, the rocket that had launched them into space and orbit. Hidden within this rocket was a command module (CM), a service module (SM), and a lunar module (LM). The command module was titled "Odyssey," and the lunar module was titled "Aquarius." The command module was where the main controls were located, and it held the water tank.⁶ The lunar module was the part of the spacecraft used for landing on

⁵ "Apollo 13." Smithsonian Air and Space Museum,

airandspace.si.edu/explore-and-learn/topics/apollo/apollo-program/landing-missions/apollo13.cfm. ⁶ Cole, Michael D. *Apollo 13: Space Emergency*. Enslow Publishers, 1995.

the moon's surface. The service module held the fuel cells, the engine, and the oxygen tanks.⁷ Since Jack Swigert was the command module pilot, he would do the job of separating and reattaching the different parts of the spacecraft. First he separated the CM and the SM from the 3rd stage rocket and turned them around. Then he connected the LM to the CM, and disconnected the LM from the Saturn V. The rocket was then jettisoned into space. This all occurred about three hours into the mission. The rest of the day went pretty well, along with the next day.

Jump to April 13th, 1970. It was the third day of the mission, and things were about to heat up. The crew had just done a forty-nine minute broadcast for everyone back on Earth. After the broadcast, Haise and Lovell were cleaning up in Aquarius. Jack Swigert was in Odyssey when a command was received from NASA to stir the cryo tanks. Swigert went to do as NASA said and stir the tanks, but the whole craft was shaken. The crew thought they were hit by a meteorite. The crew's first reaction to this bang was to close the hatch between the CM and the LM. Jim Lovell looked out the window only to see that some sort of gas was spilling out from the ship; it was the oxygen. There had been an explosion. An oxygen tank on the SM had exploded. There were two oxygen tanks and one hydrogen tank. The oxygen in tank number two was completely gone, and the oxygen in tank number one was draining. The explosion happened in tank two, but it had also ruptured tank one. However, another conflict was arising. Not only had the explosion caused the oxygen tanks to leak, but it had also destroyed two of the service module's three fuel cells. (Cells one and three were ruined.) The fuel cells gave the ship electricity. The explosion was titled as a main B bus undervolt.⁸

⁷ Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

⁸ Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

What would they do? Apollo 13 now only had half of an oxygen tank and one fuel cell left. They would have to conserve everything to the best of their ability. Once the explosion occurred, everyone back at Mission Control and the crew knew that there would be no moon landing for Apollo 13. They were stuck. The crew was about 45,000 miles from the moon, and about 225,000 miles from Earth.⁹ To start, the crew shut down most of the power they were using in the spacecraft. This would help to conserve the power for later when they would need it, like during re-entry. They would need a new plan, too. They couldn't just turn around and go back, so they would need to swing around the moon and return home. The LM had other supplies on it including more oxygen. Instead of landing the LM on the moon, the crew would use it as a "lifeboat", and also as a way to get around the moon.

Back in Houston, everyone at Mission Control was in panic. They had never lost a man in space before, and they weren't going to now. Mission Control called engineers and technicians that worked on and built the Apollo 13 spacecraft to come in and help figure out a new plan. They also brought in men to test out different trajectory plans in the flight simulators. Their new trajectory plan was to send the crew around the moon, in order to "slingshot" them back toward Earth. The crew would have to ration everything they had whether it was the power on the spacecraft or the crew's water supply. Every day, each man was only allowed to drink six ounces of water. The leaking oxygen was pushing Apollo 13 off course.¹⁰ Because of this, a course correction burn was needed. This would hopefully help to get them back on course. April 13th was the day of the first course correction burn. During the burn,

⁹ Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

¹⁰ Cole, Michael D. *Apollo 13: Space Emergency*. Enslow Publishers, 1995.

Lovell looked through a telescope to see where they were going. Haise was in charge of starting and stopping the engine, and Swigert watched the clock to time the burn.

April 14th, 1970 was a very busy and long day for Apollo 13's crew and Mission Control team. The world had now heard about the terrible tragedy that had struck Apollo 13. People were very scared for the men who were so far away from Earth. They felt personally for the crew, and hoped and prayed that everything would go well for them. People thought "How?", "What?", "Why?", and "What a tragedy".¹¹ When Apollo 13's journey started, the media may not have been very interested in the mission, but they were now. On Earth, thousands of people gathered around their televisions to watch the fate of the crew. It was a time when the United States was really brought together as one. In space, however, the crew had yet more problems to solve. Since they were limited on oxygen, they needed to try and save it. There was carbon dioxide polluting the air that needed to be filtered out, but there was a conflict. Both Odyssey and Aquarius had hydroxide canisters meant for cleaning the air, but some of them were round and some of them were square. This meant that in order to prevent too much carbon dioxide from getting around the spacecraft, and potentially suffocating the crew, Mission Control would have to find a way to literally fit a square peg in a round hole. They could only use materials that the crew had on board to try and make the filter. Once they figured out a solution, they relayed it back to the crew, and they put it together in space. April 14th also brought another course correction burn. As soon as this was done, however, the power had to be shut down.

