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The Apollo 1 Fire

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1.0 INTRODUCTION

Most of us remember the Space Shuttle Columbia and Challenger disasters. These were not the first in the space program. Most of the beginning of the space program was adapting lessons learned in the past and then making changes when you had a failure. A failure is when something does not function as was intended.

The Apollo Program was in progress during my childhood, but the Apollo 1 accident happened just after I was born. I had only heard of the fire, yet never paid much attention to it until I became a licensed professional engineer, and wanted to learn from mistakes as to prevent them from happening again. We should always try to learn from these disasters as they have the worst consequences and the ones we definitely want to prevent in the future.

The main goal of the Apollo Project was to take a man to the moon and bring him back to Earth safely. As with Project Mercury, it was conducted in stages. On January 27, 1967, a preflight test was being conducted for the first crewed flight that was scheduled to launch on February 21, 1967. Like Project Mercury, there were failures that required analysis and re-engineering. Sometimes the failures led to loss of life as in Apollo 1.

Project Apollo's main goal was landing Americans on the moon and returning them safely to Earth. Other goals of the project included:

- Establishing the technology to meet other national interests in space
- Achieving preeminence in space for the United States
- Carrying out a program of scientific exploration of the Moon
- Developing human capability to work in the lunar environment

2.0 THE CREW

The Apollo 204 (AS-204) mission eventually became known as Apollo 1. The crew of three astronauts consisted of Virgil I. Grissom, Edward H. White, and Roger B. Chafee. All three were military officers and had worked on previous space missions. The photo was taken by NASA during training in January 1967 in front of the launch pad at Launch Complex 34. All three would die in the fire on the structure behind them.



Figure 1 The crew members of Apollo 1

2.1. Virgil Ivan Grissom

Virgil Ivan “Gus” Grissom was born April 3, 1926 in Mitchell, Indiana. He received his Bachelor of Science in Mechanical Engineering from Purdue University in 1950. He was a United States Air Force pilot and was one of the original Mercury astronauts. He held the rank of Lieutenant Colonel (O-5) in the Air Force. He had 4600 flight hours, of which 3500 was in jet aircraft. He was the command pilot for the AS-204 mission. He went into space during Project Mercury, as the second American into space, and Project Gemini. He is one of the Mercury astronauts depicted in the movie “The Right Stuff.” Lt Col Grissom was very outspoken as a member of Project Mercury and this continued into the Apollo Program. He was very critical of aspects of the Apollo Program. He had concerns about the Apollo spacecraft and he voiced them.

A little discussion should be made of Lt Col Grissom. He was in the space program from the beginning, being among the first group of astronauts selected for Project Mercury. He made the second successful flight in the program in the Liberty Bell 7 spacecraft. After splashdown, the explosive bolts blew his hatch prematurely. He was able to escape the capsule and it sank in the Atlantic Ocean. Questions remained as to whether he panicked and blew the hatch before the planned time, or if there was another reason the detonation of the bolts. It was later determined that he did not have the injuries that would have been sustained in manually setting off and that the explosive bolts were either defective, set off by static electricity, or a combination of the two. The hatch mechanism likely used mercury fulminate, which is highly sensitive to electric charge.

It was having Lt Col Grissom’s Liberty Bell flight, where the capsule was lost that engineers opted to omit the explosive bolts on the hatch in the Apollo spacecraft. A manual hatch was installed instead. This hatch could not be opened by the flight crew.

2.2. Edward Higgins White

Edward Higgins White II was the son of a military officer. He was born on November 14, 1930 in San Antonio, Texas. He graduated from the United States Military Academy (USMA) at West Point in 1952 with a Bachelor of Science. He received a Master of Science in Aeronautical Engineering from the University of Michigan in 1959. He was a United States Air Force Officer holding the rank of Lieutenant Colonel (O-5). He had 3000 flight hours, of which 2200 was in jet aircraft. He was among the second group of astronauts selected, which was in 1962 for Project Gemini. He went into space during Project Gemini and was the first American astronaut to perform as spacewalk (also known as an EVA). He was the Senior Pilot for the AS-204 mission.

2.3. Roger Bruce Chaffee

Roger Bruce Chaffee was the rookie. This was to be his first time in space, although he worked a ground assignment for Project Gemini. He was born on February 15, 1935 in Grand Rapids, Michigan. He received a Bachelor of Science in Aeronautical Engineering from Purdue in 1957. He was a Navy Pilot holding the rank of Lieutenant Commander (O-4). The equivalent of Major in the Air Force. He had 2300 flight hours, of which 2000 was in jet aircraft. He was selected in the third group of astronauts in 1963, which was for Project Apollo. He was the Pilot, which was the lowest ranking crew member.

3.0 GOALS OF THE MISSION

The AS-204 mission was the first crewed mission of the Apollo program. Apollo, like Project Mercury, was progressive. The objective on Friday January 27, 1967 was to carry out a “Plugs-Out Test”. A “Plugs-Out Test” was a pre-launch test that was developed in Project Mercury to test the spacecraft systems. The test was to perform a simulated countdown to launch. The goals of the AS-204 mission were to test the launch facility, tracking and control systems, and performance of the Saturn launch vehicle and second stage booster. The mission was to last for two weeks.

