



# America's Greatest Projects - Apollo Project - Part 1

An Online Continuing Education Course for Engineers

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## I. Tragedy and Death Before the First Apollo Flight

Everything seemed to be going well for the Apollo Project, the third in a series of space projects by the United States intended to place an American astronaut on the Moon before the end of the 1960's decade. Apollo 1, known at that time as AS (Apollo Saturn)-204 would be the first manned spaceflight of the Apollo program and would launch a few months after the flight of Gemini 12, which had occurred on 11 November 1966. Although Gemini 12 was a short duration flight, Pilot Buzz Aldrin had performed three extensive EVA's (Extra Vehicular Activities), proving that Astronauts could work for long periods of time outside the spacecraft.

The three U. S. Astronauts were in the Block 1 Command Service Module at the Kennedy Space Flight Center on Launch Pad Complex No. 34. They had been putting the CSM through a rigorous test in preparation for what would be their journey into outer space on 21 February 1967. The astronauts, Commander Gus Grissom, and Pilots Roger Chaffee and Ed White, outfitted in their shiny new spacesuits, had just about completed their pre-launch activities for the day.

Suddenly, a spark (believed to have come from a loose terminal connection) ignited a bundle of wires in the oxygen-saturated CSM, and the fire quickly spread throughout the module. Even though the CSM had two escape hatches (the three-part main hatch and a boost hatch), neither could be opened in less than ninety seconds and the new nylon spacesuits, rather than offering any type of fire protection, likely contributed to the deaths of the Astronauts. The fatal date of that tragic fire was **27 January 1967**.

### The Three Lives that Were Lost

On that tragic day in January of 1967, those killed in this fatal fire, the first to take the life of a U. S. astronaut during an actual spaceflight mission, were:

**Lt. Colonel Virgil "Gus: Grissom:** age 41, from Mitchell, Indiana with a BS in Mechanical Engineering from Purdue University. Grissom flew 100 combat missions in the Korean War and was a test pilot at the Wright-Patterson Air Force Base near Dayton Ohio. Selected as one of the first seven U. S. Astronauts in 1959, Grissom flew in the Mercury Project (MA-4) and became the second American in space. He was also the Command Pilot for Gemini 3, was the first of the corps of U. S. astronauts to fly in space twice, and might have become the first American to walk on the Moon if not for his untimely death.

**Lt. Colonel Edwin H. White:** age 36, from San Antonio, Texas, received a BS degree from the U. S. Military Academy, and later received his MS degree in Aeronautical Engineering from the University of Michigan. White spent three and a half years in West Germany, flying in the 22<sup>nd</sup>

Fighter Day Squadron in defense of our NATO allies. He earned his credentials as a test pilot at the Wright-Patterson Air Force Base, logging more than 2,200 hours in jet aircraft. He was a member of NASA's second Group of Nine Astronauts and quickly moved up the pecking order due to his knowledge and intellect. He was the Pilot on Gemini 4, which completed 66 Earth orbits, and became the first American to walk in space, for approximately 20 minutes. This accomplishment helped the United States overcome the Soviet Union's early lead in the Space Race.

**Lt. Commander Roger B. Chaffee:** age 32, from Grand Rapids, Michigan, received his BS in Aeronautical Engineering, also from Purdue University. A Naval Aviator, Chaffee flew over 100 missions to Guantanamo Bay during the time of the Cuban Missile Crisis brought on by the Soviet Union. Along with thirteen other pilots, Chaffee was selected to be an astronaut as part of NASA's Group 3 in 1963. Although he never flew in the Gemini program, he served as Capsule Communicator for both the Gemini 3 and Gemini 4 missions, being the only one allowed to communicate with the crew of those spaceflights directly. Chaffee finally received his first spaceflight assignment in 1966, which was to be on Apollo 1.

## **Investigation**

Following the fire, NASA immediately formed a Review Board that consisted of seven members and began meeting the next day after the fire. Included on the Board were such distinguished NASA personnel as Maxime Faget, the principal designer of the one-man and two-man capsules used in the Mercury Project and Project Gemini. Also named to the Board was Lt. Colonel Frank Borman, who had been selected by NASA in the second astronaut group and had set a fourteen-day spaceflight endurance record on Gemini 7. The Board was chaired by Dr. Floyd L. Thompson and was charged with the responsibility to review the evidence related to the fire and to recommend changes to reduce the hazards within the CSM as well as those inherent in the Apollo Program. The Board met almost daily, often twice daily, for two months following the fire. Both houses of the U.S. Congress conducted their own hearings in an attempt to oversee the Review Board's investigation.

