

Historian Corner

By Barb Sande

barbsande@comcast.net

Program Profile

This issue profiles the Apollo 15 mission, starting with a personal reminiscence of its launch that I saw from Titusville with my parents. (I was going into my junior year of high school). I met LM pilot Jim Irwin later while in college and developed a mentoring relationship via letters back and forth with him, which is briefly discussed in his biography. I was a space fanatic probably dating back to John Glenn's flight in February, 1962 in the second grade, an unusual interest for a little girl at that time, but I loved math and science and loved reading about the challenges of spaceflight. Apollo 15 was a big step forward in advanced lunar exploration and one of the most exciting times in my life, because I talked Mom and Dad into driving to Florida from Colorado on our summer vacation with the hopes of seeing this launch in person. That trip sealed my fate—I was going to be an engineer working in the space program!

Apollo 15 Mission Overview

Launched: 07/26/1971 13:34:00 UTC LC-39A, KSC

Splashdown: 08/07/1971 20:45:53 UTC, North Pacific, USS *Okinawa* recovery ship

Saturn V AS-510 Launch Vehicle

CSM (Command/Service Module) Call Sign: *Endeavour* (CSM-112) – named after the ship used on one of James Cook's scientific voyages

LM (Lunar Module) Call Sign: *Falcon* (LM-10) – named after the USAF Academy mascot

Crew: Commander David R. Scott, LM Pilot James B. Irwin, CM Pilot Alfred M. Worden (all Air Force crew)

74 total lunar orbits

Landing site: Hadley Rille Area (Mare Imbrium) – 26.1322 degrees N, 3.6339 degrees E lunar coordinates
First "J" mission (expanded science operations, use of a lunar rover, extended lunar stay, expanded CM science operations)

Connection to Lockheed Martin/ULA: The contributions of our heritage companies to the Apollo program were listed in the MARS STAR article about Apollo 11 in 2019. This mission used the ALSD (Apollo Lunar Surface Drill), designed and built by Martin Marietta in Denver. The drill never functioned as intended on this mission.



Apollo 15 Crew: Dave Scott Commander; Al Worden, CM Pilot; Jim Irwin, LM Pilot
Photo Credit: NASA

A Hot Monday Morning in July, 1971 – A Personal Reminiscence

Just after dawn on Monday, July 26, 1971, I was abruptly awakened by the sound of loud engines. Disoriented, I slowly moved around, realizing that I was laying down on the back seat of our family car. My Mom, in the front seat, woke up and asked loudly, "What is that sound? Did we miss the launch?" My dad was outside with a borrowed sleeping bag from a neighbor parked next to us and he was also getting up, wondering what was going on. Everyone was awake now – the loud engine sounds were from two crop dusting planes releasing mosquito repellents over the large crowds parked or camping alongside the Indian River near the town of Titusville, Florida. Across the river, launch pad 39-A and the beautiful Saturn V were still lit by huge spotlights as the dawn approached. Radios came on, affirming that the launch of Apollo 15 was on schedule for liftoff at 9:34 am EDT, the weather looked good, and no technical issues were being worked. Many of us walked over to the river's edge nearby and looked at the towering Saturn V in the distance, realizing that the crew was likely already on board or on its way to the pad.

Over one million spectators were lining the streets and roads, both within KSC/CCAFS and in places like Titusville, one of the largest crowds since the Apollo 11 launch in 1969. We had scouted out places to park for the launch a few days prior to launch day, driving all the way up to the Cape from Pompano Beach, Florida, where we were staying at a small beach resort. On that visit, we also did the bus tour at KSC, getting a close look at the Saturn V on LC-39A (sadly, I could not find the pictures). I drained my dad's wallet at the souvenir shop at the visitor's center (much smaller than the shops there now), collecting everything I could get my hands on for the Apollo 15 mission. We drove all the way back to Pompano Beach (my dad drove 400 miles that day),

tired but excited about the events that were coming in a few days. On the day before the launch (Sunday, July 25), we got up at 4:00 AM, having packed the car the night before, and headed north again, arriving in Titusville and scoring a parking spot for \$20—my dad was outraged by that cost—at a little park area on the south end of town, not far from where the NASA causeway joins Highway 1. We were allowed to leave the parking spot to go to restaurants for meals and to the displays that were in the shopping mall nearby. That evening, everyone in that dirt parking area made lots of friends as we were all watching the activity directly across the river. We retired to the uncomfortable car seats and a borrowed sleeping bag and tried to get some rest.

Back to the morning of the launch: everyone was buzzing about the crop duster planes and the imminent launch. An entrepreneurial person nearby in the parking area was selling cinnamon rolls and doughnuts and the coffee was extremely popular with the adults. Our parking area also had port-a-potties for the “important” stuff (probably justifying the \$20 fee). The sun had risen, and the temperatures started to climb—Florida in July—and we all found places to sit along the Indian River on the ground; a few smart people had chairs or were sitting on the roofs of their cars if they were closer to the river. Of course, several people had radios and even a few small portable TVs. I was bursting with energy and nervousness, clutching my small Kodak Instamatic camera, and shading my eyes from the sun.

The countdown continued. At T-8 seconds, the five F-1 engines of the Saturn V were ignited with their combined thrust of 7.6 million pounds, and the exhaust plumes extending a long way on either side of the launch pad. For the observers across the Indian River, this was a silent event except for cheers and “aahs” of the crowd, as the sound of ignition had not traveled that far yet. At T-0, the huge rocket began its slow climb away from the pad and then the sound hit us in waves!! I was crying and trying to watch and take pictures with my tiny camera all at the same time, while the noise and vibrations shook me and the ground beneath me. I have never heard or seen anything like that since, in the many years of watching Titan, STS, Atlas, Delta and other launches. Those subsequent launches were always impressive, but the Saturn V was in another class. Apollo 15 headed downrange and we were able to see and cheer Stage I/II separation.

