



“Go at throttle up”

“The naming of the crew for the next flight is a major event in the process of returning the Shuttle to flight.”

Rear Admiral Richard H. Truly,
NASA Associate Administrator for Spaceflight
STS-26 crew announcement, January 9, 1987.

One year before Dick Truly’s statement, the Shuttle manifest for 1986 featured a demanding 15 launches, including 13 from the Kennedy Space Center (KSC) and the first two from Vandenberg Air Force Base (AFB) in California, as shown in Table 11.1.

The highlights included the first deployments of the liquid-fueled Centaur upper stage, the maiden launch from Vandenberg (to send a Shuttle into polar orbit for the first time), and the long awaited deployment of the Hubble Space Telescope (HST). The two delayed Tracking and Data Relay Satellite (TDRS) deployments were also on the manifest, along with four missions carrying commercial satellites, one of which was intended to retrieve the Long Duration Exposure Facility (LDEF) deployed during the STS-41C mission in April 1984. There were three further classified Department of Defense (DOD) missions (two from KSC and the second launch from Vandenberg) and two Spacelab science missions (Astro pallet-only payload, and Earth Observation Mission 1 Small Module and pallet payload).

All 12 of the 1986 missions included at least one member from the Thirty-Five New Guys (TFNG) Class of 1978 on each flight crew. Now a full decade after they responded to the call for new astronauts to train as crewmembers on the Space Shuttle, the remaining 33 members of the TFNG continued to be a strong presence at the forefront of American human space flight.

TABLE 11.1: STS CREW ASSIGNMENTS (1986) NASA ASTRONAUTS ONLY

STS Flight	Primary payload	Orbiter	Planned launch date	Commander	Pilot	Mission Specialists
61-C	Satellite deployment	Columbia	Jan 12	GIBSON R.	Bolden	NELSON HAWLEY G. Chang-Diaz
51-L	TDRS-B	Challenger	Jan 28	SCOBEE	Smith M.	ONIZUKA RESNIK McNAIR
61-E	Astro-1	Columbia	Mar 6	McBRIDE	Richard R.	Leestma HOFFMAN Parker
61-F	Ulysses solar polar orbiter	Challenger	May 15	HAUCK	Bridges	Hilmers Lounge
61-G	Galileo Jupiter probe	Atlantis	May 20	WALKER D.	Grabe	THAGARD VAN HOF TEN
61-H	Satellite deployment	Columbia	Jun 24	COATS	Blaha	Springer FISHER A. BUCHLI
62-A	DOD	Discovery	Jul 1	Crippen	Gardner S.	MULLANE Ross GARDNER D.
			1 st Vandenberg			
61-M	TDRS-C	Challenger	Jul 22	SHRIVER	O'Connor	Lee RIDE Fisher W.
61-J	Hubble deployment	Atlantis	Aug 18	Young J.	Bolden	McCandless HAWLEY SULLIVAN
61-N	DOD		Sep 4	SHAW	McCulley	Leestma Brown M. Adamson
61-I	Intelsat-4; LDEF retrieval		Sep 27	WILLIAMS D.	Smith M.	Bagian Dunbar Carter
62-B	DOD		Sep 29			
			Vandenberg			
61-K	Earth Observation		Oct 1	Brand	GRIGGS	STEWART Garriott O.
	Mission - 1					
61-L	Satellite deployment		Nov 1			
71-B	DOD		Dec			

Even taking into account the skills of the astronauts and ground crews, and the success of past missions, it was clearly obvious that suddenly increasing flight operations from nine missions in 1985 to 15 in 1986 – and from two different launch sites on opposite sides of the country – was going to be difficult at best, even without considering potential hardware failures and weather delays. The difficulties experienced each side of the 1985 Christmas holidays in getting STS-61C off the ground, and in returning it to Earth during early January 1986, certainly underlined that, but no one could foretell the enormous and tragic setback the very next mission would bring.

History reminds us that Tuesday, January 28, 1986, would end as a second dark day in NASA's history. The vivid events of that day are etched in the memory of those who were there or watched the event unfold on TV around the world. They would give rise to the desire to honor the sacrifice of those lost that day and, when the time was right, to return astronauts to orbit. Dick Truly's statement which opened this chapter was a step in that direction. The tragic accident which claimed the lives of seven brave astronauts, including four members of the 1978 selection, came 19 years and one day after the horrendous pad fire that claimed the three lives of the first Apollo crew, thereby adding to those still-raw memories of nearly two decades before.

CHALLENGER

The primary goal of STS-51L was to launch the second TDRS (TDRS-B). This was one of the scheduled duties for Mission Specialist (MS) Ellison Onizuka during the six-day *Challenger* flight. He was also due to film Halley's Comet with a hand-held camera. *Challenger* was also to carry the Spartan Halley spacecraft, a small free-flying satellite that MS Ron McNair and Judith Resnik were to release and then pick up two days later using *Challenger's* Remote Manipulator System (RMS) robotic arm, once Spartan had observed Halley's Comet during its closest approach to the Sun. This intended mission would never be completed.

STS-51L (January 28, 1986)

Flight Crew: Francis R. SCOBEE (CDR), Michael J. Smith (PLT), Ellison S. ONIZUKA (MS-1), Judith A. RESNIK (MS-2), Ronald E. McNAIR (MS-3), Gregory B. Jarvis (PS-1, Hughes Communications Inc.), S. Christa McAuliffe (PS-2, Teacher)

Spacecraft: Challenger (OV-099) 10th mission

Objective: 25th Shuttle mission; deployment of TDRS-B; observations of Comet Halley; Teacher in Space program

Duration: 1 minute 13 seconds (planned as 6 days 34 minutes)

Support Assignments: For this mission, Fred GREGORY served as Lead Capcom, with fellow Group 8 astronaut Dick COVEY, who were both in the Mission Control Center (MCC) as the disaster of 51L unfolded on the TV screens, audio links and computer consoles around them. Had the flight proceeded according to plan, the SPacecraft ANalysis (SPAN) team would have been led by John CREIGHTON, with Steve NAGEL and Don WILLIAMS in support. [1] No other details of planned support roles by the TFNG could be found in the sources researched by the authors.

