APOLLO 12

COMMAND MODULE YANKEE CLIPPER PRIMARY ACCESS HATCH BOOST COVER RELEASE DECAL

THE SPACE COLLECTIVE

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This research document details the authenticating factors, history, and relevance of the Apollo 10 Command Module primary access hatch Boost Cover Release decal.

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1.0. Scorch Mark Photo-Matching

Photo-matching is the process by which images of an artifact as it exists today are compared to images of the same artifact during the event in question, which in this case is the Apollo 12 recovery on November 24, 1969.

Photographs taken during recovery operations by the recovery and support crews aboard the USS Hornet were used as a basis for comparison, with a particular focus on re-entry scorch marks and taking into account any damage from removal as well as expected age and wear.

1.1. *(Left) Recovery crew opening the primary access hatch during recovery operations. (Right) Close-up view of the Boost Cover Release decal during recovery operations.*

1.2. *(Right) Apollo 12 Boost Cover Release decal as it appears today.*

As compared to the partially-obscured mission photograph above, the decal scorch marks, honeycomb pattern, lettering and visible kapton foil underlayer match precisely with the decal as it exists today.

2.0. Heat Shield Honeycomb Pattern

The Apollo Command Modules were coated in an ablative heat shield structure that was composed of a fiberglass honeycomb, integrated with a phenolic resin and bonded with an epoxy-based adhesive to a cleaned, stainless steel shell. This role was performed by North American Aviation [1]. The heat shield was designed to withstand temperatures in excess of 3200°C. Each Command Module was protected by approximately 370,000 manually-filled honeycomb cells.

A primary characteristic of this heat shield structure was its distinct hexagonal honeycomb pattern.

2.1. *(Right) Close-up view of the Apollo 11 Command Module hatch door detailing the heatshield hexagonal honeycomb pattern. This pattern was consistent across all Command Modules.*

Image courtesy of the Smithsonian National Air & Space Museum, Washington D.C.

Measurements provided by the National Air & Space Museum in Washington DC conclude that the honeycomb cells on the Command Module hatch doors measure between 9.53mm to 12.7mm. Measurements taken from the residual honeycomb pattern prevalent on the Boost Cover Release label are consistent with these measurements.

2.2. *(Below) Apollo 12 Boost Cover Release decal with hexagonal imprint from the Command Module hatch door visible through re-entry scorch marks on the left.*