The launch was over, a most astonishing experience for everyone gathered there. Mom, Dad and I headed back to the car, laughing at people scrambling to get out and get to the major highways. My dad took a picture with my Instamatic of a pair of shoes that someone had left behind. We finally got on the road around noon and drove all the way to the Huntsville, Alabama, area that evening. The next day, we toured the Alabama Space

and Rocket Center, then continued our drive back to Colorado, taking a few more days to get there. We pulled into the driveway of our home in Aurora on Friday, July 30, about one hour before *Falcon* separated from *Endeavour* and headed to the lunar surface. I raced inside to turn on the TV and did not leave it very often over the next week. Now it’s time to move into the actual program profile of Apollo 15; most of the profile will be about the excursions done on the moon.

Apollo 15 Heads to the Moon

Apollo 15’s launch was in a more southerly direction because of the extra weight on-board, resulting in a lower park orbit of 90 nautical miles. The Lunar Module (LM) *Falcon* on this first J-mission weighed 4,000 pounds more than an H-mission LM because of increased fuel and oxidizer tank sizes, added science experiments and instrumentation, additional batteries and solar cells, and the 500-lb weight of the new Lunar Rover Vehicle (LRV), built by Boeing.

At 11:36 minutes into the mission, the S-IVB engine shut down, leaving Apollo 15 in their low orbit. The engine fired again at 2:50:02 into the mission, setting Apollo 15 on its TLI (trans-lunar injection) trajectory towards the moon. The S-IVB stage was jettisoned and impacted the moon about an hour after the crew arrived in lunar orbit.

The crew, with Commander Dave Scott, LM Pilot Jim Irwin, and CM Pilot Al Worden, were pleased with the booster performance and they had a nominal LM extraction and docking. Scott was the only veteran astronaut in the group and his first mission (Gemini 8 with Neil Armstrong) was shortened significantly when their spacecraft started spinning uncontrollably after docking with an Agena upper stage due to an RCS thruster failure. He also served as the CM pilot on the Apollo 9 mission in March, 1969. Irwin and Worden were rookies and all three were in the Air Force; coincidentally, all three also attended the University of Michigan for engineering studies.

Arrival at the Moon; *Falcon* to the Surface

After having only minor technical issues on the way to the moon and only requiring two course corrections (four had been planned), Apollo 15 performed a successful SPS (Service Propulsion System) burn on the far side of the moon and entered lunar orbit on July 29. The SPS then performed a descent orbit insertion burn of 24.53 seconds, with both craft now in a much lower orbit of 58.5 by 9.6 nautical miles. As the crew rested, Mission Control noted that the orbit was becoming increasingly elliptical due to mass concentrations on the lunar surface, so corrections were made with the RCS thrusters on July 30 before separation.

Falcon separation was attempted at 100:15:36 mission elapsed time but was unsuccessful; this was due to a

loose instrumentation umbilical that was fixed, and separation was successful 25 minutes later. CM pilot Worden executed an SPS burn to raise the orbit of *Endeavour* to prepare for his scientific work. *Falcon* began its descent at a slightly higher altitude than planned; the crew could not see surface features initially because of the LM descent attitude, but a pitch-over event allowed them to see the surface in front of them. Commander Scott did not recognize any features from training and was concerned they would overshoot the intended landing site, but he finally recognized the Hadley Rille and began the maneuvering to try and target the planned landing site. The larger engine bell on this J-Mission LM descent stage kicked back so much dust that the surface was invisible; the very second LM Pilot Irwin called "Contact," Scott shut off the descent engine, leading to a hard drop to the surface because they feared reflective energy from the engine would damage the LM structure. *Falcon* was near a small crater and leaning back at an angle of 6.9 degrees and to the left at 8.6 degrees, still below the maximum acceptable tilt angles; they were also over 2,000 feet from the desired landing site, but that was irrelevant with the ability to use the rover.

Stand-Up EVA; EVA-1

After landing, a sleep period was scheduled for Irwin and Scott, as their first EVA was planned to be seven hours long. Scott was concerned about the landing site and clearances, so they got permission to put on their spacesuits, depressurize the LM and remove the top hatch and docking mechanism. Scott stood on top of the ascent engine cover and put his head outside. He did a 22-picture stereo panorama and other photos of the terrain and was relieved to see that clearances were quite good, with no huge boulders nearby to impede the rover. Thirty minutes after opening the hatch, Scott re-entered, closed the hatch and *Falcon* was repressurized.

While Irwin and Scott slept, the pressure inside the descent engine oxidizer tanks slowly dropped; the low-speed telemetry during the night mode made it difficult to understand the cause, but Mission Control was unwilling to wake the crew. Finally, the crew was awakened one hour early, and they transitioned to high-data-telemetry. This revealed that the valve of the urine transfer device was open even though the receptacle was capped, resulting in a loss of about 8 pounds of oxygen (out of 95 total pounds, with half of that being reserve). Scott and Irwin noted in the post-flight debrief that Mission Control should have awakened them as soon as the leak was detected.