April 15th, 1970 was a big day in moving forward with the mission. The crew members were anxious to get back to their families. This was the day that they would "slingshot" around the moon. In order to go around the moon, they used the LM's landing engine as a booster,

¹¹ Miles-Kroening, Kylie, and Tommy Miles. "Apollo 13 Rescue Crew Member." 5 Nov. 2017.

which is not what it was supposed to be used for. While they passed behind the moon, they were cut off from Mission Control. As Apollo 13 passed around the moon, the men were disappointed. They were disappointed because they had come so close and worked so hard to land on the moon, and yet there they were, passing around it. Besides disappointment, the men were facing harsh temperatures. Because they had to shut down all the power in order to save it, the temperature had dropped to about fifty degrees fahrenheit. The men were very cold and tired. At night they had some interesting sleeping positions, just because they were so cold.

On April 16th, the crew was on their way home; they had a chance of surviving. Since the temperature was so cold, condensation had started to form on all of the controls in the CM. Jack Swigert was nervous that things would not power back up because they were so wet, and they could have short circuited or froze. The controls did indeed power back up, despite the crew's fears, and it was time for another correction burn. After that, the spacecraft would be shut down again to save as much power as possible for re-entry. The crew had started to charge the re-entry battery. It would take fifteen hours to charge. As the crew was nearing home, Jack Swigert turned on the power of the spacecraft. He then switched the power from Aquarius to the re-entry battery on Odyssey. Apollo 13 would be home ten hours earlier than if they were on the original return trip.¹²

On April 17th, everyone working on the Apollo 13 mission only had one obstacle left: re-entry. The CM's battery was all charged and ready to go. There would be one more course correction burn. This would be the last burn to get the crew onto a straight course home. After

¹² Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

the burn the crew was almost ready for re-entry, but first they would have to drop parts of their spacecraft. Since the only part of the ship with a heat shield was the CM, the crew would have to jettison the LM and the SM. The lunar module had served the crew very well as a lifeboat, so they were sad that they were not able to land on the moon with it. As Apollo 13 dropped the service module into space, the crew withdrew their cameras as fast as they could to take as many pictures as possible before the SM was obstructed from view. "There's one whole side of that spacecraft missing!"¹³ said Jim Lovell. This was the first time the crew had seen all the damage done by the oxygen tank explosion that had prevented them from landing on the moon. After the SM had disappeared, it was time to release the LM. As they dropped the lunar module, Mission Control said "Farewell, Aquarius. And we thank you."¹⁴ Jim Lovell also said, "She was a good ship."¹⁵ Now everything was set for re-entry.

As Apollo 13 descended into re-entry, all the condensation that had built up all over the CM was now drenching the crew. When they got far enough into Earth's atmosphere, they lost their communications with Mission Control because of all the heat that was building up outside of Odyssey. Mission Control started counting. Re-entries usually took around three minutes.¹⁶ One minute went by, then two, then three, but Apollo 13 still hadn't answered. Joe Kerwin (the capsule communicator assigned during that part of the mission) was asking multiple times if Apollo 13 was there. Finally, more than three minutes after re-entry had begun, Jack Swigert answered Kerwin. Apollo 13 was alright! They splashed down into the South Pacific Ocean,

¹³ Cole, Michael D. *Apollo 13: Space Emergency*. Enslow Publishers, 1995.

¹⁴ Cole, Michael D. *Apollo 13: Space Emergency*. Enslow Publishers, 1995.

¹⁵ Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

¹⁶ Cole, Michael D. *Apollo 13: Space Emergency*. Enslow Publishers, 1995.

where they were recovered by a team of pararescuemen. They were then flown by helicopter to the U.S.S. Iwo Jima, which sailed them to Hawaii.¹⁷ There they were reunited with their families.

Jim Lovell, Fred Haise, and Jack Swigert were all awarded the Presidential Medal of Freedom.¹⁸ The men were honored with parades and would forever be known as heros. However, Apollo 13's crisis made America question NASA and the space program. Would they ever send anyone else to the moon? Was this NASA's breakthrough in proving that they really could accomplish anything? (In total there were 17 Apollo missions.) Apollo 13 matters in American history because it was a failed space mission that turned into a huge conflict, helped NASA compromise together on how to bring the crew home safely, and improved future space missions. Apollo 13 led to new and improved spacecraft. This mission also helped NASA to be more precise in their preflight checks to make sure that everything would go well. Everyone at Mission Control compromised and worked together to fix Apollo 13's problem. It was a successful failure.

¹⁷ "Apollo 13." Britannica School, Encyclopædia Britannica, 20 Dec. 2016.

¹⁸ Cole, Michael D. Apollo 13: Space Emergency. Enslow Publishers, 1995.

Appendix A



This is a diagram of the Apollo 13 spacecraft. The labeled portions include the SM, the CM, and

the LM.

Appendix B



https://www.nasa.gov/multimedia/imagegallery/image_feature_2222.html

The crew of Apollo 13 (from left to right): Jim Lovell, Jack Swigert, and Fred Haise.





https://spaceflight.nasa.gov/gallery/images/apollo/apollo13/html/as13-59-8500a.html

A picture the crew took of the damaged SM shortly after it was jettisoned. Notice the

right side of the module, which is completely missing its paneling due to the explosion.

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