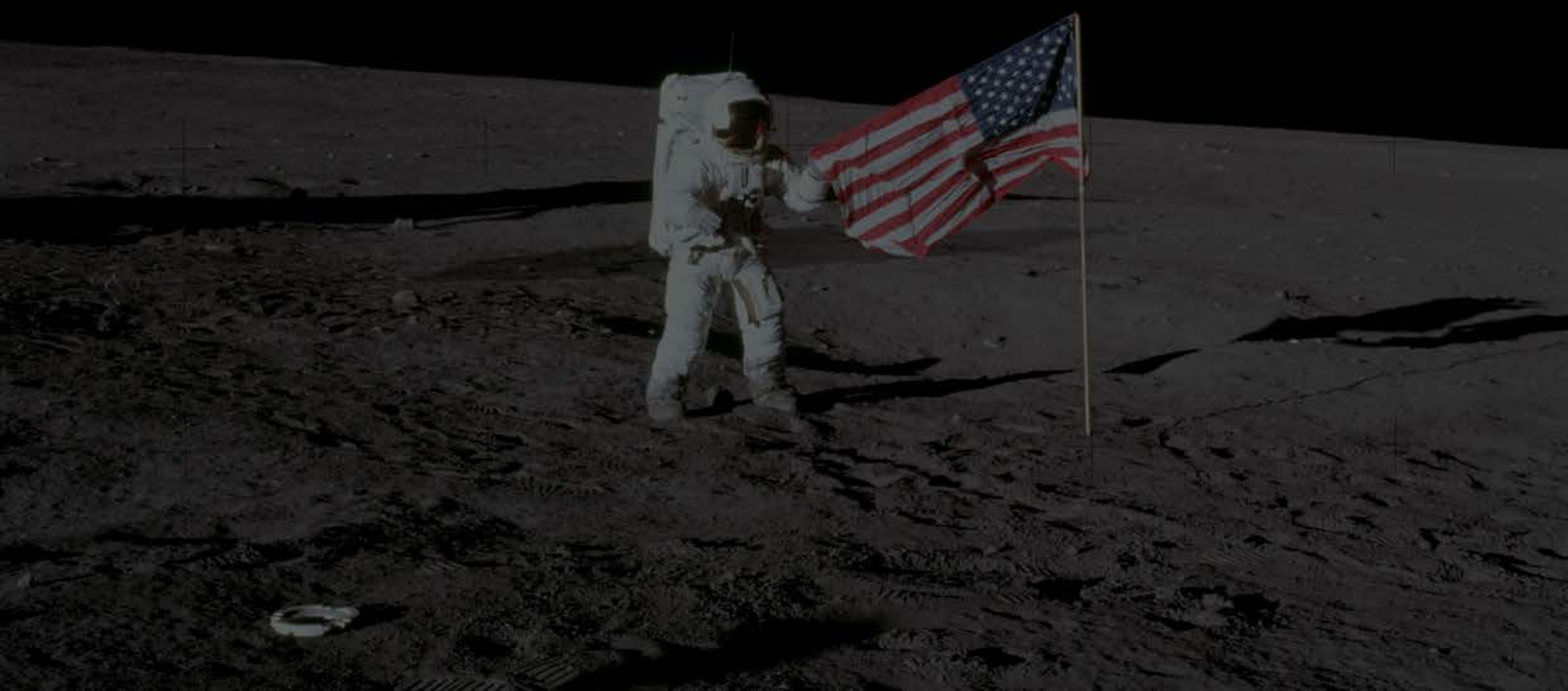
[1] North American Aviation (NAA) was a major American aerospace manufacturer, responsible for a number of historic aircraft, including the T-6 Texan trainer, the P-51 Mustang fighter, the B-25 Mitchell bomber, the F-86 Sabre jet fighter, the X-15 rocket plane, and the XB-70, as well as Apollo Command and Service Module, the second stage of the Saturn V rocket, the Space Shuttle orbiter and the B-1 Lancer. Through a series of mergers and sales, North American Aviation became part of North American Rockwell, which later became Rockwell International and is now part of Boeing.

3.0. Primary Access Hatch Decal Material

The Command Module was coated in layers of reflective mylar foil, often referred to as kapton foil, with one side gold and the other silver. It is a common misconception that the gold side of the foil faced out into space when in actual fact, it was the other way around; the silver side was exposed to outer space, with the gold side being adhered to the outer shell of the Command Module. This belief is brought about by photographs of the Command Module in orbit around Earth and appearing gold in color. This gold color was due to the light reflected off the Sun, which gives the impression that the Command Module was coated in gold foil as opposed to silver.

The Boost Cover Release decal comprises the original underlayer of kapton foil as was attached to the Command Module and topped by a separate layer bearing the decal. The gold side of the foil faces away from the decal as expected, with the silver side visible in the "COV" and “ELE” text areas as a result of damage from the extreme heat of re-entry.

3.1. *(Left) Close-up view of the “COV” section of “COVER” and “ELE” section of “RELEASE”on the Apollo 12 Boost Cover Release decal. (Right) Close-up view of the kapton foil underlayer.*



4.0. Primary Access Hatch Silicone Rubber Overspill

Red-colored RTV silicone rubber was applied to the exterior of the Apollo Command Module to protect potentially vulnerable areas from the extreme heat of re-entry. The silicone rubber was applied in liquid form using a chalking gun but could also be painted onto the desired area by hand using a brush. Potentially vulnerable areas of the spacecraft included the squared section of the hatch door window and tool inserts ports, such as the Boost Cover Release tool port.

As the silicone rubber was applied as a liquid by hand, it would often slightly overspill onto the hatch decals. The Apollo 12 Boost Cover Release decal exhibits such overspill on the circular tool insert opening section. This is consistent with the areas sealed with silicone for further protection.