The STS-51L flight had originally been scheduled for December 1985, but was then rescheduled for launch on January 22, 1986. Operational difficulties further delayed the flight, bumping it daily from January 22 through to Saturday January 25. That morning, a group of senior NASA officials met at the Cape for their “L-1 [Launch minus one] day review.” The weather was of principal concern, with the recent cold spell persisting and rain forecast for the next day. For a Shuttle launch, rain would present a no-go situation because even something as innocuous as raindrops could damage the delicate heat tiles on the exterior of the Orbiter, causing pockmarks that might later compromise the integrity of the tiles during the intense heat of re-entry. The group met again later that night, with rain still threatened for the next day, so a decision was made to postpone the launch for another 24 hours.

To the crew’s frustration, the weather on Sunday, January 26 was fine. NASA officials were still concerned about a build-up of threatening weather both in the vicinity of the Cape and at the emergency landing field in Africa. However, the expected bad weather never materialized, and in fact conditions would have been perfect for a launch.

Speaking to reporters after the evening meeting on January 26, NASA’s Associate Administrator, Jesse W. Moore, issued a sadly prophetic statement: “We’re not going to launch this thing and take any kind of risk because we have that schedule pressure. We’re going to continue to abide by the flight rules that we’ve established in this program and we’ll sit on the ground until we all believe it’s safe to launch.” [2]

The following day, Monday 27, the crew were dressed in their flight suits, boarded a transfer bus, and were driven the six miles out to Launch Pad 39B, delighted to hear updates stating that the launch countdown was proceeding and on schedule.

Once at the launch pad, the 51L crew disembarked and entered a small elevator that would take them up to the entry level, where the Shuttle’s open hatch awaited them. They gathered in the area outside the hatch where they donned the rest of their flight suits and safety harnesses. Mission Commander (CDR) Dick Scobee and Pilot (PLT) Mike Smith then put on their helmets and safety harnesses before

being assisted through the hatch into the Orbiter. They were followed in turn by the two MS who would sit behind them on the flight deck for the launch, Judy Resnik and Ellison Onizuka. Finally, it was the turn of the remaining three crewmembers, who would occupy seats on the middeck during the launch phase. They were MS Ron McNair, Payload Specialist (PS) Greg Jarvis from the Hughes Aircraft Company, and a schoolteacher named Christa McAuliffe, who had been selected after a nationwide search among suitable educator applicants.

While the crew were being strapped in, the skies over the Cape were clear, with an air temperature of 4.4°C (40°F). Then, with just nine minutes left on the countdown clock, a hold was announced after it was discovered that an external handle on the Orbiter's hatch was stuck and would not close properly. Technicians were rushed in and tried to remove a bolt causing the problem but were unable to do so. Over the next four hours, the crew waited patiently until the bolt was finally blown, but by then the crosswinds had picked up over the KSC runway to a level that was unacceptable in the event of an emergency Return To Launch Site (RTL) abort. The decision was made to postpone the flight once again, until 9:38 am the following morning. The crew was understandably frustrated by yet another delay, especially Judy Resnik. Unfortunately, she had become used to the frustration of technical problems and launch delays, having suffered two such setbacks on her first flight, STS-41D in 1984. STS-51L had now been delayed five times.

It was freezing cold on Launch Pad 39B the following morning, Tuesday, January 28. As night gave way to morning, a dull and wintry sunrise had slowly spread daylight over the Cape. Despite the extreme chill in the air, the early forecast was for clear skies, and the crewmembers, woken at 6:30 am, were told this could be their day. Out by the launch pad, where *Challenger* had stood poised for launch over the past 38 days, a battery of 45 massive flood lamps that had lit the steel launch tower during the night were extinguished.

By 7:00 am, the temperature stood at -3°C (27°F), and NASA's "ice team" had completed their morning inspection of the Shuttle's huge external fuel tank, which had been refueled with super-cooled propellants. It was also the team's job to report on the amount of ice at the launch pad in these conditions, in case it reached dangerous levels. Their report was alarming. Sheets of ice and thick, sharp stalactites had formed over many of the pad facilities. Given the massive vibration associated with a Shuttle launch, this ice could be dislodged and tumble down onto the ascending Orbiter. The team managed to break off and remove many of the thicker sections of ice, but it soon began to build up again in the chill, moist air. The situation, as they reported, was far from ideal. Nevertheless, preparations continued.

Once again, the crew were assisted into their flight suits and, following a ten-minute briefing, were driven out to the launch pad. On arrival they stepped down from the van and CDR Scobee chatted briefly with the launch pad crew. "My kind of day," he said. "What a great day for flying."

As she was preparing to enter *Challenger* through the open crew hatch, Christa McAuliffe was handed a last-minute gift by a launch technician that caused her to chuckle. It was a shiny red apple, presented to America’s favorite teacher. Although she was unable to take it on board, Christa handed the apple back with a smile, thanking the man for his kindness.

By 8:36 am, all seven crewmembers had clambered through the open hatch and were tightly strapped into their seats aboard *Challenger*, where they began going through their pre-launch checks. During this time, they were informed that liquid hydrogen tanking problems, delays created by hardware interface problems, and a broken water pipe on the pad, had led to the launch being rescheduled for 11:38 am.

NASA officials were still edgy about the cold weather and how it might affect the launch. Up until that time, the average temperature experienced on Shuttle launches had been 23°C (73°F), and the coldest temperature at any lift off was 10.5°C (51°F). By mid-morning, the temperature at the Cape had only crept up to a few degrees above zero. The launch pad crew had earlier been asked to double-check for any problems with ice build-up. Not only could it damage launch equipment, but it had been known on some previous missions that ice falling from the cryogenic-filled External Tank (ET) had hit and damaged the fragile tiles of the Shuttle’s exterior during launch. While the pad crew’s report at 8:44 am was not altogether encouraging, it did state that the majority of the ice could either be cleared away in time, or even melt to an acceptable level before the revised launch time. They conducted a third inspection at 10:30 am, during which they cleared away some lingering ice from the launch platform. Meanwhile, at T-70 minutes, *Challenger*’s hatch was closed, sealing the crew inside.