Now that the crew was awake, they started preparations for the first lunar EVA. Those preparations took four hours before Mission Control gave the GO to depressurize the LM. Scott backed out of the LM, came down the stairs, and became the seventh man on the lunar surface. His words: "As I stand out here in the

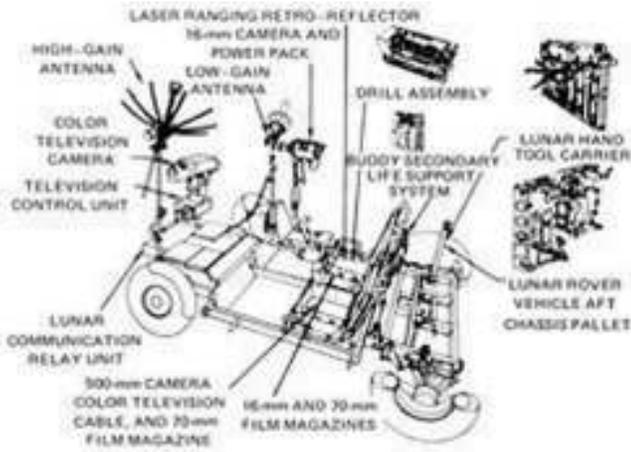
wonders of the unknown at Hadley, I sort of realize there's a fundamental truth to our nature. Man must explore. And this is exploration at its greatest." Irwin joined him a few minutes later and they spent some time setting up the new and improved television camera to monitor the deployment of the rover. Irwin also collected a contingency sample in case they had to evacuate the surface in a hurry.

The LRV deployment was relatively easy, using a system of lanyards and pulleys, with most of the deployment being automatic. Let's briefly explore the rover development and design:

Overview – Lunar Rover Vehicle

Boeing won the LRV contract in October, 1969, beating out Bendix, Grumman and Chrysler. A major subcontractor was General Motors Defense Research Laboratories in Santa Barbara, California. Boeing used facilities in Seattle and Kent, Washington, and Huntsville, Alabama, for design, build, integration and test. Four LRVs were built, and development only took 17 months; the LRV proved to be very reliable, safe, and flexible during lunar operations.

The LRV had a mass of 460 pounds and could hold a payload of 1,080 pounds (astronauts in full suits, tools, and collected samples). Built using aluminum alloy tubing for the frame, the LRV had side-by-side seats of tubular aluminum with nylon webbing. The wheels were unique designs by GM and were called "resilient" wheels; they used aluminum hubs and tires with zinc-coated steel strands, along with titanium chevrons on the wheel/surface contact area to provide traction. Each wheel had its own electric drive, a DC motor capable of 0.25 horsepower and brake system. Overall power was provided by two 36-volt silver-zinc-potassium hydroxide non-rechargeable batteries, charged to 121 Amp-Hours. The LRV was driven using a T-shaped hand controller and navigation was provided by a directional gyro and odometer. An operational constraint of LRV operations was known as the walk-back limit, based on the consumables in the astronaut suits if the rover failed and the astronauts had to walk back. The rover was always driven to the furthest planned distance first, then returned along a traverse back to the LM. On Apollo 15, the LRV traveled a total of 17.25 miles, with a maximum range from the LM of 3.1 miles and a longest traverse of 7.75 miles.



Configuration of LRV
Diagram Courtesy of NASA

Back to EVA-1: After deploying the LRV, Commander Scott took it for a "spin" in the vicinity of the LM. The Commander always drove, while the LM pilot helped with navigation and observations of formations and possible lunar samples. The LRV had no steering from the front wheels (this mysteriously fixed itself after the first EVA), but this did not hamper the excursion. The EVA commenced at a leisurely 6 mph with the LRV, and Scott and Irwin traveled to the base of Hadley Delta via the Hadley Rille (a rille is defined as a fissure or narrow channel on the moon's surface). They were in search of Elbow crater, which would help them establish exactly where they landed using the vector of distance and direction from their starting point.

Arriving at Elbow crater, they took photographs and Scott aligned the S-Band antenna so that Mission Control could operation the TV camera on the LRV. The crew took four samples from Elbow crater in a radial pattern, then moved on to their second station, St. George crater, which was the main objective of EVA-1. St. George crater was supposed to have ejecta that might reveal information about the interior of Hadley Delta, but no ejecta was seen so they decided to move on to a boulder sitting in the open. They took several samples at the boulder, then collected pebbles from the regolith (surface material). At this point, Mission Control was concerned about the time expended so far on the EVA and directed the crew to proceed back to the LM.

Back at Falcon, Scott and Irwin deployed the ALSEP (Apollo Lunar Surface Experiments Package). Scott had difficulties with the drill used to place heat-flow experiment probes. This drill, the ALSD or Apollo Lunar Surface Drill, was built by Martin Marietta and was one of the only contributions by that heritage company to the Apollo program. Mission Control finally told them to call it a day, after 6 1/2 hours of EVA. Apparently, during this entire time on the surface, Irwin was unable to get water from his water bag. This extreme dehydration

may have been a factor in Irwin's later health issues (four major heart attacks, the last one being fatal), described in his biography in this profile.

EVA-2

The second EVA targeted the Mount Hadley Delta region again. The first stop was at a site named Front. Scott felt the terrain variation was uninteresting, so they continued to another site about 1.9 miles away up the Delta. There they sampled a fresh-looking 3-foot crater and took other samples. Most were the common breccias, but there was one with porphyritic basalt, which was more significant geologically. Both crewmembers benefited greatly from their extensive geology training prior to the mission; CM pilot Worden also had extensive training to help him in feature identification and observation from orbit.

Scott explored a 40-foot crater nearby and a core sample was taken from inside the crater. Returning to the LRV, they drove 650 feet to a large boulder, which had a greenish tinge due to magnesium oxide. Continuing to Spur crater, they found and collected many small fragments on the rim. At this point, they saw what became the most famous lunar sample collected during the entire Apollo program. Sample #15415, a rock weighing 9.5 ounces, became known as the "Genesis Rock;" it was pure plagioclase or Anorthosite (extruded magma). Initially it was thought to be from the Moon's primordial crust, but later it was determined to be about 4.1 billion years old, forming after the Moon's crust solidified. It was still one of the oldest samples obtained on any mission. Later analyses of the oldest lunar rock samples found evidence of water in some of those samples, although this sample did not yield that same evidence. Plagioclase is in the Feldspar mineral group and is major constituent mineral on Earth, the lunar highlands and on Mars.