4.1. *(Right) Close-up view of the Boost Cover Release decal tool insert section highlighting the silicone overspill. (Bottom) Close-up view of the primary access hatch Boost Cover Release tool insert port detailing red silicone overspill.*

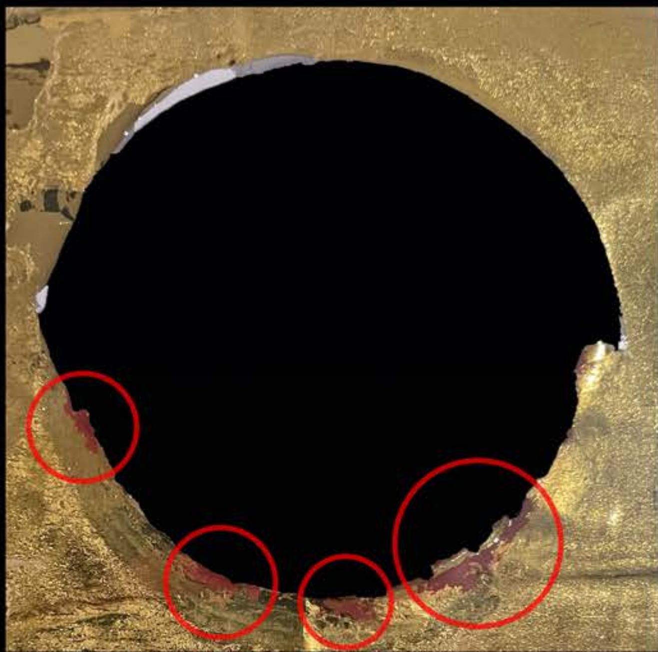


Image courtesy of the Smithsonian National Air & Space Museum, Washington D.C.

5.0. Decal Recovery

Charles “Chuck” E. McKim worked for North American Aviation (which later became Rockwell International) in Downey, California. During his time there, McKim was one of the Operational Team Leaders on the recovery and deactivation/decontamination teams from Rockwell for all Apollo and Skylab missions.

During his time in this role at Rockwell, McKim recovered material from Yankee Clipper, including this Boost Cover Release decal from the primary access hatch. The recovery of the decal was very fortuitous, as it and the entirety of the kapton coating the spacecraft were destined to be discarded.

After the recovery of the Apollo 12 Command Module Yankee Clipper by the USS Hornet on November 24, 1969, in the South Pacific Ocean, the spacecraft was off-loaded from the recovery ship, where it was taken to the deactivation site. It was here where McKim performed the duties associated with his role in the deactivation and decontamination of the spacecraft. It was during this phase of post-flight testing and analysis that he recovered the would-be discarded Boost Cover Release decal from Yankee Clipper’s primary access hatch door.

McKim earned the coveted Silver Snoopy Award for professional excellence, dedication, and significant contributions to the Apollo and Skylab Programs.

6.0. About Chuck McKim

Chuck joined the Navy during WWII, and his ship transported British and Canadian troops to Normandy on D-Day. In 1948, he was recalled to active duty and taught electronics at the Naval War College. He joined North American Aviation as an electronics technician. He worked on various missile programs and culminated his career as a Post-Flight Test Engineering Technician on the Apollo Program. He was a member of the Recovery Team on the U.S. carriers that sailed out to the Pacific Ocean to cover the Apollo Command Modules after splashdown. He retired from the Space Division with 20 years of service.

Silver Snoopy Award letter awarded to Chuck McKim commending his contributions to the Apollo Program, signed by Apollo 12 Lunar Module Pilot Alan Bean.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS 77058

REPLY TO
ATTN OF:

Charles E. McKim
2230 Faust Avenue
Long Beach, Calif. 90815

Dear Chuck:

We of the Astronauts' Office take special pleasure in commending you for the dedication you have continually demonstrated in the accomplishment of your assignments.

As a charter member of the Deactivation/Decontamination Team since 1966, your performance as Operational Team Leader has resulted in significant contributions to the Apollo/Skylab programs during the past eight years. In your role as Team Leader you have been directly responsible for insuring team and equipment readiness to perform the critical task of safing the command module aboard the recovery ship and the hazardous task of defueling operation at the port of entry. The concern and emphasis you have placed on the early return of the spacecraft to Downey for post flight analysis of flight problems to provide corrective action for subsequent missions is recognized. Your approach to this large and demanding task has been positive and orderly resulting in timely support for all missions and continued improvement in operational procedures.

In recognition of your contribution, we who man the spacecraft would like to present you with the Astronauts' "Silver Snoopy" award for professional excellence.

Sincerely,

Alan L Bean

NASA Astronaut

In 2005 McKim co-authored a North American Aviation paper titled 'Apollo Revisited' in which he and fellow North American Aviation employee Jay White detailed a summary of events during the Apollo Program and their tasks related to the sequence of historical events.

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NAAR – Spring 2005

Apollo Revisited

by Chuck McKim and Jay White

"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the Earth".