As the countdown ticked by, Scobee and Smith ran through all their checks, keeping an eye out for any malfunctions in the Shuttle’s systems. They were mindful that they would be completely at the mercy of technology for the first two minutes and eight seconds of the launch, as *Challenger* hurtled ever faster into the Florida skies atop 3,000,000 kg of thrust.

The countdown finally clicked over into the final ten seconds before launch. As the count reached the six seconds mark to lift off, the Shuttle’s three main engines burst into life, quickly building up thrust prior to the ignition of the twin Solid Rocket Boosters (SRB). On board, Scobee reported the firing of the main engines to his crew, saying, “There they go, guys!” An excited Judy Resnik cried out, “Alright!” followed by Scobee reporting that all three engines were at 100 percent of their rated power.

At 11:38:00:010 am EST, *Challenger*’s SRBs roared into life, and the winged spacecraft began to rise atop a brilliant pillar of white-hot flame. Clouds of black, orange and white billowed outward as the Shuttle cleared the launch tower and

rose into the sky. KSC Public Affairs Officer (PAO) Hugh Harris calmly announced to the onlookers and television audience: "Lift off! Lift off of the twenty-fifth Space Shuttle mission and it has cleared the tower." Steady as a rock, *Challenger* soared into the heavens, trailing a 200-meter geysers of fire and smoke.

Sixteen seconds into the flight, *Challenger* automatically executed a single-axis rotation, and Dick Scobee reported, "Houston, we have a roll program," as the Shuttle arched gracefully backward, assuming a 'heads down' orientation and the correct downrange course for passing through the Earth's atmosphere. This flight configuration ensured that aerodynamic stresses on the Shuttle assembly were tolerable prior to entering orbit.

A further 20 seconds later, *Challenger's* engines were throttled down to 65 percent of full power as the crew prepared themselves for the Shuttle's passage through the period of highest turbulence, known in the NASA lexicon as Max-Q, or maximum dynamic pressure. At this point, the force of air rushing past the ascending Shuttle assembly could cause severe damage, so the acceleration process is deliberately slowed.

Over the next 14 seconds, the crewmembers were jolted around in their seats as *Challenger* passed through a fierce wind shear. Soon after, the air began to thin as they reached higher altitude, and the outside pressure decreased, at which time the main engines could be brought back up to full thrust. "Throttling up," Scobee announced to ground controllers.

Group 8 astronaut Dick Covey was the Capcom that day, running through the post-launch sequences with Scobee and Smith. All the data before him indicated a perfect flight trajectory as *Challenger* headed east out over the Atlantic, and he responded to Scobee's call with, "*Challenger*, go at throttle up."

Everything was proceeding normally as Dick Scobee pressed the transmit button. It was 70 seconds into the flight. "Roger," he responded. "Go at throttle up." Suddenly the Shuttle assembly began to shudder and sway violently. Pilot Mike Smith realized something was seriously wrong and just had time to utter the words, "Uh oh!" before a massive fireball flashed along the length of *Challenger*, followed by a titanic explosion.

In hindsight, the launch should never have taken place under the prevailing conditions of that freezing cold morning. Even as the final countdown was taking place, two O-rings located in the lowermost field joint of the right-hand SRB had become rock hard due to the extreme cold, which resulted in them losing their designed ability to seal the crucial joint completely. As the Shuttle assembly blazed a path into the Florida skies, a puff of black smoke escaped from the joint at the bottom of the right-hand booster rocket. This then became a thin stream of superhot propellant gas which grew in intensity. Acting like a blowtorch, the white-hot plume of gas then played on one of the steel struts holding the SRB

against the huge, hydrogen-filled ET. The strut was burned through and broke apart, at which point immense aerodynamic forces caused the booster to sever and swivel around, slamming into the massive fuel tank, which ruptured. Two million liters of propellant exploded in a huge fireball.

There is an understandable misconception that *Challenger* was consumed by the ensuing fireball, but the Shuttle was actually lost when it was ripped apart by the force of the air, as explained by veteran Shuttle astronaut Don Peterson, a crewmember on STS-6, *Challenger*'s maiden flight into space in April 1983.

“When that vehicle turned sideways, the wind force just ripped it apart,” Peterson once told JSC interviewer Jennifer Ross-Nazzal. “When we launch the Shuttle and we light all five engines, we’re burning ten and a half tons of fuel per second. That’s the weight of three full-sized automobiles every second being burned up. The amount of energy and the force and the power that’s in that vehicle is gigantic ... and when you’re boring through the atmosphere at high speed, the wind force is tremendous. The Shuttle is not designed to stand big side loads. You’ve got to keep it pointed exactly properly. Once that rocket came loose and pushed the stack sideways, it just came apart. It just literally disintegrated.” [3]

There was immediate confusion among those on the ground watching the launch. One moment they were watching a perfect launch and the Shuttle assembly soaring into the blue Florida skies; the next moment, a vast white, orange and red cloud billowed outwards from where *Challenger* had been, and the two boosters unexpectedly emerged from the conflagration, still firing wildly. The cheers of the spectators were quickly choked back amid the confusion, and silence soon fell as the reality of what the massive fireball above them meant hit home. As the seconds ticked by, debris trailing white smoke drifted out of the billowing cloud, while people still clung to the increasingly forlorn hope that *Challenger* had somehow survived the explosion and would appear at any moment, heading back for a landing at the Cape.

Across the United States, millions of people were watching the launch live on television, including many thousands of schoolchildren and teachers who had been following Christa McAuliffe’s training, in anticipation of watching the lessons she was going to transmit to them from orbit. Once they realized that something had gone horrifyingly wrong, shocked teachers, many of them crying uncontrollably, ushered their confused and frightened students back into their classrooms. A collective grief would sweep across the country for many days to come, while images of the Shuttle erupting into a fireball and disintegrating on live television will be forever burned into the minds and memories of those who witnessed the tragedy.

As Rhea Seddon later told *Popular Mechanics* magazine: “I happened to be at an off-site building [near the Johnson Space Center, JSC] doing some training for

my next mission. The launch was supposed to start around the same time as our meeting, so we found a TV and turned it on. It's always a joyful morning, especially to see friends go to space.