Genesis Rock: Sample 15415
Photo Credit: NASA

Time was running out on the walk-back constraint, so the crew was ordered to collect many small fragments from that same area. They returned to *Falcon* along the same path. At a crater known as Dune, Scott stopped the LRV long enough to collect samples from the area, including from a large basalt rock. Back at the LM, the drilling continued for the heat-flow experiment, but the ALSD would not penetrate more than a few inches before getting stuck. A post-flight analysis found that the drill design was flawed, with the flutes too close together at the joint joining the sections of the stem. A few other experiments were attempted, including an unsuccessful core sample, and the last task of the day was to set up the American flag. The crew had been outside *Falcon* for 7 hours and 12 minutes.



LM Pilot Jim Irwin Salutes the American flag on the Moon (*Falcon* and LRV in background)
Photo Credit: NASA

EVA-3

This third EVA was originally intended to traverse to an area known as the North Complex. This was canceled so that the crew could spend more time on trying to extract the core sample. Irwin and Scott slowly managed to work the sample out of the ground, finally retrieving a 7.9-foot sample that had 50 distinct layers. The crew continued to fix problems with the LM static TV camera, then made a film of the LRV in action and then finally set off for Hadley Rille. They arrived at a 50-foot crater near their original target area and decided it met the objective, stopping to collect samples. The regolith was extremely soft and turned out to be among the youngest (newest) material walked on by an astronaut on the moon. They continued to the Rille with an objective to sample exposed bedrock; this was attempted in a couple of areas. This also led to the retrieval of a huge basalt rock dubbed "Great Scott," weighing 21 pounds.

Traversing back to the LM, Scott performed the Galileo experiment with a hammer and a falcon feather, demonstrating that the gravity field of the moon, unhampered by atmospheric drag, would cause the same acceleration in the two bodies and they would reach the surface at the same time. The experiment was

a success; Scott then drove the rover about 300 feet from the LM so that its camera could observe the ascent stage lift-off. He placed a small Bible on the hand controller and then walked to a small hollow where he placed a plaque bearing the names of the fourteen astronaut and cosmonaut fatalities known at that time in 1971. The plaque was accompanied by a Fallen Astronaut statuette (a matter of some controversy after the mission). Scott and Irwin were outside the LM for 4 hours and 50 minutes on EVA-3.

Endeavour in Orbit

After *Falcon* departed for the lunar surface, Worden took the CSM to a higher orbit. *Endeavour* was designed with an upgraded Scientific Instrument Module (SIM) bay that had a door that could be jettisoned (that occurred during the translunar coast). The SIM contained a gamma-ray spectrometer and laser altimeter, a mapping camera, and a panoramic camera. Many of the instruments caused difficulties during assembly, integration and test before the launch. Also present were an alpha particle spectrometer and a mass spectrometer, located on a boom. Worden had difficulty with the booms during his scientific observations (an artifact of testing on Earth that could not fully simulate space conditions), but many photographs and analytical data were obtained. A Particles and Fields Subsatellite was released from the SIM bay into lunar orbit after the *Falcon* crew returned; this satellite operated for 17 months, returning data about plasma and energetic particle interactions and mass concentrations on the lunar surface.

Worden also did exercises to ensure he retained muscle integrity and he greeted NASA after emerging from the far side of the moon in different languages. Worden was in orbit alone for nearly four days. Just before *Falcon* left the surface, he had to perform an 18-second SPS burn to correct for drift over the launch site.

Falcon Departs the Moon; Return to Earth

The ascent stage of *Falcon* departed the moon at 17:11:22 GMT on August 2 after 66 hours and 55 minutes on the lunar surface. The camera on the LRV captured the launch and the Air Force theme played as they rapidly ascended (fed from *Endeavour* through Mission Control). Two hours later, *Falcon* docked with *Endeavour*, equipment and samples were transferred, and the LM ascent stage was jettisoned and intentionally crashed on the lunar surface. Seismometers left from Apollo 12, 14 and 15 picked up the impact. During the EVAs on the surface, doctors had noticed irregularities in both Scott's and Irwin's heartbeats but did not inform them (Scott was not happy about that decision). As noted earlier and in Irwin's biography, he had several serious heart problems after returning and died in 1991 of a heart attack. The doctors theorized they had both suffered from potassium deficiency due to the hard work on the surface.

The crew spent two more days in orbit around the moon, doing more observations and releasing the subsatellite. On August 4, at 21:22:45 GMT, the SPS engine burned for 2 minutes and 21 seconds, sending the crew into a trans-earth trajectory. The next day, Worden performed a 39-minute EVA at approximately 171,000 nautical miles from Earth to retrieve the film canisters in the SIM. *Endeavour* approached Earth on August 7, jettisoning the service module and re-entering Earth's atmosphere. One of the main parachutes failed after deploying, but only two were required for a safe splashdown. The crew were recovered by the USS *Okinawa* after a phenomenally successful mission lasting 12 days, 7 hours, 11 minutes, and 53 seconds. At home, I was so, so happy after seeing the launch and then sharing in the exploits of the crew on the lunar surface (some of those EVAs were after a proper bedtime, but my folks were indulgent and let me watch as much as possible on my summer break). This mission did result in an increase in interest in the Apollo program, primarily due to the interesting scenery at the landing site and the use of the LRV. Sadly, none of the crew ever flew again due to a controversy with a deal they made to carry (without NASA's knowledge) first day covers that they would bring back and sell to fund their children's education. The Fallen Astronaut statue that Scott left on the moon was supposed to be the only version, but the artist tried to sell limited editions of the statue, causing another controversy. The crew was reprimanded, although they did get a partial exoneration after a successful lawsuit by Al Worden and the covers were returned to them.