—President John F. Kennedy, addressing a joint session of Congress, May 25, 1961

Those challenging words were answered emphatically and resolutely for the next decade by thousands of dedicated aerospace pilots, scientists, engineers, technicians and workers.

It's been over 35 years since the first Apollo moon landing on July 20, 1969 by Apollo 11. Of all the Apollo flights that followed, none captured the attention of worldwide viewers as when Astronaut Buzz Aldrin spoke the words, **"Houston, Tranquility Base here. The Eagle has landed"** followed a few hours later by Astronaut Neil Armstrong when he descended the ladder to the moon's surface and said, **"That's one small step for man, one giant leap for mankind".**

Several manned Apollo flights had taken place in preparation for the moon landing flight. The first, Apollo 7, an earth orbit flight, qualified the Apollo spacecraft for manned lunar flight. Apollo 8, first flight with Saturn V, made the first lunar orbit. Apollo 9, an earth orbit flight, qualified the Mobile Quarantine Facility (QF) astronaut transfer vehicle to be used after lunar landing. Finally, Apollo 10, a lunar orbit flight, with descent to within 50,000 feet of the lunar surface.

The follow on flights and lunar landings of Apollo 12, 13, 14, 15, 16 and 17 extended our exploration of the lunar surface. Only Apollo 13 was unable to complete the lunar mission due

Photo from the Chuck McKim Collection

DEACTIVATION/DECONTAMINATION (D/D) AND POST FLIGHT TEST TEAMS

Front Row: —#1—, — Shimuzu, Harry Morman, Bert Richards, Lino Salazar

2nd Row: Floyd Schmidt, Ossie Ried, Don Coleman, P.R. McCarley. —#2—, Jim Michaels

3rd Row: —#3—, Max Boggs, Mark Gordon, Bill Schmidt, Ben Bolger, Chuck McKim

4th Row: —#4—, —#5—, Jay White, —#6—, —#7—, Dick Brundin

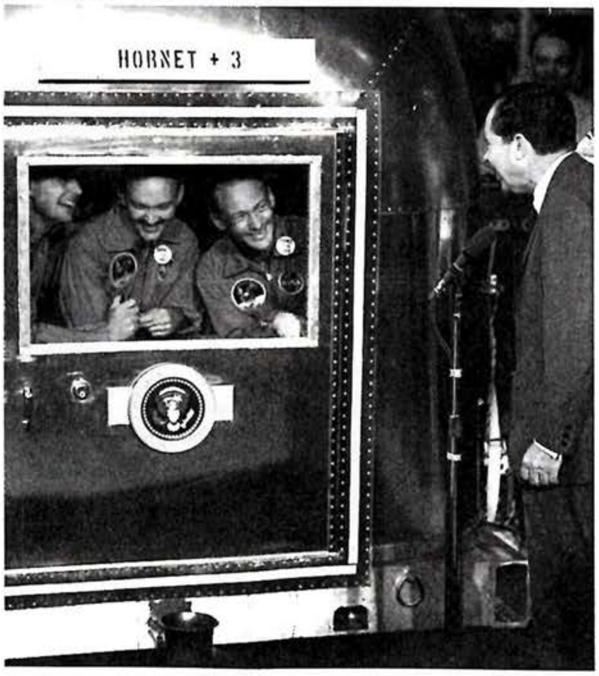
Editor's Note: All names are left to right. Neither Jay nor Chuck could recall the names of the team members identified by the numbers. Can any of our readers come up with the names to match the faces?

to failure of an oxygen tank in the Service Module during transition to the moon. With extraordinary improvisation by Mission Control in Houston and outstanding adaptability by the crew, the spacecraft made a successful return, landing and recovery.

While checkout of the Command and Service Modules was being conducted by Test and Operations personnel in Building 290 in Downey, other personnel were being trained for deactivation/decontamination (D/D) operations to be conducted on the spacecraft following recovery operations by the U.S. Navy. D/D operations on the early earth orbit flights were conducted at the naval facilities in Norfolk, VA. For the following lunar flights, the D/D operations were conducted at Ford Island and Hickam AFB in Honolulu and at the Naval Base in San Diego, CA.

Each of the two D/D teams was headed by a Team Leader and included an Electrical Engineer, RCS Engineer and three technicians. The team was further augmented by Quality Control, Engineering and NASA personnel. D/D team members were required to have passports, current physical examinations and inoculations for possible worldwide deployment, depending upon spacecraft landing area. The teams worked 12-hour shifts, normally completing the D/D operations in three days. The authors were both team leaders.