"I said, 'Oh, look, you can see the boosters coming off'. And one of my crewmates – he was looking at his watch – said, 'No, it's too early'. We weren't supposed to jettison the boosters until they were burned out. The camera panned back, and all you could see was a cloud of ... stuff. We thought the engines were still going, with the Shuttle attached to the [fuel] tank. Then they showed the ocean and there were pieces coming down – big chunks of something." [4]

As Mission Control Capcom on the STS-51L mission, Dick Covey was the designated sole communicator with the crew aboard *Challenger*. "We had been disciplined to watch our data, not to get distracted by watching whatever video might be running in the control center," he recalled, also for *Popular Mechanics* magazine. "So I'm watching my data, and there's nothing unusual through the throttle up. The engine guys confirm that the engines look good, so I make a call: 'Go at throttle up'. Dick [Scobee] responded. And then I'm starting to think about what's the next thing that's coming, if we're going to make a call or whatever, and the data just went all *Ms*, which is 'missing'.

"Fred [Gregory] was in charge of weather and so he was able to watch the video, and he almost immediately says, 'Look!' And so I turned and I looked, but I didn't know what I was looking at. I didn't see how it originated, nor did I understand exactly what it was. It just didn't register with me. At best, the Orbiter was separated from everything else and maybe trying to find a way to fly. And the worst thing in an emergency when you are flying is to have someone on the ground trying to talk to you without giving you the help that you need. So I was reluctant to be a distraction unless I had something I could tell them. If they weren't talking to us, then they either didn't have the ability to talk to us, or they were busy enough that they didn't want to talk to us. I asked for emergency procedures, contingency aborts, anything that we could do to help them. And then it became obvious that there wasn't anything we could do, and we were spectators in a tragedy.

"People said, 'Well, the External Tank obviously exploded', because that was what made the big fireball. But what caused it, nobody had a clue. It was days, if not a week, before any of us could say, 'All right, now I'm starting to understand what went wrong'. It was disappointing, angering almost, to find out that discussions had been held relative to [the known issue of joint failure in the SRBs]. Why wasn't that a bigger issue? How did we get to the point of accepting that indicator of a system not working the way it was designed? Why had we been willing to accept that?" [4]

Two days after the tragedy, as investigations got underway to determine the cause of the loss of *Challenger* and her seven crewmembers, a somber President Ronald Reagan gave a moving tribute at a memorial service for the seven

astronauts at the JSC central mall. In his speech he recalled the lives lost: Richard (Dick) Scobee, Mike Smith, Judy Resnik, Ron McNair, Ellison Onizuka, Greg Jarvis and Christa McAuliffe. He also cited the stirring words of the poem *High Flight* by John Gillespie Magee, and reminded those present that the spirit of the American nation was based on heroism and noble sacrifice.

The cremated remains of the *Challenger* crew were eventually returned to their families for burial, with the final resting place for Dick Scobee and Mike Smith located within the peaceful surroundings of the Arlington National Cemetery in Virginia. Ron McNair’s remains were originally buried at the Rest Lawn Memorial Park in Lake City, South Carolina; Ellison Onizuka in the National Memorial Cemetery of the Pacific in Honolulu, Hawaii; and Christa McAuliffe in Calvary Cemetery, Concord, New Hampshire; Greg Jarvis’s ashes were returned to Hermosa Beach, California, where they were scattered by his family in the Pacific Ocean. Judy Resnik’s family members have never revealed the location of her final resting place. Some sources say that her ashes were buried at sea, others that she is buried in a Jewish cemetery in her home town of Akron, Ohio. What is known is that unidentifiable remains found intermingled within the crushed crew cabin were later cremated together and placed beneath a *Challenger* memorial stone and plaque at Arlington National Cemetery.

The Rogers Commission

On February 3, 1986, six days after the loss of *Challenger*, President Ronald Reagan formed a Commission (Executive Order 12546) to investigate the tragedy. Chaired by attorney William P. Rogers, the commission included: former astronaut Neil A. Armstrong; attorney David C. Acheson; educator and engineer Eugene E. Covert; physicist Richard P. Feynman; editor and publisher Robert B. Holz; Major General Donald J. Kutyna, United States Air Force (USAF); aerospace engineer Robert W. Rummel; aeronautical engineer Joseph F. Sutter; astronomer Dr. Arthur B. C. Walker, Jr.; physicist Albert D. Wheelon; Brigadier General Charles Yeager, USAF Retd.; Dr. Alton G. Keel, Jr.; and TFNG Sally K. Ride.

The commission interviewed over 160 individuals and conducted more than 35 formal panel investigation sessions, generating almost 12,000 pages of transcripts. There were almost 6,300 documents containing over 122,000 pages and hundreds of images, added to over 2,000 pages of hearing transcripts. The resulting report was submitted on June 9, 1986, and offered nine recommendations to improve safety in the Shuttle program. President Reagan then directed NASA to report back within 30 days on how it was going to implement these recommendations.

The recommendations and implementations included: SRB redesign overseen by an independent oversight group; reorganization of the Shuttle management

structure and the inclusion of astronauts in management roles; the creation of a new Office of Safety, Reliability and Quality Assurance, headed by an Associate Administrator; improved communications; creation of a crew escape system; revision of the Shuttle flight rate; the addition of a new Orbiter (OV-105); and relocating DOD satellites to Expendable Launch Vehicles (ELV) instead of the Shuttle. In August 1986, it was announced that the Space Shuttle would no longer carry commercial satellite payloads.

In addition to the Commission activities, NASA also put a vast effort into the investigation, including over 1,300 employees from across the NASA field centers, supported by 1,600 employees of other government agencies and more than 3,100 from NASA contractors. In addition, the U.S. military, the Coast Guard and the National Transportation Safety Board were involved in the salvage and analysis of the wreckage. [5]

In 2002, Sally Ride was interviewed about her role in the Commission for the NASA JSC Oral History Project. “The panel, by and large, functioned as a unit. We held hearings, we jointly decided what we should look into, what witnesses should be called before the panel, and where the hearings should be held. We had a large staff so that we could do our own investigative work and conduct our own interviews. The commission worked extensively with the staff throughout the investigation. There was also a large apparatus put in place at NASA to help with the investigation, to analyze data, to look at telemetry, to look through the photographic records, and sift through several years of engineering records. There was a lot of work being done at NASA, under our direction, that was then brought forward to the panel. I participated in all of that. I also chaired a subcommittee on operations that looked into some of the other aspects of the Shuttle flights, like ‘Was the astronaut training adequate?’ But most of our time was spent on uncovering the root cause of the accident, and the associated organizational and cultural factors that contributed to the accident.”