4.0 LAUNCH COMPLEX 34

Cape Canaveral Launch Complex 34 was the site of the Apollo program launches until the Apollo 7 launch on October 11, 1968. The first flight from this complex was SA-1 on October 27, 1961. Today, Launch Complex 34 is rumored to be haunted.



Figure 2 Launch Complex 34

Below is a NASA overview sketch of Launch Complex 34, where the Plugs-Out test was conducted on January 27, 1967 before the scheduled launch in February.

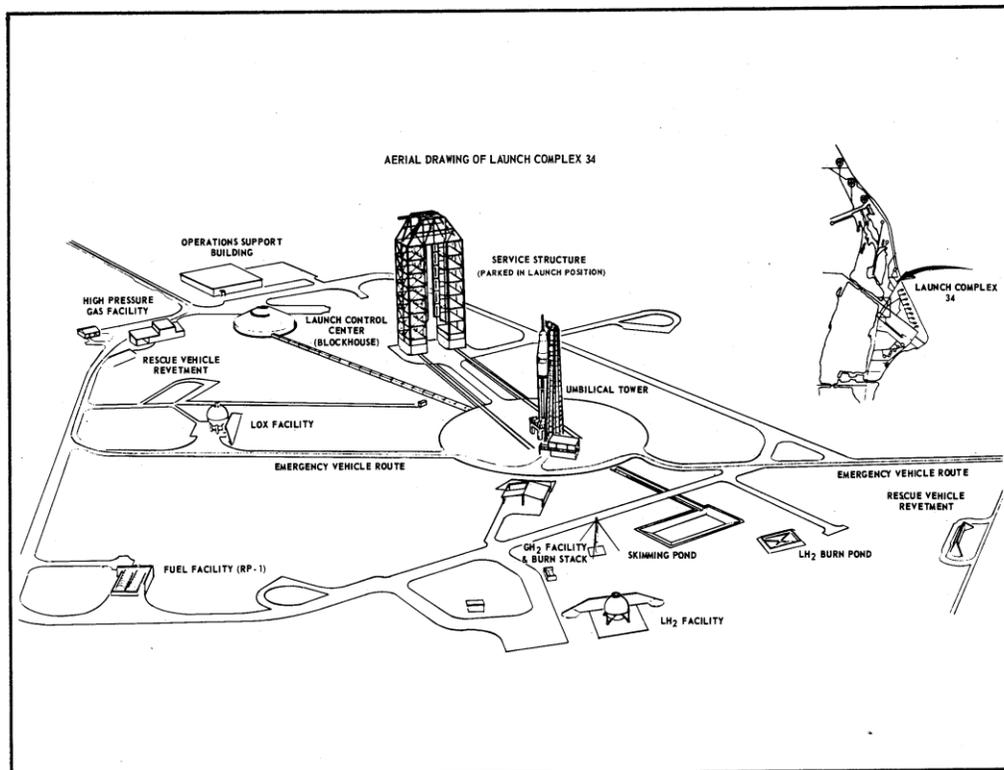


Figure 3 NASA's sketch of Launch Complex 34

The Service Structure, as shown in the sketch of Launch Complex 34 is shown in the launch position. At the time of the Plugs-Out test, the service was structure at the launch pad. It is moved into the parked position on the sketch before launch.

The next NASA sketch shown below, gives the launch vehicle with the service structure, as it would have been during the Plugs-Out Test. At launch the service structure is moved, leaving the launch vehicle and umbilical tower.