The console equipment was designed and manufactured by Engineering and Manufacturing-one console for the fuel system and one for the oxidizer system-including all hookup cables and fluid lines. Normal transport for the D/D team was by C-141 from Long Beach Airport along with drums of alcohol and freon, bottles of nitrogen and a wide variety of tools. We always looked forward to using the consumables stored in a couple of large boxes so that we would have room for fresh pineapples on the return trip from Hawaii.



NASA Photo

***President Richard Nixon welcomes the crew of Apollo 11, already confined inside the Mobile Quarantine Facility aboard the* USS Hornet.**

The D/D procedures required safing and removal of the remaining pyrotechnic devices and removal of remaining fuel and oxidizer from the RCS system and purging of those subsystems. Two basically identical consoles were used, one for each subsystem. The procedures required removal of numerous access panels on the spacecraft and installation of electric cables and fluid lines for the RCS system. All of the procedures were developed by RCS Engineering, Electrical Engineering and Test personnel and were documented and certified by Quality Control and NASA personnel.

Apollo 11 and 12 were handled differently since they were the first lunar landing flights. The astronauts were transferred directly to the Mobile Quarantine Facility and flown to Houston to a sterilization facility there. The spacecraft was run through the D/D procedure in Hawaii but the hatch remained closed there. The spacecraft was then flown to Houston and placed in an isolated area for sterilization of the interior of the CM by the D/D team.

When the CM arrived in Houston, it was necessary to transfer it from the shipping trailer to the work trailer for operations in the sterilization facility. The Houston ground crew discussed how they were going to get the crane hook in the lifting eye atop the spacecraft for over thirty minutes. A bit disgusted with all the delay, we asked PR McCarley to get it done. He shinnied up the side of the CM and with one foot in the rendezvous window, he signaled the crane operator for the hook. Five minutes later, the CM was on the trailer and ready to roll into the facility.

Of course, about two hours later we got a call from Labor Relations in Downey which we settled for a few hours of overtime. Once in the facility, the CM was pressurized with basically embalming fluid, let set for two days and then ventilated. No problems were ever encountered with lunar contamination.

Following completion of the lunar flights, the program shifted to the Skylab program. The mission was designed to place the laboratory in orbit and then to visit it with Apollo crews for extended periods of time to checkout the effects of long term space operations on crew and spacecraft. Missions were scheduled for as long as two months. Three flights were made to the laboratory by Apollo crews.

The program closed with a joint US/Russian flight termed Apollo/Soyuz. The spacecraft was modified with special adapters to allow mating of the two space vehicles while in orbit. The Russian crew consisted of two cosmonauts and the American Apollo of the normal crew of three astronauts. With that, the Apollo program came to an end having completed four prelunar landing flights, six lunar landing flights, three Skylab flights and the one Apollo/Soyuz flight.

About the Authors: Chuck McKim joined NAA on the Navaho G-26 program, shifting later to the Hound Dog/B-52 test team. He subsequently joined Apollo Test & Operations where he helped develop the Deactivation/Decontamination teams. He retired in 1975 after completion of the Apollo/ Soyuz mission. Chuck resides with his wife of 63 years, Mildred, in Clifton, CO.