The enormous amount of information the commission had to process was particularly difficult for Ride because the crew were her friends and colleagues. It made the six months on the commission even harder to work through, although she admitted she did not think too much about that at the time. “I was just going from day-to-day and just grinding through all the data that we had to grind through. But, it was a very, very difficult time. It was a difficult time for me and a difficult time for all the other astronauts, for all the reasons that you might expect. It was very, very hard on all of us. You could see it in our faces in the months that followed the accident. Because I was on the commission, I was on TV relatively frequently. They televised our hearings and our visits to the NASA Centers. I looked tired and just kind of gray in the face throughout the months following the accident.” [6]



Fig. 11.1: (top) The STS-51L crew in the White Room at KSC Pad 39B during training. [l-r] PS Christa McAuliffe, PS Greg Jarvis, MS and TFNG Judy Resnik, CDR and TFNG Dick Scobee, MS and TFNG Ron McNair, PLT Mike Smith, and MS and TFNG Ellison Onizuka. (bottom) The build-up of ice on Pad 39B is evident in this image. *Challenger*, the ET and the left-hand SRB are in the background.



Fig. 11.2: (top) Images of the last flight of *Challenger* have been published many times, but this view of children in class watching a school teacher’s strive for orbit tragically ending in front of them is especially poignant and heartfelt. (bottom) In MCC Houston, TFNG Dick Covey [right] and Fred Gregory [on his right] watch events in Florida unfold on TV screens, trying to come to terms with what had just happened to their friends and colleagues while still following serious mishap procedures.

A major malfunction

The incomprehensible loss of Shuttle *Challenger* and her crew sent NASA reeling, with the badly wounded space agency desperate to find answers as a shocked America mourned the seven astronauts and demanded to know how such a tragedy could have happened. Once one of the most respected administrations in the world – with dedicated men and women whose expertise and talents had saved the crew of Apollo 13 against enormous odds – NASA would now suffer the twin

hammer blows of blame and shame. Chronic complacency, arrogance, systemic smugness, a failure to listen and a badly rushed launch schedule lay undeniably at the heart of the accident. The finger of blame was pointed directly at these factors and the administrators were held responsible.

Lessons about these very issues had been painfully learned as a result of the Apollo 1 pad fire in January 1967, but over the intervening 20 years NASA had ineptly slipped back into many of its former bad habits, ignoring vital, urgent warnings from concerned engineers and contractors as the Shuttle program progressed and coming perilously close to disaster on more than one occasion.

The Shuttle program would eventually resume with the successful orbital flight of STS-26 in September 1988, but a reinvented NASA had learned some tough lessons about the catastrophic effects of ignorance and an egoistic closed-doors policy. Safety, a less driven mission schedule, openness and extreme caution became the new mandate and yardstick for the space agency, and this would be extended to the ongoing flight manifest for many succeeding years.

Sad to say, that lethal enemy of NASA – complacency – would once again creep into the agency’s corridors of power and result in the loss of yet another Shuttle crew of seven astronauts just 15 years later.

Mir means Peace

Twenty-two days after the loss of *Challenger*, the Soviets launched their new space station. Thought by many in the west to be named Salyut 8, continuing the series begun in 1971, it was soon identified instead as ‘Mir’, meaning ‘Peace’ or ‘World’. While it had a new name, it remained essentially an improved Salyut structure with a major redesign of its front docking pod (with one longitudinal and four radial docking ports) that could accommodate five separate spacecraft, and a sixth port at the rear. The first crew to occupy the new station was launched on March 13, docking with Mir two days later. Then, on May 5, they left Mir and transferred across to the still active Salyut 7, returning to Mir on June 25 and becoming the first crew to fly to two separate space stations on the same mission. The crew was recovered on July 16 after 125 days in space. Mir was open for business, while the American Shuttle remained firmly on the ground.

Unlike the previous Salyut stations, the hardware that Mir was based upon, the new station was not the entire structure, but was instead just the core of a much larger modular space station that expanded over the next few years. Mir became the mainstay of Soviet (and, from 1992, Russian) human space flight activities until 2000, re-entering the atmosphere in 2001 after an impressive (for that time) 15 years in orbit. Though unaware of the fact at the time, Mir would feature very prominently in the Space Shuttle program and in the careers of three TFNG during their later years in the Astronaut Office.

THE SPACE SHUTTLE RETURNS TO FLIGHT

In the wake of the loss of *Challenger*, NASA, its astronauts, its workers and contractors conducted a lot of soul searching and painful examination of the causes and effects of the accident. The formal inquiry and recovery to ensure the Shuttle could fly again safely would take time, and the original manifest of 1986 was naturally suspended. On February 10, less than two weeks after *Challenger* was lost, NASA officially announced that it was cancelling the next mission, 61E (Astro 1), and that all assigned crews were to be stood down pending the investigation and recovery effort. [7] Though some generic training would be completed, there would be no formal crew announcements for the next year. This was followed on February 20 by confirmation that the two Centaur deployments were officially removed from the manifest, as the tight launch windows could not be met and the next opportunities would not present themselves for several months. As the *Challenger* investigation continued, the concerns of the astronauts and engineers on the issue of flying Centaur on Shuttle were presented to senior management at NASA headquarters in Washington D.C. After reviewing the data, the whole Shuttle-Centaur program was officially cancelled on June 18, delaying the launch of the Ulysses and Galileo probes until an alternative method of deployment could be found and new trajectories mapped out. Back in Houston, the assigned astronauts and flight controllers celebrated with a ‘Centaur’s Been Cancelled’ beer bust in the Outpost Tavern, off the NASA Parkway just over from the main gate at JSC. [8]