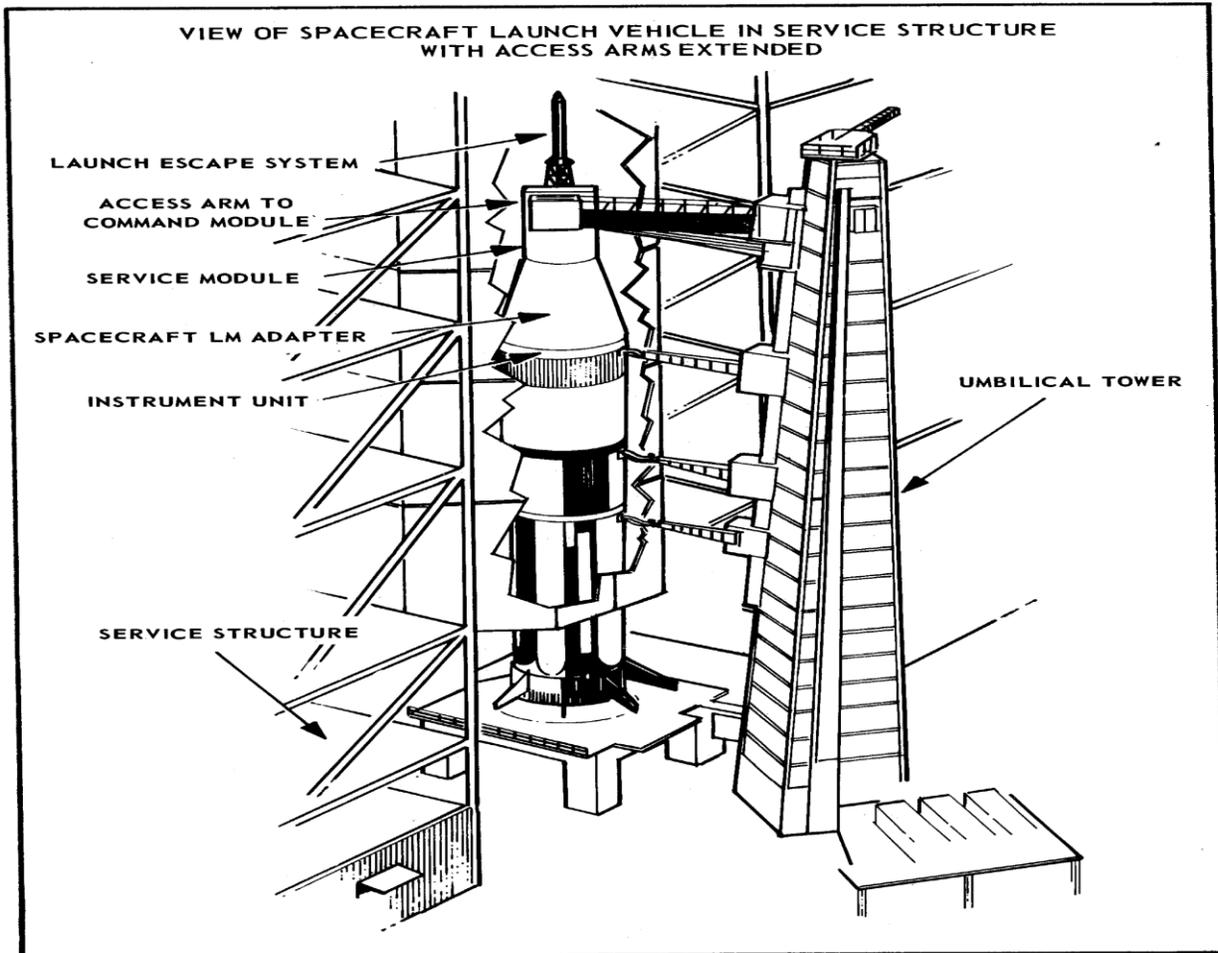


Figure 4 Sketch of the service structure

The egress route for the astronauts was attached to the umbilical tower. This was to provide an escape route for the astronauts in the case of an emergency before launch. The egress route is shown in the NASA sketch below. The “White Room” surrounds the hatch and is where the crew would step immediately upon egress (exit).

