APOLLO 8

MAN AROUND THE MOON

Astronaut William A. Anders, Lunar Module Pilot.

Astronaut James A. Lovell, Jr., Command Module Pilot.

Apollo 8

This was the bold onset of a program of space flight that will extend through many generations. For the first time men flew to the outer regions of space, free of the earth's gravity. Many men will follow the trail these three astronauts blazed. We are looking forward now to the remaining missions of the Apollo program. We are looking forward to the days when we will be manning great space stations in earth orbit, exploring the surface of the moon, and, in the more distant future, blazing new trails out to the planets. Apollo 8's pioneering flight into lunar orbit demonstrated to men everywhere the existence of a challenging new frontier for mankind in the vastness of extraterrestrial space.

Thomas O. Paine
Acting Administrator
National Aeronautics and Space Administration

Astronaut Frank Borman, Command Pilot.

A Beginning

It was Christmas time, 1968, that man broke his bonds to Earth. Three Americans, Frank Borman, James A. Lovell Jr., and William A. Anders, guided their Apollo 8 spacecraft across nearly a quarter-million miles of black void, out of the grasp of Earth, into orbit around the Moon, and back once more to a chosen pinpoint on their home planet.

Never before had man traveled so far, so fast or looked so closely upon another celestial body. Never before had so many millions listened and watched, their imaginations stretched, as the explorers spoke across the emptiness. Never, indeed, had adventure ever borne all mankind so daringly near the boundaries of its aspirations.

What the astronauts saw of the Moon, from 70 miles above that foreboding surface, can now be seen by all and studied by scientists in the array of still and motion pictures, many of them in color, taken from Apollo 8. What the astronauts succeeded in proving about the reliability of the spacecraft and its rocket vehicle confirmed that some day soon men will actually set foot upon the Moon.

It was the first time that men had been launched into space by the Saturn V, America's most powerful machine. It was the first time, too, that men had sped at nearly 25,000 miles an hour, as Apollo 8 hurled itself from orbit of the Earth and into flight toward the Moon.

Each time Astronauts Borman, Lovell, and Anders vanished behind the far side of the Moon they lost all contact with the Earth for 45 minutes on each of the 10 orbits. During the first long silence the black void crackled with tension until Mission Control in Houston reported: "We've got it! Apollo 8 is in lunar orbit."

"Good to hear your voice," said Astronaut Lovell.

On the Eve of Christmas, as the eyes of the world followed Apollo 8 across the moonscape, the astronauts invoked another, older voice, reading in turn the first ten verses of Genesis, the Story of Creation. Its conclusion—" . . . and God saw that it was good"—echoed in Astronaut Borman's words as again Apollo 8 headed into the silent, tantalizing absence of earthly communications:

"God bless all of you—all of you on the *good* Earth."

The Making of an Astronaut

To be ready for six weightless days of voyaging to the Moon and back to Earth Astronauts Borman, Lovell, and Anders had invested thousands of hours in preparation. Their training was exacting both physically and mentally.

That they had done their homework well, in classroom and laboratory, could not be doubted by any who heard their reports to Earth. The astronauts knew their selenography (lunar topography) as well as they knew the landmarks around Houston. That they were physically fit was clear from the rapidity with which they threw off the effects of a virus on their voyage outward.

Nor had the spacecraft or the mission any surprises for them. In effect, they had been to the Moon many times, their trips simulated in an Earthbound Apollo which duplicated the features of the mission down to the thump of Apollo 8's jet thrusters and the visible waxing of the Moon as the spacecraft drew ever nearer.

They brought to the flight experience in high performance aircraft and in space itself. Anders is a nuclear engineer. Lovell holds a degree in Science. Borman is an aeronautical engineer. Both Borman and Lovell have orbited the Earth in the Gemini program. Lovell holds the record. He has been in space longer than any other man. It is this extensive training, education and experience that goes into the making of an astronaut.

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1 Borman, Apollo 8 commander, jogs for fitness at Kennedy Space Center several days before launch.

2 Inside the centrifuge gondola (L. to R.): Anders, Lovell, and Borman.

3 Borman and Lovell watch Anders practice emergency exit.

4 Astronauts in the Apollo Mission Simulator which duplicates the interior of the command module and the conditions expected on space missions (L. to R.): Anders, Lovell, and Borman.