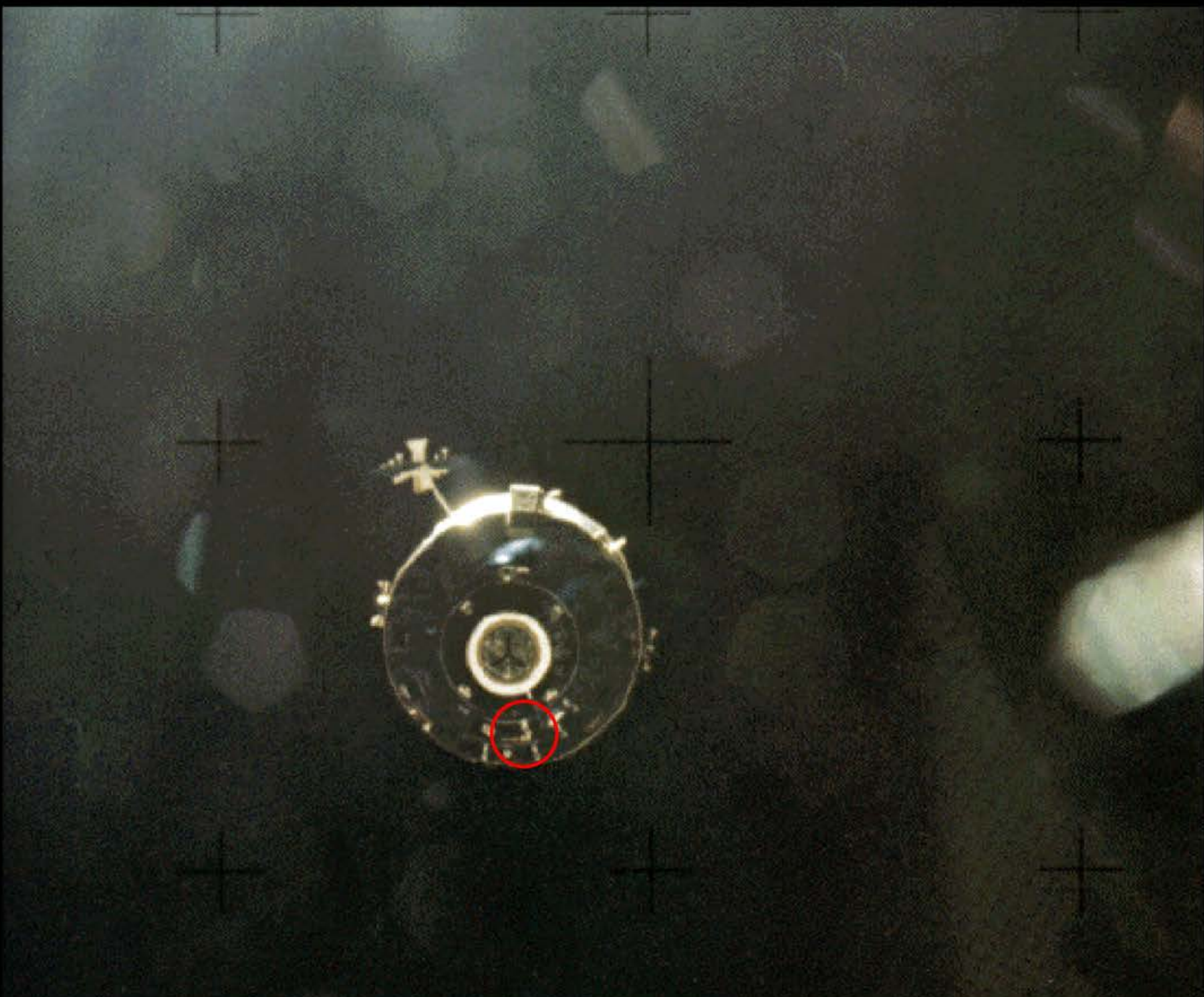
Jay White completed his assignment on the Apollo program on the Apollo/Soyuz. He transferred to Test & Operations on the Shuttle program in Palmdale. He retired in 1978 and he is currently living in Gardnerville, NV with his wife of 52 years, Bea.

7.0. Mission views from the Lunar Module Intrepid

On 19 November 1969, a little under 108 hours into the Apollo 12 mission, the Lunar Module Intrepid detached from the Command/Service Module Yankee Clipper and descended toward the lunar surface with Commander Pete Conrad and Lunar Module Pilot Alan Bean on aboard. Command Module Pilot Dick Gordon remaied aboard the Command Module in lunar orbit.

While alone in orbit, Gordon performed the Lunar Multispectral Photography Experiment, using four Hasselblad cameras arranged in a ring and aimed through one of the Command Module windows. With each camera having a different color filter, simultaneous photos would be taken by each, showing the appearance of lunar features at different points on the spectrum. Analysis of the images might reveal colors not visible to the naked eye or detectable with ordinary color film, and information could be obtained about the composition of sites that would not soon be visited by humans. Among the sites studied were contemplated landing points for future Apollo missions.

7.1. *Close-up view of the Command Module Yankee Clipper with the Boost Cover Release decal highlighted.*



The Boost Cover Release decal is visible in this mission photograph, making it one of the few artifacts that can be seen in its original configuration prior to re-entry before the composition of the decal changed due to the effects of extreme heat.

8.0. Boost Cover Release System

The boost cover release decal was used to indicate to the ground crew where to insert the necessary tool to release the boost cover on the primary access hatch in the event of an emergency on the pad. This action would allow the ground crew to get the crew out as quickly as possible, a system developed after the tragic Apollo 1 fire.