The first J-mission was a resounding success and NASA now turned to two more J-missions on the manifest: Apollo 16 and Apollo 17. These two missions, which launched in 1972, will be profiled in future MARS STAR editions, coinciding with their 50th anniversaries.

David R. Scott Biography

David R. Scott was born in San Antonio, Texas, on June 6, 1932. His father, Tom William Scott, was a fighter pilot in the Army Air Corps during WWII and rose to the rank of brigadier general; Scott recalls him as being a strict disciplinarian. Young David was sent to a military institute during the three years his father served in the war. By the time his father returned, he was very interested in aviation and was able to go up in military aircraft with his father. Although Scott wanted to attend West Point, he was unable to get an appointment, so he attended the University of Michigan on a swimming scholarship. In the spring of 1950, he received and accepted an invitation to attend West Point, primarily due to his swimming prowess. When Scott graduated from West Point in 1954, he volunteered to be commissioned in the Air Force (the USAF Academy opened that year), graduating 5th out of 633.

Scott did pilot training at Marana Air Base in Arizona, then went through additional training at other US Air Force bases before being posted to the 32nd Tactical Fighter Squadron in the Netherlands. Hoping to pursue a career as a test pilot, he was advised to get a graduate degree, so Scott enrolled at MIT and received a Master of Science Degree and the degree of Engineer in Aeronautics /Astronautics in 1962. He was chagrined when he was ordered to the USAF Academy to be an instructor and found a sympathetic ear at the Pentagon. His orders were changed to report to the USAF Test Pilot School at Edwards, under the command of Chuck Yeager. He was selected for the Aerospace Research Pilot School, flying high-altitude missions.

In 1963, Scott applied to be part of the third group of astronauts. He intended this to be a temporary detour from his military career. He was accepted and assigned to MIT to supervise the development of the Apollo Guidance Computer. He also served as CAPCOM for the Gemini IV and V missions. He was selected by Deke Slayton as a crew member on Gemini VIII with another space flight rookie Neil Armstrong, impressing other members of the Group 3 astronaut corps, as he had not served as a backup on any missions. The Gemini VIII mission attempted the first docking with the Agena upper stage. The two spacecraft began spinning after the docking and the crew, out of communication range with Mission Control, worked to immediately undock. The Gemini spacecraft began rotating much faster and Armstrong used the RCS (Re-entry Control System) thrusters to stop the tumble. In the mission rules, this use of the RCS required an immediate abort of the mission, necessitating a splashdown in the north Pacific. The main thruster failure was attributed to an electrical short.

Scott was assigned as a backup crew member for Apollo 1 and he and the other crew members spent much of their time at the North American Rockwell plant in Downey, California, supervising the build of the CSM for that mission. In the interim, the Apollo 1 fire took the lives of the primary crew on January 27, 1967 and Scott was assigned to a team to help redesign the CM hatch. He was then assigned to Apollo 8, but that mission was changed and Commander Jim McDivitt preferred to wait for the Apollo 9 mission, testing the LM and CM in earth orbit. Scott followed McDivitt to the Apollo 9 mission as CM pilot. He had extensive responsibilities on that mission that performed rigorous tests and rendezvous and docking maneuvers of the LM and CM.

Scott was named the backup commander of Apollo 12, along with Irwin and Worden as the other backup crew. This put them in line to be the prime crew for Apollo 15, which was publicly announced on March 26, 1970. After returning from that mission, the first-day cover scandal broke. Scott was assigned as a special assistant on the

Apollo-Soyuz Test Project. He did work on this project in Moscow and became friends with Alexei Leonov. In 1973, Scott was offered the job as deputy director at Dryden Flight Research Center, then he became the Center Director (a civilian role, requiring him to retire from the USAF). He retired from NASA in 1977. After NASA, his career included business projects and consulting work; he had a lucrative career working with Hollywood on various space films, including *Apollo 13* and the HBO miniseries *From the Earth to the Moon*; he also worked with the BBC on reporting and space projects and did a dual biography/history of the space race with Alexei Leonov.

Scott was married twice, first to Ann Ott in 1959 and they had two children. Later, he divorced Ann and married Margaret Black, the former vice-chairman of Morgan Stanley. They currently live in Los Angeles (Scott is still alive as of the writing of this article in August, 2021). Scott was forgiven over time for the first-day cover scandal and he was the recipient of many honors and awards, including being inducted into the US Astronaut Hall of Fame in 1993.

Alfred M. Worden Biography

Al Worden was born in Jackson, Michigan, on February 7, 1932. He was the second of six children and lived on a family farm. He received a one-year scholarship to the University of Michigan, but also applied and was accepted at West Point and at the US Naval Academy. Worden headed to West Point in 1951 and enjoyed the demanding life at that Academy, graduating 47th out of 470 in his class. He chose a commission in the Air Force after graduating, hoping for a faster promotion path. He received flight training at Moore Air Force Base in Texas. He found out he loved flying and worked his way through different aircraft types in different squadrons. In 1961, he asked to advance his career by studying Aerospace Engineering at the University of Michigan, earning Master of Science degrees in Aerospace and Instrumentation Engineering in 1963.