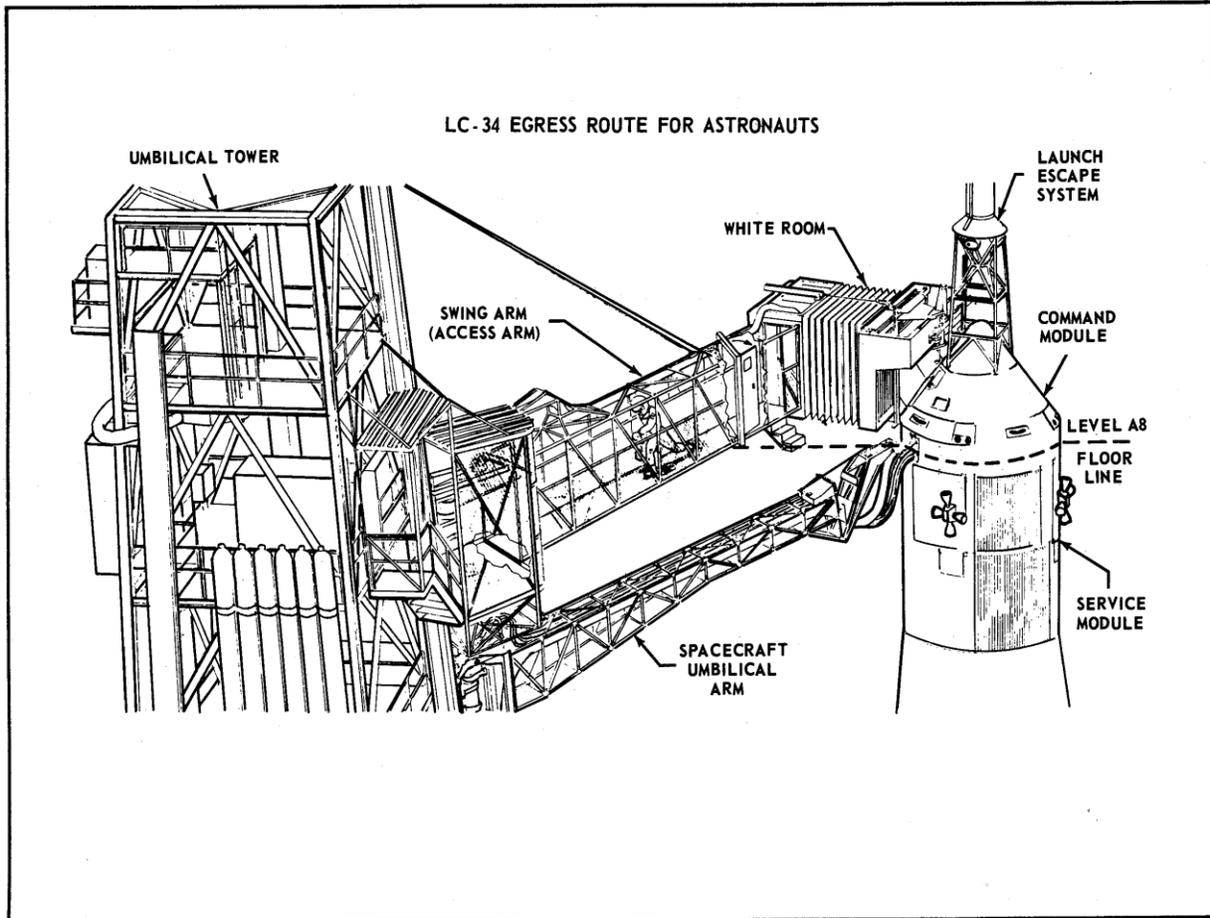


Figure 5 Sketch of the egress route

4.1. The Launch Vehicle

The AS-204 mission launch vehicle was the Saturn 1B rocket. This launch vehicle was made for the Apollo Program. This was quite different from Project Mercury that started the space program adapting a missile into a launch vehicle.



Figure 6 AS-204 Launch Vehicle

4.2. The Spacecraft

The spacecraft (Command Module) was designated as Spacecraft 012. It was built by North American Aviation, Inc. This was a different contractor than McDonnell Aircraft Corporation, the company that built the spacecraft for Project Mercury. It arrived at Kennedy Space Center on August 26, 1966. After mating with the service module (considered as part of the spacecraft), combined systems tests were conducted. There were several malfunctions noted and some of the corrections were put off until a later date.



Figure 7 Spacecraft Command Module

4.3. The Command and Service Module

The Service Module in the Apollo missions was a cylindrical structure that held critical subsystems and supplies. The Service Module was connected to the Command Module from launch until just before reentry into the earth's atmosphere. Together, the Command Module and the Service Module were the spacecraft. The command module arrived at the Kennedy Space Center on August 26, 1966. It was mated with the service module and tested in September of 1966, finishing the tests on October 1st. Several problems were noted during the tests. The design was certified by NASA in October 1966, pending the resolution of a few open items.

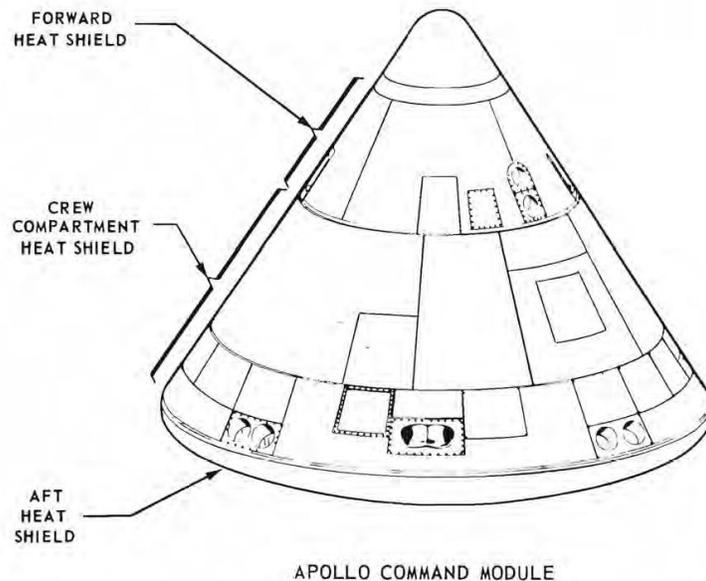
Also in October of 1966, the first manned test on the spacecraft was conducted. The goal of the test was to verify the total spacecraft system operation at sea level pressure. After the sea level test was conducted, an unmanned test was conducted at altitude pressure before conducting a manned test under this condition. The manned test, conducted on October 18, 1966 reached a simulated altitude of 13,000 ft before being discontinued. It was discontinued due to a transistor failure in an inverter. The inverter was replaced and the test was attempted a few days later using the backup crew. The second test failed due to an oxygen system regulator that was determined to have a design deficiency in a water/ethylene glycol evaporator.

During the same period, a propellant tank ruptured in one of the service modules for another spacecraft (Spacecraft 017). It was decided to test the tanks on Spacecraft 012. A water/ethylene glycol leak developed and it was returned to the factory again to examine the leakage problem.

During this period, a review was conducted that closed out most of the open items from previous design certification reviews. The final unmanned then manned tests in December of 1966 were successful. All spacecraft systems were functioning normally during these tests.