5 The back-up crew for Apollo 8 Neil Armstrong, Edwin E. Aldrin Jr., and Fred W. Haise Jr., suited up to test emergency exit from spacecraft.

6 Borman being helped into Apollo for a simulated flight in an altitude chamber.

7 Anders is lowered to ground after riding slide wire to safety, Borman and Lovell watch. The slide wire is for speedy evacuation of the spacecraft in case of trouble on the pad.

8 Borman, Lovell, and Anders clamber aboard liferaft after practice water landing.

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The Making of Apollo 8

Apollo 8 was eight years in the making.

The space vehicle (which includes both Apollo spacecraft and Saturn V rocket vehicle) stood 363 feet tall and incorporated well over 3 million working parts. It was put together inside the Vehicle Assembly Building at Kennedy Space Center, a structure so vast (716 feet long, 518 feet wide, 525 feet tall) as almost to afford a climate of its own. If fans did not circulate the air inside clouds would form and rain would fall.

Like man himself, Apollo 8 had to crawl before it could fly. It crept three and a third miles from the Vehicle Assembly Building to the launch pad aboard a crawler-transporter big enough (115 by 130 feet) to accommodate a baseball diamond. The octagonal launch pad, one of two set about 8,700 feet apart, measures 3,000 feet across.

The Apollo 8 space vehicle's first stage came from Louisiana; the second and third stages from California. They were tested and made ready in Alabama. Guidance and navigation equipment came from Wisconsin; and checked in Massachusetts. Systems in the spacecraft came from Florida and New Hampshire.

Astronaut Borman, after returning from the Moon, recognized a truth when he said, "Thousands of people made this possible."

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1 Diagram of principal parts of Apollo/Saturn V (Apollo 8) at launch.

2 Rocket nozzles of the Saturn V, each with thrust of 1.5 million pounds, dwarf the workman in the Vehicle Assembly Building.

3 Second stage of Saturn V ready for mating to first stage inside the Vehicle Assembly Building.

4 Apollo 8 being mated to the Instrument Unit atop Saturn V. The Instrument Unit is the launch vehicle's brain, controlling among other things the firing and jettisoning of the three stages.

5 Transporter starts Apollo/Saturn V and associated launch structure down crawlerway. Vehicle Assembly Building door still stands open.

6 Apollo 8 looms above crawler-transporter. Each of the 60 steel links in the crawler's treads weighs about a ton.

7 Apollo 8 towers 363 feet above the launch pad at Kennedy Space Center.

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Countdown

Electric power flowed into Apollo 8 at 7 p.m. (EST) Sunday, Dec. 15, 1968, and the countdown started. In one sense, it began a little more than a decade ago when man first learned to put relatively small objects into orbit around the Earth; in another, broader sense, perhaps, it began before the dawn of history when a nameless pioneer lifted calloused knuckles from the Earth and gazed on the heavens.

Computers raced electronically through the hundreds of systems of the great vehicle, checking the condition of their millions of parts, systematically verifying the fitness of supporting facilities on the ground. Workmen swarmed over the pad and launch tower, filling fuel tanks, installing explosives to separate the stages during the flight, checking electrical connections.

The astronauts, spelled often by their backup crew, took their stations in the spacecraft to join the countdown. They had physical examinations and finally suited up.

Men and machine were ready for the great adventure.

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1 Lovell points to chart of lunar surface that he, Anders (behind Lovell), and Borman (extreme right) were soon to see from closer range than ever before.

2 Engineers seated beneath giant TV monitor screens in Launch Control Center at Kennedy Space Center shortly before the flight of Apollo 8.

3 Apollo 8 astronauts (L. to R.): Borman, Lovell, and Anders breakfasting with mission officials early on the morning of the launch.

4 Well before 4 a.m., the astronauts don and check their space suits. In foreground, Borman; center, Lovell; and rear, Anders.

5 Technician inserts pens and penlight in pocket of Lovell's space suit. The Apollo 8 symbol is on Lovell's chest, figure 8 around the Earth and Moon suggesting the path to and from the Moon.

6 Anders adjusts his communications soft hat.

7 Apollo 8 astronauts in nearly full dress for flight. Front to back: Borman, Lovell, and Anders.

8 Astronauts leave the dressing room and walk toward van which took them to their Apollo/Saturn V space vehicle. Front to back: Borman, Lovell, Anders.