Worden then applied to the USAF Test Pilot School but was not selected. His superiors recommended him for an exchange program with the Royal Air Force in the UK at the Empire Test Pilots School in Farnborough. Returning to the States, Worden served as an instructor at the Aerospace Research Pilot School serving under its commander, Chuck Yeager. Worden applied for the third group of astronauts in 1963, but NASA did not want to interfere with (at that time) his pending orders for Farnborough. In 1966, the fifth group of astronauts was recruited; at the same time, the Air Force was seeking qualified candidates for the Manned Orbiting Laboratory (MOL). Worden felt that the MOL project would never get off the ground (very prescient) and he applied to NASA. At the age of 34, he was one of 19 candidates selected.

His early assignments including working on a team in 1966 headed by Pete Conrad to oversee the design and build of the Block II Command Module, which became the version that flew to the Moon. He was at the North American Rockwell plant in Downey when the fire occurred on the pad on January 27, 1967, killing the crew of Apollo 1. When missions picked up again, Worden was assigned to the support crew for Apollo 9, then was elevated to backup CM pilot for Apollo 12, making him the prime CM pilot candidate for Apollo 15. Worden became life-long friends with Apollo 12 prime CM pilot Dick Gordon, and they worked on contingency techniques so that the CM Pilot could bring a crippled craft home.

In 1970, Worden was picked to be prime crew on Apollo 15. As this mission turned into the first J-mission, Worden's training and responsibilities grew and he spent a lot of time working with the legendary Egyptian-American geologist Farouk El-Baz. He did geology training with the rest of the crew and supervised the construction and testing of the CSM at North American Rockwell. Before the mission, Worden appeared on *Mister Rogers' Neighborhood* to talk about space travel and take questions from the children.

After returning from the mission, where he enjoyed his isolation in orbit around the moon, the first-day cover incident was revealed. At the time, the three members of Apollo 15 were assigned as the back-up crew for Apollo 17. The astronauts were reprimanded and congressional hearings were scheduled (of course). Irwin retired, but Worden was still looking for another job at NASA. Dale Myers, the associate administrator for Manned Space Flight, helped Worden get a position at the Ames Research Center in California. Worden retired from NASA and the Air Force in 1975, having reached the rank of Colonel.

After retiring, Worden worked to re-establish his reputation with other astronauts through the Mercury 7 Foundation, ran for the House of Representatives from the 12th congressional district in Florida (losing the primary) and sued NASA about the first-day cover situation; NASA conceded the lawsuit and returned the covers to the astronauts in 1983. Worden held various positions with companies before retiring from the business world in 1996. He wrote a fantastic and best-selling autobiography, *Falling to Earth: An Apollo 15 Astronaut's Journey to the Moon*, and accepted most of the responsibility for the first-day cover incident in that book. (I highly recommend this book—very truthful, funny, and well-written.) He also wrote a children's book about space exploration and a book of poems.

Worden was married three times, had two daughters with his first wife Pamela Vander Beek and a stepdaughter from his third marriage to Jill Hotchkiss.

He married Vander Beek in 1955 and they divorced in 1969, making him the first astronaut to be divorced before flying in space. Worden died on March 18, 2020, in assisted living, after suffering an infection at home. He received many awards and accolades for his contributions to the Apollo program and is in the Astronaut Hall of Fame.

James B. Irwin Biography/My Remembrances

Irwin was born on March 17, 1930, in Pittsburgh Pennsylvania. His grandparents on his father's side emigrated from County Tyrone, Ireland. At the age of 12, Irwin told his mother that wanted to go to the moon and hoped to be the first (he ended up being the eighth on the lunar surface). He graduated from high school in Salt Lake City and received an appointment to the US Naval Academy, graduating in 1961. Irwin continued his studies at the University of Michigan, receiving Master of Science degrees in Aeronautical and Instrumentation Engineering. Irwin moved to the Air Force, receiving initial flight training at Hondo and Reese Air bases. He graduated from the Air Force Experimental Flight Test Pilot School in 1961 and the Aerospace Research Pilot School in 1963. Prior to joining NASA, he was chief of the Advanced Requirements Division at the Air Defense Command and received numerous citations.

Irwin was a developmental test pilot for the Lockheed YF-12 (Mach 3 fighter-interceptor and precursor to the SR-71). A student pilot that Irwin was teaching in 1961 crashed their plane, resulting in numerous injuries to both; Irwin had compound fractures, amnesia and nearly lost a leg but for the skills of an Air Force orthopedic surgeon. Irwin applied to NASA and was selected in the group of 19 astronauts in 1966 (same group as Worden). He worked on a team performing environmental qualification testing of the Lunar Module, then was assigned to the support crew of Apollo 10. Irwin was back-up LM pilot for Apollo 12, leading to his assignment on the primary crew for Apollo 15.

After the Apollo mission, Irwin resigned from the Air Force and NASA following the reprimands for the first-day cover incident. While on the Moon, Irwin had a spiritual epiphany and felt the presence of God. He and his wife became born-again Christians and started a ministry known as the High Flight Foundation, which was based in Colorado Springs at that time. Irwin's health was never the same after Apollo 15. In fact, the arrhythmia he suffered from on the Moon was considered very serious by Mission Control and they were concerned he had a heart attack at that time. He suffered three heart attacks, starting two years after returning (resulting in a triple-bypass) and finally culminating in his death from a fourth heart attack on August 8, 1991, making him the first moonwalker to pass away. He and his second wife, Mary Ellen Monroe, were married in 1959 and had five children. Irwin wrote several books

and did expeditions trying to find Noah's Ark on Mount Ararat. He is in the Astronaut Hall of Fame.