An item to note from the tests, is that the altitude chamber tests had the Command Module pressurized with pure oxygen four times with pressures above 14.7 psia (atmospheric). The total time of the pressurization was 6.25 hours. This is significant to note because it was 2.5 times longer than the Command Module was pressurized with oxygen during the Plugs-Out Test and fire that occurred.

After the tests, the Command Module was removed from the altitude chamber and mated to the launch vehicle at Launch Complex 34. After equipment installation and testing, the system was readied for the January 27, 1967 Plugs-Out Test. Below is a NASA sketch of the Command Module.



5.0 RELATION TO THE FIRE

There were several events that occurred during testing that may have a relation to the fire. These are possibly related to the water/glycol (coolant) spillage or leakage from the Environmental Control System. The water/glycol coming into contact with electrical connectors could cause corrosion of the connectors. Also, dried water/glycol on wiring insulation can leave an electrically conductive and combustible residue. There were six instances where water/glycol leakage or spillage occurred. There was only one instance that wetting of the connectors and wiring was detected. Actions were taken to clean the connectors and wiring on this occasion. It is possible that there was inadequate cleaning or undetected wetting occurred.

After the fire, small amounts of water/glycol were found in the Command Module. The investigation into the fire speculated that this could have been due to a water/glycol line breakage that occurred during the fire. Water/glycol and the residue may have contributed to the spread of the fire.

The amount of re-engineering required was greater than the first Gemini spacecraft. The reason may be that it was far more complex. We also think of risk and safety in a different way today than they did in the 1960s.

5.1. Plugs-Out Test

The Plugs-Out Test was to be conducted to demonstrate all of the Spacecraft 012 systems and operational procedures capabilities in a simulated launch. The Plugs-Out Test was to be a dress rehearsal for the actual launch. This included system verification, a countdown, and a flight simulation. The test included communications and instrumentation systems. The specific objectives for the test on Spacecraft 012 were stated in the Final Procedure Document. The first objective was to verify the spacecraft/launch vehicle systems operation with all umbilical and Ground Support equipment disconnected. The second objective was to verify that there was no electrical interference at the time of umbilical disconnect. The third objective was to practice astronaut emergency egress (exit) procedures at the conclusion of the test.

The test procedure was written by North American Aviation, Inc. The emergency egress practice was not part of the original procedure, which was written in July 1966. It was added at the request of the flight crew because a test subsequent to the Plugs-Out Test was to include a fully fueled vehicle. A test using a fully fueled vehicle was considered hazardous, yet this test (that killed three astronauts) was not considered hazardous.

The NASA reports of the fire, rescue efforts, and the subsequent investigation use Greenwich Mean Time (GMT). GMT is used in aviation as the time at zero degrees' longitude and uses a 24-hour cycle. GMT is sometimes referred to as "Zulu time". To give a context, 7:00 AM local time on the date of the test was 12:00 GMT.

The Plugs-Out Test began on January 27, 1967 at 7:55 AM local time (12:55 GMT) with power being applied to the spacecraft. The flight crew entered Spacecraft 012 at 18:00 GMT, after initial verification tests of system operation. The Command Pilot entered first, followed by the Pilot and Senior Pilot. The Command Pilot (Grissom) noted an odor and the count was held, while an oxygen sample was taken from the Spacecraft Environmental Control System. His description of the smell was like sour buttermilk. The count resumed at 19:42 GMT with hatch installation, and purging the cabin with oxygen began at 19:45 GMT. The count was held again for a few minutes, for troubleshooting when communications difficulties were encountered. One of the communications problems encountered was an open mic. The countdown was held at T-10 minutes (at approximately 23:20 GMT) to try to troubleshoot the communications problems. The T-10 point was the transfer of the simulated fuel cell power.

The communications problems left Lt Col Grissom frustrated, which was demonstrated when he made the remark “How are we going to get to the moon if we can’t talk between two or three buildings?” The statement was heard on a recording from the spacecraft.

There were no events that appeared to be related to the fire from the start of the T-10 hold until about 23:30 GMT. This was the time they were troubleshooting the communications problems. After this period, there were no transmissions until the one reporting the fire at 23:31:04 GMT. There were indications of crew movement that began about 30 seconds before the report of the fire. There was no indication of the reason for the movement as shown in the investigation. Any significant movement of the crew resulted in minor motion of the Command Module and is detected by the Guidance and Navigation System. The system cannot determine the type of movement being made by the crew. Movement was detected at 23:31:00 GMT until loss of data transmission that occurred during the fire. Movement is also detected by increases in oxygen flow rates. The flow rate showed a gradual rise at 23:30:24 GMT that reached the limit of the sensor at 23:30:59 GMT.

There was also a variation in the signal output from the gas chromatograph cable. The gas chromatograph was not installed in the Command Module, so the cable was acting as an antenna. This means that changes in the electromagnetic fields within the spaceship are sensed by the cable when the cable is approached, touched, moved or there are voltage fluctuations in the equipment within the spacecraft. There was a variation at 23:30:54.8 GMT. NASA speculated that the variation occurred because the cable was touched or approached by the crew, due to lack of evidence of a voltage transient.