9 Astronauts leave the building to board the waiting van. Left to right: Anders, Lovell, and Borman.

10 Lovell talks with closeout crew just before entering spacecraft. Borman and Anders are already in spacecraft.

11 Searchlights play on Apollo/Saturn V just before launch to the Moon.

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12 Spectator sees Apollo 8 off through binoculars as he waves American flag.

13 With the voyage to the Moon started, Deke Slayton huddles with fellow astronauts over a lunar surface chart in the Mission Control Center at the Manned Spacecraft Center, Houston.

14 Voyage to Moon begins on schedule: Apollo 8 lifts off 7:51 a.m. (EST) Dec. 21, 1968.

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The Voyage Out

At 7:51 a.m. (EST) Saturday, Dec. 21, 1968, Saturn V thundered and thrust against the Earth with all its 7.5 million pounds of power, lifting itself and Apollo from Cape Kennedy. Eleven minutes later Apollo 8 was in Earth orbit. In the second orbit, Saturn V's third stage fired Apollo 8 onto course for the Moon at nearly 25,000 mph.

The voyage out took two days. On each day at about 3 p.m. the astronauts appeared live on television screens on Earth. Early on Dec. 24, well within the gravitational field of the Moon, they turned the spacecraft so that its rocket engine, the Service Propulsion System (SPS), faced forward. As Apollo 8 coasted out of sight behind the Moon and out of touch with Earth at 4:59 a.m. (EST), the crew fired the SPS. Not until Apollo 8 emerged from behind the Moon did the world learn that it was in an elliptical orbit ranging between 69 and 195 miles above the Moon. Two orbits later, the astronauts again fired the SPS and achieved a nearly circular orbit about 70 miles above the Moon.

For about 20 hours, a total of ten orbits, Apollo 8 remained locked in the grip of the Moon. At 7:30 a.m. and 9:30 p.m. Dec. 24, the astronauts appeared live on television, sharing with those on Earth their view of the moonscape. For most of the rest of the time, they were busy with their cameras and sextant, photographing and locating features on the Moon, giving special attention to proposed Apollo landing sites.

Early Christmas morning, once more behind the Moon and out of contact with Earth, they positioned the spacecraft to fire the SPS and free Apollo 8 from lunar orbit. Again, until Apollo 8 emerged from behind the Moon, those on Earth did not know that the engine had indeed fired and Apollo 8 was homeward bound.

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"I have a beautiful view of the S-4B (Saturn V's 3rd stage). You could tell it was really hauling the mail."—LOVELL

"The vast loneliness up here is awe-inspiring, and it makes you realize just what you have back there on Earth. The Earth from here is a grand oasis in the big vastness of space."—LOVELL

"Waters are all sort of a royal blue, clouds of course are bright white, the reflection of the earth is much greater than the Moon. The land areas are generally a brownish, sort of dark brownish to light brown in texture."—LOVELL

"A beautiful Moon out there tonight."
"Now, we were just saying that there's a beautiful Earth out there."—BORMAN exchange with Houston

"What I keep imagining is if I am some lonely traveler from another planet. What would I think about the Earth at this altitude? Whether I think it would be inhabited or not."—LOVELL

"And in the beginning God created the Heaven and the Earth," Anders began reading on Christmas Eve TV Broadcast, as Apollo 8 passed from lunar day into lunar night.

"Looks rather like clouds and clouds of pumice stone."—BORMAN

"The sky is very, very stark. The sky is pitch black and the Moon is quite light. The contrast between the sky and the Moon is a vivid dark line."—ANDERS

"The color of the Moon looks like a very whitish gray, like dirty beach sand with lots of footprints in it. Some of these craters look like pickaxes striking concrete, creating a lot of fine haze dust."—ANDERS

"You can see by the numerous craters that this planet (the Moon) has been bombarded through the eons with numerous small asteroids and meteoroids pockmarking the surface every square inch."—ANDERS

"Langrenus is quite a huge crater; it's got a central cone to it. The walls of the crater are terraced, about six or seven terraces on the way down."—LOVELL

"The backside (of the Moon) looks like a sand pile my kids have been playing in for some time. It's all beat up, no definition, just a lot of bumps and holes."—ANDERS

"Vast, lonely and forbidding sight . . . not a very inviting place to live or work."—BORMAN

How Eyes and Ears of World Followed Apollo 8 to Moon

To keep an anxious world in contact with Apollo 8 and Astronauts Borman, Lovell, and Anders, the communications network of the Goddard Space Flight Center, Greenbelt, Md., combined 14 land stations, four instrumented ships, and eight instrumented aircraft. Circuits of cable, telephone, teletype, and radio relayed messages through terminals both on Earth and on communications satellites orbiting the Earth at an altitude of 22,300 miles.