The boost cover was part of the launch escape subsystem (LES), which was designed to carry the Command Module containing the astronauts away from the launch vehicle in cthe event of an emergency on the pad or shortly after launch. The subsystem would carry the Command Module to a sufficient height and off to the side, away from the launch vehicle, so that the earth landing subsystem could operate effectively. The aunch escape subsystem was the large, white rocket-like spire connected to the Command Module by a lattice-work tower. It was 33 feet long, had a maximum diameter of 4 feet, and weighed approximately 8,000 pounds.

The forward/rocket section of the subsystem was cylindrical and housed three solid-propellant rocket motors and ballast compartments topped by a nose cone containing instruments. The tower was made of titanium tubes attached at the top to a structural skirt that covered the rocket exhaust nozzles and at the bottom to the Command Module by means of an explosive connection.

The white, conical boost protective cover was attached to the tower and completely covered the Command Module. This cover protected the Command Module from the rocket exhaust and the heat generated by the launch vehicle's ascent through the atmosphere. It remained attached to the tower and was carried away when the launch escape assembly was jettisoned. The subsystem would activate automatically by the emergency detection system in the first 100 seconds or manually by the astronauts at any time from the pad to jettison altitude. With the Saturn V, the subsystem was jettisoned at about 295,000 feet, or around 30 seconds after the ignition of the second stage.

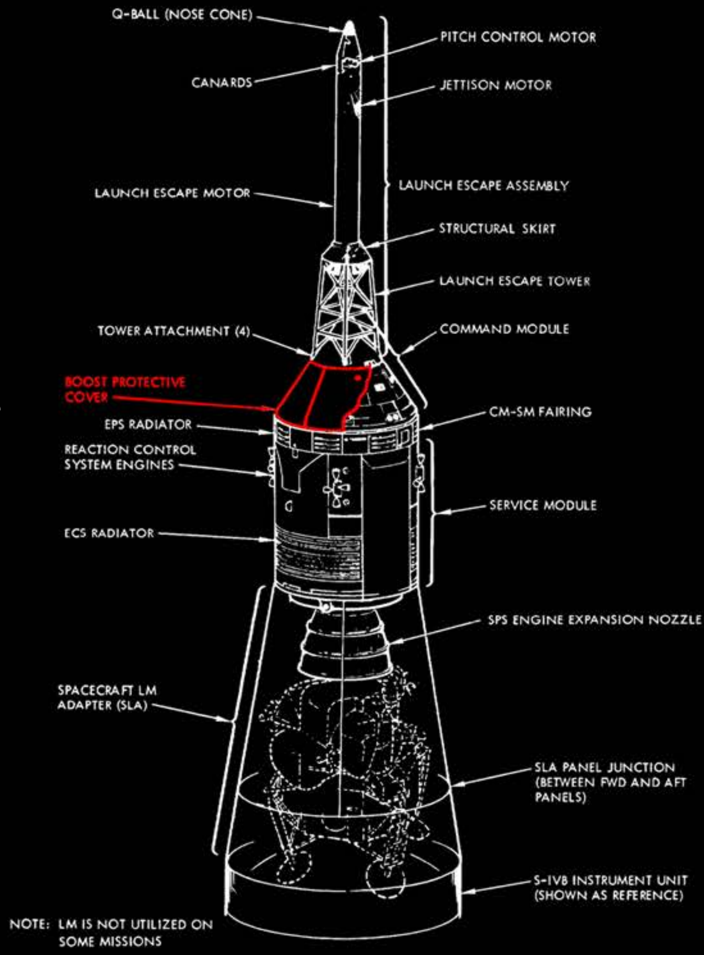
8.1. *(Right) Apollo 12 Saturn V Rocket during launch. (Left) Close-up view of the boost cover release system and LES.*

8.2. *(Right) Block II Spacecraft configuration with the boost protective cover highlighted in red.*