The mission that never was

In March 1985, Rick Hauck had been named as Astronaut Office project officer for integrating the liquid-fueled Centaur upper stage rocket into the Shuttle. Two months later, he was appointed CDR of the STS-61F Centaur-boosted Ulysses solar probe mission scheduled for a launch in April 1986. Following the *Challenger* accident, this mission was among many postponed, and the Shuttle-Centaur project was terminated. As STS-61F MS John Fabian said in his 2006 Oral History, “There were several things with Centaur: sloppiness more than anything else. Sloppiness [and] not following prescribed procedures. A [worker] climbing on the tank with a wrench... sticking out of his back pocket that’s not tethered, and it fell against the [upper stage fuel] tank and dented it. Then another guy was trying to smooth out a burr in a weld. Instead of following the normal procedure, where you put a tool down in it, firmly attach it to the side of the stage and then put a drill in with a little tip to remove the burr, but it’s all [kept] very stationary, he decided that wasn’t really all necessary... ‘I’ll just hold the drill up there and go ‘brrp’, and I’ll take it right off a lot faster’. And guess what happened. The drill slipped and went ‘brrp’ across the surface of the upper stage and made this scar right across it. And they didn’t learn their lesson. They did that twice.” In spite of all this, Fabian was

convinced that Centaur would have flown if not for the *Challenger* accident. “It’s the *Challenger* accident and the re-evaluation of risk after the accident that is really responsible for removing it from the cargo manifest.” [9]

In early to mid-January 1986, Rick Hauck and his group had been working an issue with the redundancy in the helium actuation system for the liquid oxygen and liquid hydrogen dump valves on Centaur. As they explored further, it became clear that there were signs of a compromise with the margins in the propulsive force being provided by the pressurized helium. “We were very concerned about it,” he explained in 2003. “We had discussions about it with the technical people. So I and other members of the Astronaut Office went to a board to argue why this was not a good idea to compromise on this feature, and the board turned down the request. I went back to the Crew Office and I said to my crew, in essence, ‘NASA is doing business different from the way it has in the past. Safety is being compromised, and if any of you want to take yourself off this flight, I will support you’. And of course, it was two or three weeks later that *Challenger* blew up. Now, there is no direct correlation between my experience and *Challenger*, but it seemed to me that there was willingness to compromise on some of the things that we shouldn’t compromise on.”

Asked if he had ever thought about stepping down from the mission, Hauck admitted that “I probably had an ego tied up with it so much that [I thought] ‘I can do this. Heck, I’ve flown off of aircraft carriers and I’ve flown in combat, and I’ve put myself at risk in more ways than this, and I’m willing to do it’. So I didn’t ever think of saying, ‘Well, I’m not going to fly this mission’. Knowing what I know now, with *Challenger* and *Columbia*, maybe I would. But NASA was a lot different back there when we’d never killed anybody in space flight up to that point. I mean, there was a certain amount of sense that it wouldn’t happen. So anyhow, the *Challenger* accident happened. I was assigned to be part of a Johnson [Space] Center review of requirements, and it wasn’t terribly exciting, but it was something that needed to be done. Meanwhile, other people were down at the Cape [Canaveral, Florida] sifting through wreckage and other people were assigned to the Solid Rocket Booster problem. So mine was kind of a nondescript assignment.” [10]

Hauck also felt, in retrospect, that getting ready for the ‘mission that never was’ (STS-61F), was the most challenging personal assignment during his years at NASA, “because it’s clear that that was going to be a very risky flight. As with any flight, if everything goes well, it’s not risky. It’s when things start to go wrong that you wonder how close you are to the edge of disaster. And with Shuttle-Centaur you’re much closer to the edge than in most flights, because this was going to carry the Centaur upper-stage [filled with] liquid oxygen, liquid hydrogen, in a very fragile booster in the cargo bay of the Shuttle. If there were to be a requirement for a return-to-launch-site abort, all of the liquid oxygen and hydrogen would

have had to be automatically dumped out of the booster. It's clear that that was, in my view, probably going to be one of the riskiest missions NASA had flown on the Shuttle. It won't ever compare with STS-1, which, in my view, with all the unknowns, was the riskiest one, but this was going to be one of them. So that was as demanding a time on me, I think, because the crew, along with George Abbey and the Astronaut Office, were almost like a lone voice in the agency, raising concerns about the risks involved in this mission. And, of course, when the *Challenger* accident happened, eventually Shuttle-Centaur was cancelled, which I think we're very fortunate that it was. So there was some real soul-searching. Would it have gotten to the point where I would have stood up and said, "This is too unsafe. I'm not going to do it"? I don't know, but we were certainly approaching levels of risk that I had not seen before." [11]

ASTRONAUT DEPARTURES

The whole of 1986 was a difficult time for NASA, its contractors, and of course the astronauts and their families (see sidebar: *An Office in Mourning*). The loss of their colleagues, classmates and friends was particularly hard on the close-knit astronaut community, and came at a time of decision making for the military contingent of the TFNG. They were within their second secondment to NASA, with an option to return to their parent service, remain at NASA, or leave to seek new goals in the civilian world¹. Many had planned to retire anyway, but others had to make the choice between remaining at NASA for what could be several years before they flew again, or returning to their parent service to continue their military careers, with no guarantee that such a move would enhance their chances of promotion or be rewarded with advantageous assignments. Indeed, some who had investigated that option were told they had been separated from the military process for so long that they would have to be "re-greened" or "re-blued," while some of the civilians were told that if they returned to their academic life they would have to be "re-nerded" again. The other concern was in being seen to leave NASA at a very difficult time, so close to losing *Challenger* and her crew, thereby giving the impression that the loss had triggered their decision, or that they had lost faith in NASA. Such an impression was not desirable, though not entirely inaccurate. Despite these concerns, a number of veteran astronauts, including a few from the Class of 1978, decided over the next couple of years that with the Shuttle fleet grounded it was time to move on.

¹ Astronauts who were serving military officers were considered to be on a seven-year tour of duty (with possible extensions) at NASA, in an understanding between the space agency and the DOD. Civilian astronauts were expected to remain at NASA for at least five years.