A few seconds later, at 23:30:54.8 GMT there was a significant voltage transient. NASA records showed a surge in the AC Bus 2 voltage. This was considered a significant event. The AC Bus was a three-phase bus operating at 400 Hz. There were several other parameters that showed anomalies at this time. One instance was a 1.7 second dropout in the signal from the C-band decoder and transmitter outputs, a brief dropout of the VHF-FM carrier, a fluctuation in the rotation controller null outputs, and the gas chromatograph cable signal.

5.2. Report of the Fire

The first verbal indication of the fire came from the crew at 23:31:04.7 GMT with an exclamatory remark by one of the astronauts. Analysis indicates the statement was made by White, stating “Hey Flames”. He then said “Hey! We’ve got a fire in the cockpit”. His second transmission was cut off. Chaffee is heard a few seconds later stating “We have a bad fire! We’re burning up!” A scream is then heard. The emergency procedures dictated for the Senior Pilot to unlatch and remove the hatch. The Senior Pilot, White, occupied the center couch. Indications are that Grissom initiated the hatch-opening procedure and was reaching for the inner hatch handle. Witnesses observed the television picture of the Command Module hatch window. There were personnel stationed on the adjustable level that was adjacent to the command module that responded to the report of the fire. The Pad Leader ordered the start of crew egress procedures to get them out of the Command Module. The technicians then started towards the

White Room (where the crew was to enter upon egress from the Command Module) surrounding the hatch, when the Command Module ruptured.

All transmissions of voice and data stopped by 23:31.22.4 GMT, which was approximately three seconds after the Command Module ruptured. The witnesses monitoring the television screen showing the hatch window reported that the flame spread from the left to right side of the Command Module, and then covered the entire area of visibility. A NASA summary timeline is shown below.

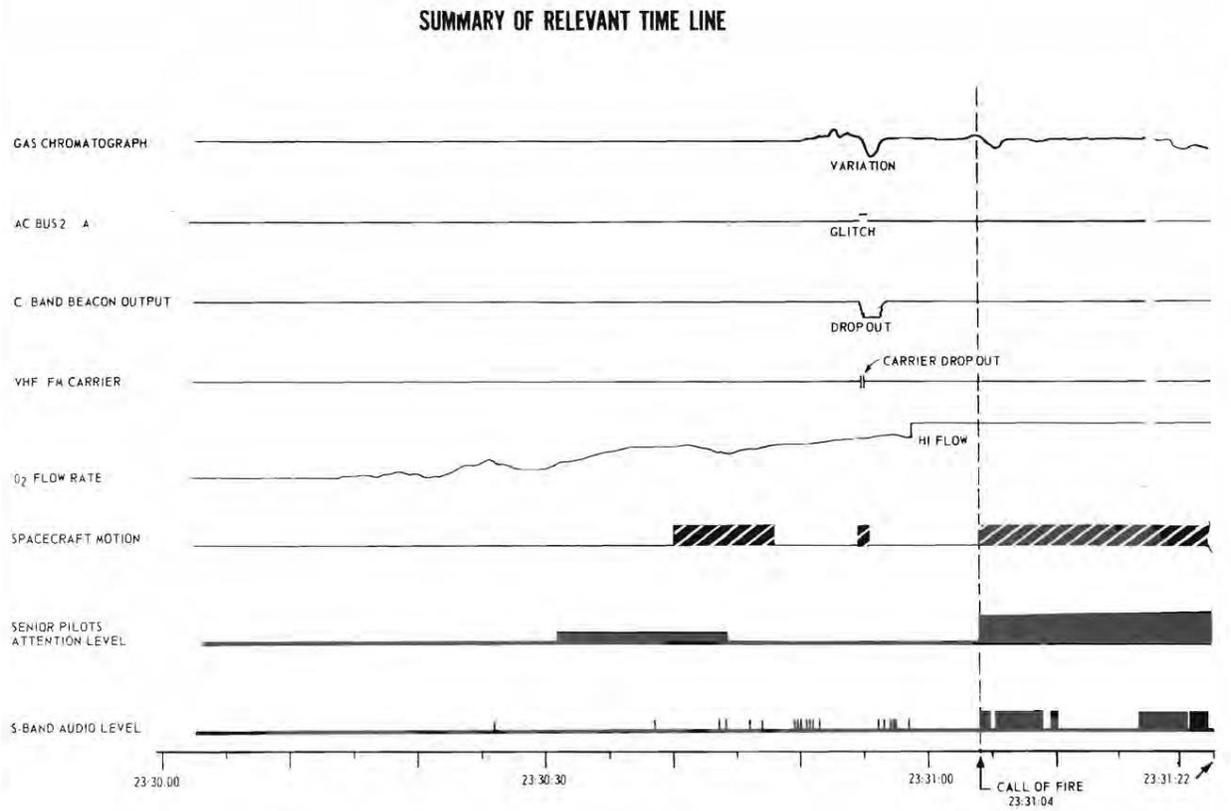


Figure 8 NASA summary timeline

After the Command Module ruptured, flames and gases spread through the access hatches and into two levels of the service structure. Combustible material was ignited on the service structure, impeding rescue efforts. Pad personnel fled the immediate area, believing that the Command Module exploded or was about to explode, due to the sound of the Command Module rupturing. Personnel on the level next to the Command Module evacuated the level. They then returned with fire extinguishers to begin rescue efforts and assist in fighting the fires.