Not only did the system enable Mission Control in Houston to talk with the astronauts and millions to see them on their television screens, but it also monitored the physical functions of spacecraft, rocket engines, and the men themselves. Only during the times when Apollo 8 swept to the far side of the Moon were the astronauts truly alone.

So long as Apollo 8 remained no farther away than Earth orbit the smaller of the land stations, with antennas 30 feet in diameter, could stay in touch. For greater distances, 85-foot antennas at Madrid, Spain, and Canberra, Australia, and the 210-foot antenna at Goldstone, Calif., were so spaced around the Earth that despite its rotation, one of them would always provide the vital communications link to Apollo 8.

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1 The 210-foot diameter antenna at Goldstone, Calif., biggest in the network that communicated with, monitored, and tracked Apollo 8.

2 Workers inside the 210-foot dish at Goldstone.

3 USNS Redstone, one of instrumented ships used to track and communicate with Apollo 8.

4 An 85-foot-diameter antenna as seen by a technician at Goldstone.

5 In the bulbous nose of this four-engine KC-135 are radio antennas that monitored Apollo 8.

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Homeward Bound

Apollo 8 broke out of Moon orbit at about 5,500 mph. and under the influence of the Earth's gravity gathered speed with each passing hour as it headed for home. Eventually, upon reaching the atmosphere of the Earth, the speed reached almost 25,000 mph., fast enough, if the angle of flight were too steep, to burn the spacecraft to a cinder or, if the angle too shallow, to bounce it off into space again. To land safely Apollo 8 had to be threaded through what at 80 miles above the Earth amounted to the eye of a needle—an imaginary doorway some 400 miles by 26 miles.

Apollo 8, its service module discarded, hit the eye of the needle blunt end first and began tracing a flaming arc through the atmosphere. Twice the craft was rolled so that the aerodynamic lift designed into it not only slowed descent but actually caused it to climb briefly. The deceleration force on the astronauts rose to six times the ordinary force of the Earth's gravity.

Three drogue parachutes automatically deployed at 24,000 feet when Apollo had slowed to about 300 mph. At 10,000 feet when the spacecraft had slowed to about 140 mph., the 83½-foot orange and white blossoms of the main 'chutes unfolded and eased Apollo 8 into the Pacific a mere 5,000 yards from the main recovery ship, the carrier Yorktown.

It was 10:51 a.m. (EST) Monday, Dec. 27, but 4:50 a.m. and still dark on the ocean about 1,100 miles southwest of Hawaii. Just after sunrise, an hour and 20 minutes later, Astronauts Borman, Lovell and Anders stepped out of the helicopter and onto the red carpet on the deck of the Yorktown.

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1, 2 Navy frogmen drop from helicopter to prepare Apollo for recovery and help astronauts transfer to the helicopter.

3, 4 Anders gets a hand out of the bobbing spacecraft.

5 Lovell is hoisted to recovery helicopter.

6 Leaving the helicopter, Borman, Lovell, and Anders (L. to R.) wave to cheering crewmen on decks of the prime recovery ship Yorktown.

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7 "We're just happy to be here," Borman tells the Yorktown crew.

8 Anders, Borman, and Lovell (L. to R.) being introduced to crew of recovery ship Yorktown.

9, 10, 11, 12, Apollo 8 command module follows astronauts aboard Yorktown.

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13 Steak and egg breakfast for three aboard Yorktown. They wear robes for physical examinations, which indicated that the astronauts were in good condition except for fatigue.

14 Anders, Borman, and Lovell (L. to R.) listen to congratulations from President Johnson.

15 The astronauts stand beside their Apollo command module as it was being prepared for shipment to the United States. "It's a great ship," Borman said.