**Dr. Floyd L. Thompson (1898–1976)** was the third Director of NASA Langley Research Center, serving in that capacity from 1960 to 1968. Born in Salem, Michigan, he served four years in the United States Navy following graduation from high school. After his military service, he entered the University of Michigan and was awarded a Bachelor of Science degree in Aeronautical Engineering in June 1926.

He was an outstanding Research Center leader during the challenging beginning of the crewed space flight era. He guided research leading to programs of international importance, including Project Mercury as well as the concept of erectable space vehicles which led to the development

of *Echo*, the world's first passive communications satellite. He was also responsible for the solid-fueled launch vehicle, Scout, which was used to propel a satellite into orbit.

He began his career at the NACA (National Advisory Committee Aeronautics) Langley Memorial Aeronautic Laboratory after graduation, where he specialized in flight instrumentation and operations, and pressure and loads measurements. Thompson progressed through various assignments to become Langley's Chief of Research, was appointed Associate Director in charge of all research, and became Director of Langley in May 1960. Thompson had been awarded honorary doctorate degrees for his outstanding career in the flight sciences and for his development of the space flight teams necessary for the Mercury Project and Project Gemini by both the University of Michigan and the College of William and Mary.

As the chairman of the Apollo 204 (later Apollo 1) Review Board, Thompson and his committee were tasked with determining the causes of the tragedy and the recommendations for preventing anything close to a similar occurrence in the future. Because of the critical nature of the fire and the politics of the Space Race, they first met on 28 January 1967 and usually twice daily thereafter to review proposed plans, to determine requirements for testing and analysis of the data, and to provide basic direction. Witnesses were interviewed and film and other evidence were thoroughly reviewed. Command Module 012, as it was known to the NASA Administration before it became forever known as part of Apollo 1, was taken apart at the launch complex. When the Review Board determined that tests had progressed to a point where the Command Module could be removed without disturbing the evidence, CM 012 was transferred to the Pyrotechnic Installation Building on 17 February 1967.

### **Time Was a Major Factor**

Command Module 014, originally scheduled to be flown as Apollo 7, had been shipped to the Kennedy Space Center on 01 February 1967 to establish exact location and condition of all components prior to the accident. CM 012 was painstakingly taken apart component by component and studied closely, with any and all components that showed evidence of abnormal fire effects being examined both internally and externally. Disassembly was completed two months after the fire by the end of March 1967.

In just slightly over two months from the time of the tragedy (can you just imagine how long that investigation would take today?), he and the Review Board presented their findings and recommendations to James E. Webb, NASA's Administrator, on 05 April 1967. Although nearly a dozen findings and recommendations were offered, some of them were redundant or inconclusive, but all of them were sincere and illustrated deep concern about astronaut safety as well as that of the entire NASA support staff.

Numerous witnesses were called to testify before the Review Board, nearly all of them NASA department heads and engineers, during the two-month investigation. One of the most compelling testimonies was given by **Dr. Joseph F. Shea**, at the time the head of the Apollo Spacecraft Program Office. A Bronx native, Dr. Shea received his Ph. D. in Engineering Mechanics from the University of Michigan. He went to work for NASA in 1961 and played a key role in shaping the course of the Apollo Program. He had been a leading proponent in NASA's decision which favored lunar orbit rendezvous and supported design and testing of the Saturn V rocket which would carry astronauts into outer space and to the Moon. Unfortunately for Dr. Shea, who was considered by many to be the top "systems engineer" of his time, he apparently became too personally and too deeply involved in the investigation. After urging his colleagues to move quickly with the investigation and to implement the necessary changes in order to put some distance between the USA and the Soviet Union regarding the "Space Race," he suffered a nervous breakdown. Subsequently, the stress of the tragedy caused NASA to replace him in late 1967, and he left NASA shortly thereafter.

A condensed synopsis of those findings and recommendations is listed below:

### **Finding 1:**

The CSM had a momentary power failure. Return of power quite likely caused an electrical arcing, possibly in more than one location.

### **Recommendation:**

A sub-committee listed the many fire hazards that were present at the instant that the fire erupted. However, there was no mention of backup or redundant power, shielding, grounding, surge protection or even fire suppression. They did identify the most probable location as the ECS (Environmental Control System) where the initial arcing occurred, and they did offer the statement that "No evidence was discovered that suggested sabotage." Many of the NASA engineers and astronauts were disappointed with this inconclusive determination.

### **Finding 2:**

The CSM contained many types and classes of combustible material in areas contiguous to possible ignition sources. That included notebooks, test reports, and other non-inflammable materials near the astronauts' couches. Tests were performed in the full oxygen environment to which the three astronauts had been subjected. This verified that the CSM test conditions were extremely hazardous.