It was approximately one minute and thirty seconds after the crew first reported the fire that the Pad Leader, Donald Babbitt, reported that attempts to remove the hatches had been started on his orders. Mr. Babbitt, reported that he heard Mr. Chafee say "There is a fire in here," He then ordered the mechanical lead man, Mr. Gleaves, to "Get them out of there". It was just after that

the Command Module ruptured. The Pad Leader had entered the White Room a couple of times, but retreated to breathable air. It was estimated that hatch removal efforts began one minute after the fire was first reported by the crew.

The Command Module had three hatches installed. The outermost hatch was called the boost protective cover (BPC). It was part of the cover that shielded the Command Module during launch. This hatch is jettisoned before reaching orbit. This hatch was not fully latched due to the test requirements, but difficulty opening it occurred during rescue attempts. The thick smoke that filled the White Room further complicated opening the hatch.

The middle hatch is called the ablative hatch and becomes the outermost hatch after the boost protective cover is jettisoned. The inner hatch seals the pressure vessel wall of the Command Module and is the first opened by the crew when they egress unaided. These hatches were in place and latched after crew ingress (entry).

The rescue attempts were able to remove the middle hatch. The inner hatch opening revealed intense heat and smoke coming from inside the Command Module. The two outer hatches were opened approximately five minutes of the first report of the fire or at 23:36 GMT. The visibility inside the Command Module was poor.

It should be noted that the inner hatch was held shut with the pressure higher inside the Command Module. During Project Mercury, explosive bolts were added to the escape hatch for egress during an emergency. These were added at the insistence of Grissom. They were removed after Grissom's Project Mercury flight where the spacecraft was lost after splashdown.

The crew could be seen on the couches after fire personnel arrived. The initial observations revealed the Command Pilot (Grissom) was laying on his back on the floor of the Command Module. The Senior Pilot was lying transversely across the Command Module. The Pilot was found on his back on his couch.

The investigation determined that the Command Pilot left his couch (left hand couch) to avoid the initial fire. The Senior Pilot remained on his couch (center couch) as for a planned emergency egress and attempted to open the hatch for an emergency egress. The Pilot, Chaffee, remained on his couch (right hand couch) to maintain communications until the hatch could be opened by the Senior Pilot. A slightly higher pressure inside the Command Module than outside made the inner hatch impossible to open due to the resulting force on the hatch.

The Pad Leader was relieved after the firemen arrived, to be treated for smoke inhalation. He told the doctors the crew was deceased, but did not broadcast on the communication channels. Crew removal efforts ceased until the Command Module had been adequately ventilated.

They took photographs as part of the investigation and resumed removal efforts at 05:30 GMT on January 28, 1967. Removal of the crew took 90 minutes and completed seven and one half hours after the accident.

6.0 THE INVESTIGATION

After the accident, began the investigation to determine what happened. The Apollo 204 Review Board was established on January 27, 1967 through oral instructions to investigate the cause of the fire. These instructions were from the Deputy Administrator, Robert Seamans. The investigation was conducted by NASA. Today, outside agencies, including the FBI would be involved in the investigation. In the case of the AS-204 fire, the NASA Administrator received permission from President Johnson to conduct an internal investigation.

The source of the ignition was never identified. They did determine that it likely started near the floor at Lt Col Grissom’s location in the spacecraft. It was determined that the crew died of cardiac arrest due to a high concentration of carbon monoxide.

The fire did lead to changes to make space flight safe enough for the United States to land on the moon in 1969 with the Apollo 11 flight. The hatch was replaced with a hatch that would open outward quickly, to facilitate an emergency egress.

7.0 NASA TIMELINE OF MAJOR EVENTS IN THE APOLLO 1 FIRE

Event	Date	GMT Time
Plugs-Out Test initiated when power applied to spacecraft.	27 Jan 1967	12:55
Following completion of initial verification tests of system operation, command pilot entered spacecraft, followed by pilot and senior pilot.		18:00
Count held when command pilot noted odor (sour buttermilk) in spacecraft environmental control system suit oxygen. Sample taken.		18:20
Count resumed with hatch installation.		19:42
Cabin purge with oxygen begins.		19:45
Open microphone first noted by test crew.		22:25
Count held while communication difficulties checked. Various final countdown functions performed during hold as communications permitted.		22:40
From this time until about 23:53 GMT, flight crew interchanged equipment related to communications systems in effort to isolate communications problem. During troubleshooting period, problems developed with ability of various ground stations to communicate with one another and with crew.		22:45
Final countdown functions up to transfer to simulated fuel cell power completed and count held at T-10 minutes pending resolution of communications problems. For next 10 minutes, no events related to fire. Major activity was routine troubleshooting of communications problem. All other systems operated normally during this period.		23:20
First indication by either cabin pressure or battery compartment sensors of a pressure increase.		23:21:11
Command pilot (Grissom) live microphone transmitted brushing and tapping noises, indicative of movement. Noises similar to those		