16 President Johnson presents NASA's Distinguished Service Medal to Astronauts Borman, Lovell and Anders, Jan. 9, 1969.

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Apollo Program Management

Direction of the Apollo Program, the United States' effort to land men on the Moon and return them safely to Earth before 1970, is the responsibility of the Office of Manned Space Flight (OMSF), National Aeronautics and Space Administration, Washington, D.C.

NASA Manned Spacecraft Center (MSC), Houston, is responsible for development of the Apollo spacecraft, flight crew training and flight control.

NASA Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for development of the Saturn launch vehicles.

NASA John F. Kennedy Space Center (KSC), Fla., is responsible for Apollo/Saturn launch operations.

NASA Goddard Space Flight Center (GSFC), Greenbelt, Md., manages the Manned Space Flight Network under the direction of the NASA Office of Tracking and Data Acquisition (OTDA).

Apollo/Saturn Officials

Dr. George E. Mueller
Associate Administrator for Manned Space Flight, NASA Hqs.

Lt. Gen. Samuel C. Phillips
Director, Apollo Program OMSF, NASA Hqs.

George H. Hage
Deputy Director, Apollo Program, OMSF, NASA Hqs.

William C. Schneider
Apollo Mission Director, OMSF, NASA Hqs.

Chester M. Lee
Assistant Mission Director, OMSF, NASA Hqs.

Col. Thomas H. McMullen
Assistant Mission Director, OMSF, NASA Hqs.

Dr. Robert R. Gilruth
Director, Manned Spacecraft Center, Houston

George M. Low
Manager Apollo Spacecraft Program, MSC

Kenneth S. Kleinknecht
Manager, Command and Service Modules, Apollo Spacecraft Program Office, MSC

Donald K. Slayton
Director, Flight Crew Operations, MSC

Christopher C. Kraft, Jr.
Director Flight Operations, MSC

Clifford E. Charlesworth
Glynn S. Lunney
M. L. Windler
Apollo 8 Flight Directors, Flight Operations, MSC

Dr. Wernher von Braun
Director, Marshall Space Flight Center, Huntsville, Alabama

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Lee B. James
Manager, Saturn V Program Office, MSFC

William D. Brown
Manager, Engine Program Office, MSFC

Dr. Kurt H. Debus
Director, John F. Kennedy Space Center, Fla.

Miles Ross
Deputy Director, Center Operations, KSC

Rocco A. Petrone
Director, Launch Operations, KSC

Walter J. Kapryan
Deputy Director, Launch Operations, KSC

Dr. Hans F. Gruene
Director, Launch Vehicles Operations, KSC

Rear Adm. Roderick O. Middleton
Manager, Apollo Program Office, KSC

John J. Williams
Director, Spacecraft Operations, KSC

Paul C. Donnelly
Launch Operations Manager, KSC

Gerald M. Truszynski
Associate Administrator, Tracking and Data Acquisition, NASA Hqs.

H. R. Brockett
Deputy Associate Administrator, OTDA, NASA Hqs.

Norman Pozinsky
Director, Network Support Implementation Division, OTDA

Dr. John F. Clark
Director, Goddard Space Flight Center, Greenbelt, Md.

Ozro M. Covington
Assistant Director for Manned Space Flight Tracking, GSFC

Henry F. Thompson
Deputy Assistant Director for Manned Space Flight Support, GSFC

H. William Wood
Chief, Manned Flight Operations Division, GSFC

Tecwyn Roberts
Chief, Manned Flight Engineering Division, GSFC

L. R. Stelter
Chief, NASA Communications Division, GSFC

Maj. Gen. Vincent G. Huston
USAF, DOD Manager of Manned Space Flight Support Operations

Maj. Gen. David M. Jones
USAF, Deputy DOD Manager of Manned Space Flight Support Operations, Commander USAF Eastern Test Range

Rear Adm. F. E. Bakutis
USN, Commander Combined Task Force 130 Pacific Recovery Area (Primary)

Rear Adm. P. S. McManus
USN, Commander Combined Task Force 140 Atlantic Recovery Area

Col. Royce G. Olson
USAF, Director, DOD Manned Space Flight Office

Brig. Gen. Allison C. Brooks
USAF, Commander Aerospace Rescue and Recovery Service

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