Apollo 1 (AS-204)—Lessons and Legacies

50 years later, what legacies live on today?

February 6, 2017

Presenter

Grier Wilt, Extravehicular Activity Flight Controller and Instructor

Presenter Organization

JSC Flight Operations Directorate

emerge

JOHNSON SPACE CENTER

APOLLO

FIFTY YEARS

This and previous presentations are archived at sma.nasa.gov

Apollo 1 Lessons and Legacies

Astronauts Gus Grissom, Ed White, and Roger Chaffee lost their lives January 27, 1967, during ground testing of the Apollo Command Module.

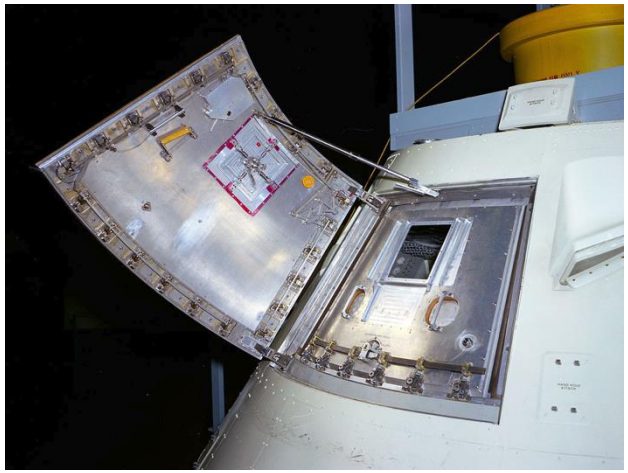
This year marks the first of many momentous events associated with the 50th anniversary of Project Apollo. Every event, from spectacular achievement to tragic failure, has taught us something. NASA's long history of preserving lessons learned as part of our legacy has helped us grow personally, professionally, and technically, shaping our engagement in future challenging missions. January 27, 2017 marked the 50th anniversary of the Apollo 1 fire. We look to the past with a fresh view of the legacies that live on today to inspire and protect tomorrow's explorers.

“We’ve got a bad fire—let’s get out.”

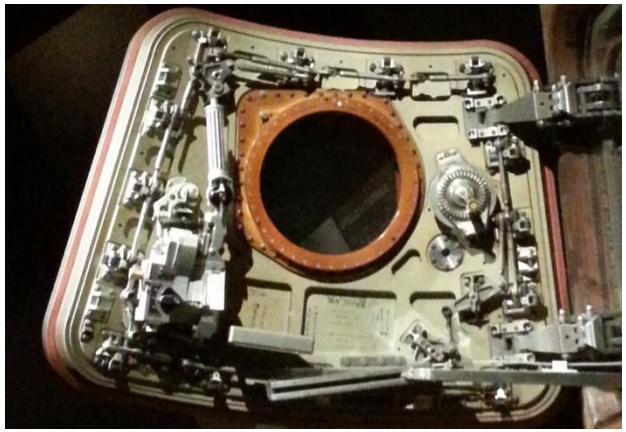
The AS-204 “Plugs Out” Test

- On January 27, 1967, the Apollo 1 crew entered the spacecraft to perform an important launch countdown rehearsal test.
- After several hours of routine testing, the countdown checklist continued to the point when ground personnel would “pull the plugs” and the spacecraft would go into a simulated fuel cell environment.
- Tragedy struck at about 5.5 hours after the start of the simulated countdown, when a significant transient in the AC Bus 2 voltage was observed indicating a major short circuit somewhere in the Command Module wiring.
- Just seconds later a crew member’s voice was heard, “We’ve got a bad fire–let’s get out. We’re burning up!”
- Rescue efforts were hampered by the fire and smoke, and the inability to enter the inward-opening Command Module hatch.

The Recovery



The Block I hatch, as used on Apollo 1, consisted of two pieces, and required pressure inside the cabin be no greater than atmospheric in order to open. A third outer layer, the boost protective hatch cover, is not shown.



The Block II unified hatch combined the inner and outer hatches of the earlier design for improved opening speed.

- Fire fighting improvements
  - Emergency oxygen masks
  - Portable fire extinguisher
  - Protection panels to isolate a fire
  - Ports to connect extinguisher to douse fire behind panel
- Increased test monitoring of crew biomedical data
- Command Module redesign
  - Nylon cloth replaced with beta fiber
  - Covers added over wiring
  - Integrated hatch redesigned for crew exit in under 10 seconds
- Cabin atmosphere changes—60-percent oxygen, 40-percent nitrogen at 16 psi during ground testing
- Flammable materials replaced
  - Out: nylon, polyurethane, silicone, fiberglass
  - In: Teflon™, glass, aluminum, stainless steel, beta cloth
- Wiring modifications
  - Wiring covers added and 3D mockup for harness build
  - Integrated subsystem schematics developed from wire lists
- Changes to Command Module contractor processes
  - Spacecraft manager and personalized team assigned to each vehicle
  - Assistant program manager for safety position staffed
  - Tighter change control process during checkout phase established
  - Additional protection for wiring and plumbing installed
  - NASA spacecraft management and designer walkthrough inspection added

… but beyond the immediate actions, what legacies live on today?