AN OFFICE IN MOURNING

Between the creation of the NASA astronaut team in April 1959 and its frequent expansion up to the end of 1985, the agency had lost eight astronauts in training or off-duty accidents. These all occurred in the relatively short period between October 1964 and October 1967. The eight were: Ted Freeman (Group 3, 1963), killed in a T-38 crash in October 1964; Elliot See (Group 2, 1962) and Charles Bassett (Group 3) killed together in a T-38 crash in February 1966; Gus Grissom (Group 1, 1959), Ed White (Group 2) and Roger Chaffee (Group 3), killed in the Apollo 1 pad fire in January 1967; Ed Givens (Group 5, 1966) killed in an off-duty auto accident in June 1967; and C.C. Williams (Group 3) also killed in a T-38 crash in October 1967.

For over 18 years, the Astronaut Office had not had to address the painful and difficult issue of the loss of a serving member of the Corps, until *Challenger* in January 1986. But just four months later, tragedy struck again when Group 11 Ascan Stephen Thorne was killed in an off-duty private plane crash in Houston, Texas.

Civilian MS James ‘Ox’ van Hoften announced in June 1986 that he would be the next member of the Class of 1978 to leave the agency, joining Bechtel National Inc., of San Francisco, California, the following month. [12] Then, on July 24, it was announced that the first representative of the United States Army, Robert ‘Bob’ Stewart, was to return to the service effective August 1, to take a position with the U.S. Space Command at Colorado Springs, Colorado. [13] Space Command is a joint service organization that both manages and operates the nation’s military space program. Stewart, who was also in line for promotion to Brigadier General, was to work in the organization’s Plans Division.

During the hiatus following the loss of *Challenger*, and the subsequent cancellation of his 61F mission to deploy Centaur, Rick Hauck was asked by NASA Administrator James Fletcher to serve as the NASA Associate Administrator for Congressional, Public, and International Relations. He was appointed to the role in August 1986 but would still retain his astronaut status, and was to resume his astronaut duties at JSC in early February 1987. [14]

After Sally Ride had completed her work on the Rogers Commission investigating the *Challenger* accident in August 1986, she was named the Special Assistant for Strategic Planning at NASA Headquarters, Washington D.C. [15] At the time, Ride had already been planning to leave the agency after her third mission, a decision brought forward in part by the cancellation of that flight.

Then, in September, Don Williams become Chief of the Mission Support Branch in the Astronaut Office, a position he held until December 1988 when he was named to his next mission. In October, Dale Gardner, who had been assigned

to STS-62A, the first mission from Vandenberg, returned to the U.S. Navy (USN) and was assigned to U.S. Space Command, Colorado Springs, Colorado, as Deputy Director for Space Control.

Praising the workers

Perhaps one of the least headline-grabbing assignments which all astronauts undertake during their years at the agency is to travel across the United States to meet the thousands of workers, in hundreds of companies large and small, who build and prepare the hardware that will fly on a mission. Reaching out in person to the workforce was seen as especially important during difficult times, such as experienced in the aftermath of the *Challenger* accident, when it seemed that the Shuttle might never fly again and the task to get the vehicle back into orbit was monumental. The responsibility felt by those who worked on space hardware to ensure the astronauts were safe was acknowledged and appreciated during visits by members of the Astronaut Office in both good and bad times in the program, and such visits were intended to encourage and support the workforce as well as to congratulate and appreciate their efforts. The efforts of such workers tended to go under the radar whenever a mission was successful, but could be thrust into the spotlight when things went wrong.

Early in September 1986, STS-51A pilot Dave Walker found himself participating in one of these outreach assignments at KSC. He was visiting the Pad Operations and Mobile Launch Platform teams to brief them on the current status of the astronaut training program, as part of the Return-to-Flight initiative. “On behalf of the astronaut corps,” he told them, “I want to extend my sincere appreciation for the outstanding job you’ve done and are still doing under some difficult circumstances. You have not been forgotten and we want you to know we still have the highest confidence in the jobs you do.” He added, “This is not the time to bury our heads in the sand, but to look up and go forward with the tasks that will lead us back to flying the Shuttle again.” [16]

Ground simulation ‘crews’

Though the Shuttle had been grounded, the work to return the system to flight continued as the investigation and recovery from the loss of *Challenger* progressed. Over the next two years, a number of astronauts continued generic training, covering aspects of their previously assigned payloads or missions pending a return to flight. They also worked in ‘crews’, participating in milestone ground simulations and major training exercises as part of the Return-to-Flight Program. These were not official flight crews but were formed from teams originally assigned pre-*Challenger* or from groups assigned to fulfill the role of a formal Shuttle crew. On October 29, 1986, the former STS-61H crew (Mike Coats, John Blaha, Anna Fisher, Robert Springer and James Buchli) participated in a fully-integrated simulation at JSC.

In early November, it was revealed that the revised numbering system that had first been assigned to Shuttle missions in September 1983 had been scrapped. When the launch schedule had to be abandoned following *Challenger*, the numbering system was deemed to be both cumbersome and confusing. In future, the system that had been used up to STS-9 would be reinstated. STS-51L was the 25th time the Shuttle had launched and, despite the tragic outcome just seconds later, NASA classed the flight as a ‘mission in progress.’ For the resumption of flights, it was decided that the next mission, the 26th launch, would officially be designated STS-26, followed by STS-27, STS-28 and so on.

Though there were no plans to launch a Shuttle for some time, over at KSC the Orbiter *Atlantis* was moved from the Vehicle Assembly Building (VAB) to Pad 39B to support planned evaluations of the new weather protection systems installed at the pad. Taking full advantage of the opportunity to have a Shuttle on the pad again, it was also decided to conduct a number of concurrent tests on countdown and emergency procedures on and around the pad area. On November 2, an Emergency Egress Test Crew used *Atlantis* sitting on Pad 39B to develop their experiences of pad operations and emergency egress procedures. This crew consisted of rookie astronauts Frank Culbertson (CDR), Steve Oswald (PLT), Carl Meade, Kathy Thornton and David Low (all MS), and Pierre Thuot and Jay Apt (taking the role of PS for the tests). Their participation reflected the type of support roles conducted by members of the TFNG a few years earlier in the build up to STS-1. Culbertson, Low and Thornton were members of the Group 10 selection (1984), while the other four had been selected as Ascans in 1985 (Group 11).