In 1973, I was a freshman struggling (like most of us did) through the basic classes in Electrical Engineering at the University of Colorado in Boulder. I read that Jim Irwin had published an autobiography of his experiences on the Apollo 15 mission and his deep Christian belief. I called my parents in excitement because Irwin was going to sign the book at a Bible bookstore in Aurora. My Dad went and got a signed copy of "*To Rule the Night: The Discovery Voyage of Astronaut Jim Irwin*" (I was deep into my second semester, so I couldn't skip classes) and talked to Irwin about my interests and our viewing of his launch in 1971. He gave Irwin our home address. During my sophomore year, I received a short letter from Irwin at the High Flight Foundation telling me that he was doing a presentation at the Engineering school in Boulder about the Apollo 15 mission. My parents came up and we attended the presentation together; I introduced myself and my parents to Irwin after the presentation (he remembered my dad) and we started a real correspondence after that point. He wrote me four or five letters encouraging me in my Engineering studies and I wrote right back, asking him questions and getting advice. It was a wonderful follow-on to have this mentoring after seeing the launch of Apollo 15. Sadly, I have looked in about every storage box in our house and have not found those letters or my pictures of the launch. I will have to be content with the memories and my eternal gratitude to my late parents for taking me to see the launch.

Resources and Links

Apollo Flight Journal: <https://history.nasa.gov/afj/>

[*To Rule the Night: The Discovery Voyage of Astronaut Jim Irwin - Irwin, James B & Emerson, William A. Jr., Published by A.J. Holman, 1973 – Available at Amazon and secondary markets*](#)

[*Falling to Earth: An Apollo 15 Astronaut's Journey to the Moon – Worden, Al & French, Francis, published by Smithsonian Books, 2012 – Available at Amazon and Smithsonian books*](#)

Apollo 15 Mission report:
https://www.nasa.gov/mission_pages/apollo/missions/apollo15.html

Wikipedia: Astronaut Biographies, general overviews of the mission:
https://en.wikipedia.org/wiki/Apollo_15

On This Date in History

This section has milestones retrieved from publicly available information for LM, ULA and heritage programs

from 10 to 60 years ago (2011, 2001, 1991, 1981, 1971, 1961). Delta launches prior to the formation of ULA, unless it included an LM or heritage company payload or upper stage, are not listed. No classified programs are identified, even if the program is now considered unclassified, except for the Discoverer program (Corona). The events reflect milestone activity in the quarter before the release of the MARS STAR – where appropriate, key press releases are also included; significant milestones are in bold. The list is not intended to be all-inclusive due to historical record inaccuracies. Occasionally, a major space milestone not accomplished by any of our heritage programs will be included due to its significance.

Events in July (10 to 60 years ago)

- **07/08/2011: STS-135 (*Atlantis*) launched, LC-39A, KSC; 4-person crew, Raffaello MPLM for ISS; Last STS flight**
- 07/15/2011: GPS-IIF-2 launched by ULA Delta IV-M+ (4/2), LC-37B, CCAFS
- 07/12/2001: STS-104 (*Atlantis*) launched, LC-39B, KSC; 5-person crew, ISS assembly/components
- 7/23/2001: GOES-12 launched by LM Atlas IIA, LC-36A, CCAFS
- 07/29/1991: Lockheed UGM-133 Trident D-5 (four) launched, USS *Pennsylvania*, ETR
- 07/11/1981: Lockheed UGM-73 Poseidon C3 (four) launched, USS *George C. Marshall*, ETR
- 07/16/1971: Classified launched by Thorad SLV-2H Lockheed Agena-D, SLC-1W, VAFB
- **07/26/1971: Apollo 15 launched, LC-39A, CCAFS; first use of Lunar Roving Vehicle and First J-Mission; Subject of the Program Profile in this edition of the MARS STAR History Corner**
- 07/01/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS
- 07/07/1961: GD SM-65E Atlas launched, LC-13, CCAFS
- 07/07/1961: Discoverer 26 launched, Thor DM-21, Lockheed Agena-B, LC-75-3-5, VAFB
- 07/12/1961: RCA Tiro-3 (Tiro-C) launched by Thor DM-19 Delta, LC-17A, CCAFS
- 07/12/1961: MIDAS-3 launched by GD Atlas LV-3A Lockheed Agena-B, LC-1-2 Point Arguello; maiden flight of Atlas LV-3A Lockheed Agena-B
- 07/13/1961: Lockheed UGM-27 Polaris A2 launched, LC-29A, CCAFS
- 07/20/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS
- 07/21/1961: MM HGM-25A Titan I launched, LC-20, CCAFS
- **07/21/1961: Mercury-Redstone 4 (Liberty Bell – Gus Grissom) launched, LC-5; spacecraft sank during recovery operations. Second manned US spaceflight; significant space milestone**
- 07/21/1961: Discoverer 27 launched by Thor DM-21 Lockheed Agena B, LC-75-3-4, VAFB; **LAUNCH FAILURE**

- 07/25/1961: MM HGM-25A Titan I launched, LC-19, CCAFS
- 07/31/1961: GD SM-65E Atlas launched, LC-11, CCAFS

Events in August (10 to 60 years ago)