We Engage Through the NASA Safety Culture Lens …

Our current Safety Culture ideals have been shaped by past tragedies such as Apollo 1.

Cultural weaknesses can be recognized more readily than in the days of AS-204.

Reporting Culture—Procedures were subjected to last-minute changes that were not effectively tracked, recorded, or communicated.

Just Culture—Poor morale and process discipline were evident in Command Module contractor performance prior to the incident.

Flexible Culture—Willingness to change course on design issues was weak in the presence of compelling important information.

Learning Culture—Test planning failed to appreciate the significant hazards of a 100-percent oxygen environment.

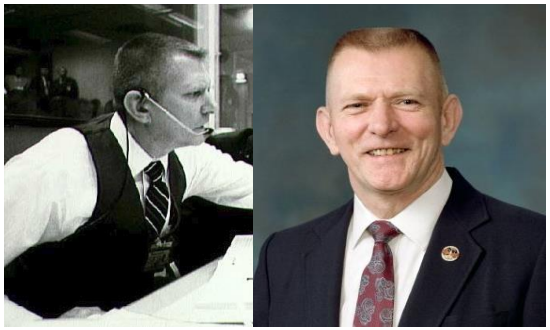
Engaged Culture—NASA provided insufficient surveillance over management functions.

The Apollo 1 Crew's Legacy Lives on …

"I can assure you if we had not had that fire and rebuilt the command module ... we could not have done the Apollo program successfully, so we owe a lot to Gus, and Rog, and Ed. They made it possible for the rest of us to do the almost-impossible."

–John Young

Astronaut John Young flew on Gemini 3 with Grissom in 1965.



Gene Kranz was Flight Director for Gemini 4 in 1965, featuring Ed White's milestone first successful American extravehicular activity.

"We were too gung-ho about the schedule and we locked out all of the problems we saw each day in our work ... Not one of us stood up and said, 'Dammit, stop!' … When you leave this meeting today you will go to your office and the first thing you will do there is to write "Tough and Competent" on your blackboards. It will never be erased. Each day when you enter the room these words will remind you of the price paid by Grissom, White, and Chaffee."

–Gene Kranz

"Three courageous men lost their lives in this tragic accident. They died in the service of their country. Because of their deaths, manned space flight will be safer for those who follow them. The names Grissom, White, and Chaffee are recorded in history and the most fitting memorial the country can leave these men is the success of the Apollo program—the goal for which they gave their lives."

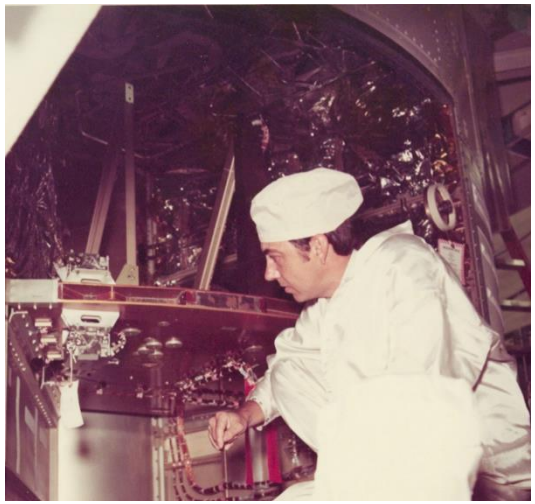
–U.S. Senate Committee on Aeronautical and Space Sciences

JSC's Lessons and Legacies Panel

On January 24, 2017, JSC featured a distinguished panel representing those who have lived the lessons and created the legacies of Apollo 1:

Frank Borman—Apollo 8 Astronaut
Walt Cunningham—Apollo 7 Astronaut
Gary Johnson—Apollo Power Distribution (1964-1969)
Glynn Lunney—Chief, Flight Dynamics (1964-1968)

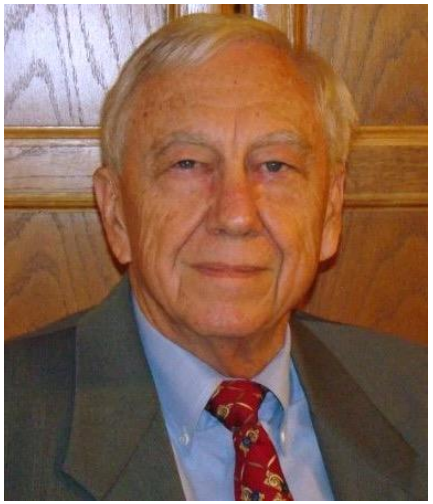
For more information on Apollo 1, Challenger, and Columbia, visit:
https://knowledge.jsc.nasa.gov/index.cfm?event=Legacies2017



Gary Johnson served 1964-1969 as NASA MSC Project Engineer, Power Distribution and Sequencing Section for subsystem support, Apollo sequencer system.

Gary Johnson on Apollo 1's legacy:

"Apollo 1 prompted MSC to put in place a more robust assurance organization, independent of the Program, reporting to the Center Director. This provides a resource that should always be thinking 'What if?' to help prevent hazards. It took a while to do it, but that concept is now a reality throughout the Agency."



Johnson retired in 2006 as NASA JSC Associate Director for Technical, Safety and Mission Assurance (S&MA) Directorate.