transmitted earlier in test by live microphone when command pilot was known to be moving.		23:30
No voice transmissions from spacecraft from this time until transmission reporting fire.		23:30:14
Slight increase in pulse and respiratory rate noted from senior pilot (White).		23:30:21
Data from guidance and navigation system indicated undetermined type of crew movement. Gradual rise in oxygen flow rate to crew suits began, indicating movement. Earlier in Plugs Out Integrated Test, crew reported that an unspecified movement caused increased flow rate.		23:30:24
Senior pilot's electrocardiogram indicated muscular activity for several seconds		23:30:30
Additional electrocardiogram indications from senior pilot. Data show increased activity but were not indicative of alarm type of response. More intense crew activity sensed by guidance and navigation system.		23:30:39
Crew movement ended.		23:30:44
All of senior pilot's biomedical parameters reverted to "rest" level.		23:30:45
Variation in signal output from gas chromatograph.		23:30:50
Significant voltage transient recorded.		23:30:54.8
Command pilot microphone noises ended.		23:30:58.6
Oxygen flow rate reached limit of sensor.		23:30:59
Additional spacecraft movement noted		23:31:00
First voice transmission ended.		23:31:10
Fire broke from its point of origin. Evidence suggests a wall of flames extended along left wall of module, preventing command pilot, occupying left couch, from reaching valve which would vent command module to outside atmosphere. Original flames rose vertically and spread out across cabin ceiling. Scattering of firebrands of molten burning nylon contributed to spread of flames. It was estimated that opening valve would have delayed command module rupture by less than one second.		23:31:12
First verbal indication of fire reported by crew		23:31:04.7
Cabin pressure exceeded range of transducers, 17 pounds per square inch absolute (psia) for cabin and 21 psia for battery compartment transducers. Rupture and resulting jet of hot gases caused extensive damage to exterior.		23:31:16
Beginning of final voice transmission from crew. Entire transmission garbled. Sounded like, "They're fighting a bad fire—let's get out. Open 'er up." Or, "We've got a bad fire—let's get out. We're burning up." Or, "I'm reporting a bad fire. I'm getting out." Transmission ended with cry of pain, perhaps from pilot.		23:31:16.8

Command module ruptured, start of second stage of fire. First stage marked by rapid temperature rise and increase in cabin pressure. Flames had moved rapidly from point of ignition, traveling along net debris traps installed to prevent items from dropping into equipment areas. At same time, Velcro strips positioned near ignition point also burned.		23:31:19.4
End of final voice transmission.		23:31:21.8
All spacecraft transmissions ended. Television monitors showed flames spreading from left to right side of command module and shortly covered entire visible area. Telemetry loss made determination of precise times of subsequent occurrences impossible.		23:31:22.4
Third stage of fire characterized by greatest conflagration due to forced convection from outrush of gases through rupture in pressure vessel. Swirling flow scattered firebrands, spreading fire. Pressure in command module dropped to atmospheric pressure five or six seconds after rupture.		23:31:25
Command module atmosphere reached lethal stage, characterized by rapid production of high concentrations of carbon monoxide. Following loss of pressure, and with fire throughout crew compartment, remaining atmosphere quickly became deficient in oxygen and could not support continued combustion. Heavy smoke formed and large amounts of soot deposited on most spacecraft interior surfaces. Although oxygen leak extinguished most of fire, failed oxygen and water/glycol lines supplied oxygen and fuel to support localized fire that melted aft bulkhead and burned adjacent portions of inner surface of command module heat shield.		23:31:30
Fire apparatus and firefighting personnel dispatched.		23:32
Attempts to remove hatches.		23:32:04
Pad Leader (Donald Babbitt) reported that attempts had started to remove hatches.		23:32:34
Hatches opened, outer hatches removed. Resuscitation of crew determined to be impossible.		23:36
Pad leader (Babbitt) ascertained all hatches open, left White Room, proceeded a few feet along swing arm, donned headset and reported this fact.		23:36:31
Firefighters arrived at Level A-8. Positions of crew couches and crew could be perceived through smoke but only with great difficulty. Unsuccessful attempt to remove senior pilot from command module.		23:40
Doctors arrived.		23:43
Photographs taken, and removal efforts started.	28 Jan 1967	00:30
Removal of crew completed, about seven and one-half hours after accident.		07:00
Command module 014 shipped to KSC to develop disassembly techniques for selected components prior to their removal from command module 012.	01 Feb 1967	

Disassembly plan fully operational.	07 Feb 1967	
Command module moved to pyrotechnics installation building at KSC, where better working conditions were available.	17 Feb 1967	
Disassembly of command module completed.	27 Mar 1967	

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