- **08/05/2011: LM/NASA Juno Spacecraft launched (mission to Jupiter) by ULA Atlas V 551, LC-41, CCAFS**
- 08/06/2011: LM BSAT-3c/JCSAT-110R launched on Ariane 5 ECA, ELA-3, Kourou, French Guiana (also launched Astra 1N satellite).
- 08/06/2001: DSP-21 launched by LM Titan IVB (402)/IUS, LC-40, CCAFS
- **08/08/2001: LM Genesis launched by Delta II 7325-9.5, LC-17A, CCAFS; Genesis parachute failed to deploy on September 8, 2004, but samples were obtained (PARTIAL SPACECRAFT FAILURE AT RETURN)**
- 08/10/2001: STS-105 (*Discovery*) launched, LC-39A, KSC; 7-person crew, ISS assembly, Leonardo MPLM
- 08/02/1991: STS-48 (*Atlantis*) launched, LC-39A, KSC; 5-person crew, TDRS-5 deployment
- 08/30/1991: Lockheed UGM-133 Trident D-5 launched, USS *Kentucky*, ETR
- 08/06/1981: FLTSATCOM 5 launched by GD Atlas SLV-3D/Centaur-D1AR, LC-36A; **LAUNCH FAILURE**, Payload Fairing collapsed
- 08/13/1981: Lockheed UGM-96 Trident 1 C4 (four) launched, USS *John C. Calhoun*, ETR
- 08/22/1981: Lockheed UGM-73 Poseidon C3 launched, USS *Nathanael Greene*, ETR
- 08/28/1981: Lockheed UGM-96 Trident 1 C4 launched (four), USS *Simon Bolivar*, ETR
- 08/07/1971: Multiple technology demonstration satellites launched, GD Atlas E/F, BMRS-A2, VAFB
- 08/12/1971: Classified launched by Titan III (24)B, SLC-4W, VAFB; maiden flight of Titan III (24)B
- 08/02/1961: Lockheed UGM-27 Polaris A2 launched, LC-29A, CCAFS
- 08/04/1961: Discoverer 28 launched, Thor DM-21 Lockheed Agena-B, LC-75-3-4, VAFB; **LAUNCH FAILURE**
- 08/04/1961: MM HGM-25A Titan I launched, LC-20, CCAFS
- 08/09/1961: GD SM-65F Atlas launched, LC-13, CCAFS; maiden flight of Atlas F
- 08/10/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS; **LAUNCH FAILURE**
- 08/12/1961: Lockheed UGM-27 Polaris A1 launched (six); USS *Abraham Lincoln*, ETR
- 08/18/1961: Lockheed UGM-27 Polaris A2 launched, USNS Observation Island, ETR; **LAUNCH FAILURE**
- 08/22/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS
- 08/23/1961: GD SM-65D Atlas launched, LC-576B-3, VAFB
- 08/23/1961: Ranger 1 launched by GD Atlas LV-31 Lockheed Agena-B; **PARTIAL FAILURE OF AGENA**

- 08/30/1961: Discoverer 39 launched by Thor DM-21 Lockheed Agena-B, LC-75-3-4, VAFB

<https://www.ulalaunch.com/missions>
<https://news.lockheedmartin.com/news-releases?year=2021>
<https://space.skyrocket.de>
<http://www.astronautix.com>

Events in September (10 to 60 years ago)

- **09/10/2011: LM/NASA GRAIL A/B launched by ULA Delta II 7920H, LC-17B, CCAFS; last launch of Delta II heavy, last launch from LC-17**
- 09/08/2001: USA-160 and 160-2 launched by LM Atlas IIAS, SLC-3E, VAFB
- **09/30/2001: Four technology demonstration satellites launched by LM Athena I, Kodiak LP-1, Alaska; last flight of Athena I; first orbital launch from Kodiak**
- 09/12/1991: STS-48 (Discovery) launched, LC-39A, KSC; 5-person crew, UARS deployed
- 09/17/1991: MM LGM-118 Peacekeeper launched, LF-01, VAFB
- 09/03/1981: Classified launched by MM Titan III(32)D, SLC-4E, VAFB
- 09/22/1981: MM MGM-31A Pershing launched (two), Fort Bliss
- 09/29/1981: MM MGM-31A Pershing launched (two), Fort Bliss
- 09/01/1971: LAR-2 launched by GD Atlas E/F, BMRS A-1, VAFB
- 09/10/1971: Classified launched by Thorad SLV-2H Lockheed Agena-D, SLC-3W, VAFB
- 09/07/1961: MM HGM-25A Titan I launched, LC-20, CCAFS
- 09/08/1961: MM HGM-25A Titan I launched, LC-19, CCAFS
- 09/08/1961: GD SM-65E Atlas launched, LC-13, CCAFS; **FAILURE**
- 09/09/1961: Samos 3 launched by GD Atlas LV-3A Lockheed Agena-B, LC-1-1, Point Arguello; **LAUNCH FAILURE**
- 09/12/1961: Discoverer 30 launched by Thor DM-21 Lockheed Agena-B, LC-75-3-5, VAFB
- 09/13/1961: Mercury-Atlas 4 launched by GD Atlas LV-3B, LC-14, CCAFS (test flight)
- 09/13/1961: MM MGM-31 Pershing 1 launched, LC-30A, CCAFS
- 09/17/1961: Discoverer 31 launched by Thor DM-21 Lockheed Agena-B, LC-75-1-1, VAFB; **SPACECRAFT FAILURE**
- 09/23/1961: MM HGM-25A Titan I launched, LC-395A-1, VAFB
- 09/26/1961: MM MGM-31 Pershing I launched, LC-30A, CCAFS
- 09/29/1961: MM HGM-25A Titan I launched, LC-20, CCAFS
- 09/29/1961: Lockheed UGM-27 Polaris A1 launched, LC-25A, CCAFS

Next Edition

Tune in for a History on the Road edition! In the next MARS STAR, I will explore the Kennedy Space Center and the Cosmosphere (in Hutchinson, Kansas). Coming soon: 60th anniversary of the flight of John Glenn, Apollo 16, 25th Anniversary roundtable of the Titan/Centaur Cassini launch, Apollo 17.

Barb Sande, MARS STAR and MARS Facebook Page Historian. Contact me at barbsande@comcast.net or 303-887-8511 or find MARS Associates on Facebook.

Reference websites:

<https://nssdc.gsfc.nasa.gov/planetary/chronology.html#2014>
https://en.wikipedia.org/wiki/Timeline_of_spaceflight