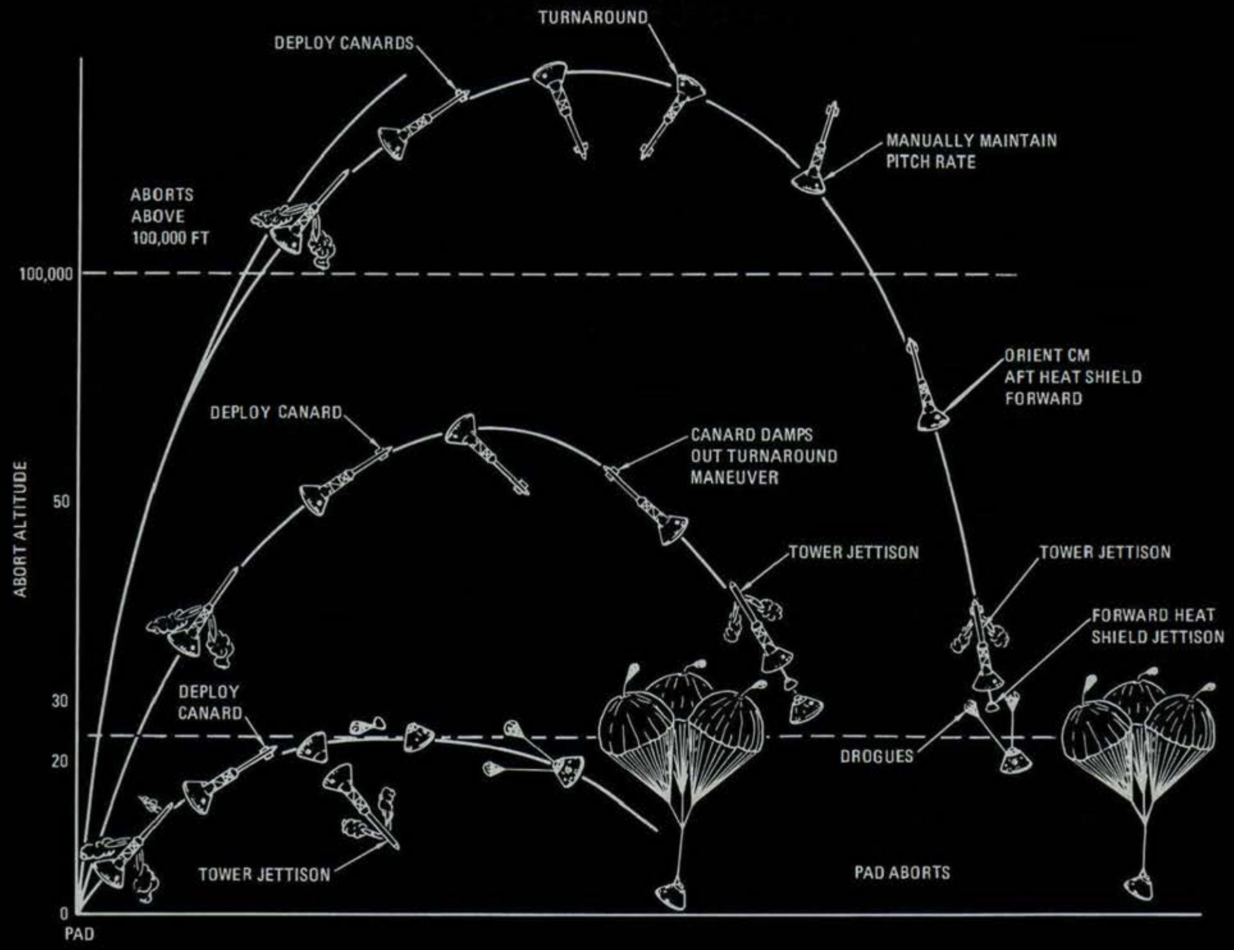
The boost protective cover was attached to the launch escape tower base and was made of impregnated fiberglass, honeycomb-cored laminated fiberglass, and cork. It has 12 "blow out" ports for reaction control motors, vents, and an 8" diameter window that aligned with the Command Module primary access hatch window, providing ground crew and astronauts a clear line of sight into and out of the spacecraft. It is made up of differential pressure transducers and electronic modules. This allows the emergency detection system to measure the differential of dynamic pressures about the pitch and yaw axes in order to monitor the angle of attack of the spacecraft.

An automatic abort would initiate in these two time-critical conditions:

1. Loss of thrust on two or more engines on the first stage of the launch vehicle.
2. Excessive vehicle angular rates in any of the pitch, yaw, or roll planes.



8.3. *(Bottom) Diagram of how the boost cover and launch escape system operates at different altitudes.*



This document and the research contained within was authored by Richard Garner, Director of The Space Collective Ltd. 2019-2023.

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