On November 18, the former STS-61C crew (Hoot Gibson, Charlie Bolden, Steve Hawley, Pinky Nelson and Franklin Chang Díaz) participated in a partial countdown, again using *Atlantis* on Pad 39B, to give the launch team a chance to maintain their skills and procedures during the period of flight inactivity. The mock countdown had begun at 19:40 pm the previous day and continued through to 11:00 am on November 18, ending with a simulated firing of the Orbiter’s three main engines. For the final two and a half hours of the test, the Gibson crew lay in *Atlantis* simulating the final moments to lift off. Despite the crew encountering a number of technical problems which could have scrubbed a real launch, the test brought back fond memories for the participants of their own experiences in trying to get STS-61C off the ground earlier in the year. “We felt it was a real good test, everything went pretty well,” reported Hoot Gibson after the simulation ended. However, seeing an Orbiter on Pad 39B stirred less happy memories in the astronaut than those of his launch on 61C from Pad 39A eleven months earlier. “I think it’s going to be very difficult to look at an Orbiter or look at the launch pad [without recalling *Challenger* and her crew]. They were our companions. They were our close friends, and I don’t think I’m ever going to quite get over that completely. I decided a long time ago [that] I was going to keep going and that I want to fly [the Shuttle again].” Later that same day, after the pad simulation had been

completed, the seven astronauts comprising the Emergency Egress Test Crew participated in another three-hour crew escape test, before *Atlantis* was finally returned to the VAB. [17]

ANNOUNCING A RETURN-TO-FLIGHT CREW

It had been over a year since the previous crew announcement, but on January 9, 1987, the identity of the long-awaited 26th Shuttle crew, also termed the Return-to-Flight Crew, was revealed by NASA. The CDR would be TFNG Rick Hauck, who would be returning to JSC from his role as Acting Associate Administrator for External Relations in Washington D.C. during the first week of February to train for STS-26. The mission was to deploy the much-delayed second TDRS (TDRS-C), the next in the series after the one lost on *Challenger* (TDRS-B), and was planned for launch with a crew of five no earlier than February 1988. Joining Hauck would be fellow TFNG Dick Covey as PLT (formerly PLT of STS-51I), and MS Pinky Nelson (MS STS-41C and 61C), together with John M. ('Mike') Lounge (MS STS-51I) and David C. Hilmers (MS STS-51J) from the Class of 1980. In announcing the crew, Richard H. Truly said, "I am particularly pleased to assemble a group of such experienced individuals led by one of our senior space flight veterans, and I am very proud of them." With seven flights between them, they were indeed an experienced crew, and labeling Hauck as a "senior space flight veteran" indicated just how far the TFNG had journeyed since arriving at NASA as rookies nine years before.

The selection of these astronauts for this key mission was spearheaded by George Abbey. Due to the importance of the Return-to-Flight mission, former astronaut Dick Truly (who had become the agency's new Associate Administrator for Spaceflight at NASA Headquarters in February) specified early on that the next crew would be made up of five veteran astronauts who were not susceptible to Space Adaptation Syndrome (SAS), an important consideration for such a short flight.

At the time of the *Challenger* accident, the next crew in line was the Astro-1 science mission crew headed by TFNG Jon McBride, followed by Rick Hauck's crew who were due to fly the first Shuttle Centaur mission on STS-61F. Of the two astronauts, Hauck had flown two missions, commanding the second of them (STS-51A), while McBride had only flown once as PLT (STS-41G). Hauck had also been the lead contender to be the first pilot of the 1978 group to fly, on STS-7, and was considered one of the most experienced in the group, and thus received the CDR position on STS-26. McBride retained his unconfirmed position as CDR for the re-manifested Astro-1 mission for the time being. Mike Lounge and Dave Hilmers from the 1980 selection had previously been assigned to Hauck's 61F crew, so it seemed sensible to retain them as a trained unit for this new, important mission. The question was who would fulfill the role of PLT. Hauck had lost his

original PLT during the hiatus following *Challenger*. Roy Bridges, from the 1980 selection, had been assigned to 61F, but had already decided to leave NASA and return to the USAF after that mission. However, after *Challenger* and with the Shuttle fleet likely to be grounded for at least two years, he had decided to bring his departure forward. Bridges had left the Astronaut Office in May 1986 to take command of the 6510th Test Wing at Edwards AFB in California.

In his 2018 book about George Abbey, author Mike Cassutt explained that while there were other candidates for the PLT seat on STS-26, it was important to try to keep the ‘crew’ as intact as possible. Dick Covey had been preparing for the role of launch and landing Capcom for STS-61F (commanded by Hauck), and after the departure of Roy Bridges he had joined the rest of the crew in a series of generic simulations and was therefore integrating into the crew. While it seemed sensible to assign Covey as PLT for the mission, there was one issue which might have prevented this. Normally, a pilot astronaut would fly their first mission in the right seat, under a veteran CDR, and would then be expected to take the command seat themselves on their second mission. If Covey stayed on the STS-26 crew, he would become the first Shuttle PLT to fly in that position twice, delaying the opportunity for his own command. When informed of the plan, however, it did not take Covey long to accept a second PLT slot, reasoning that while he might not be in command, he would be flying a second time much earlier than he expected to, and on a very important mission.

To make the crew up to the minimum complement of five, Pinky Nelson, a veteran of STS-41C and 61C (and with the added experience of two EVAs behind him), had already been assigned. At the time, Nelson was on leave of absence at the University of Washington. “In terms of the technical work that was going on there [at the time], things were just being pulled together and teams were being made to work on various aspects of this and that,” Nelson recalled in 2004. “We all got little assignments and went off and got back to work, which was good therapy for the folks in the office, to dig in and try and really find out what happened and see if we can get back flying again. It became obvious after a few months that not much was happening. I’m not very good at sitting around, so I actually asked to take a leave and I spent six months up in Seattle, working at the University of Washington in the Astronomy Department just thinking about astronomy, because I didn’t feel like I had much of a contribution to make down there. Then, after being here for six months, George Abbey must have figured out that I was having too good of a time, so he assigned me to the STS-26 crew and made me come back.” [18]

A new Chief Astronaut and Deputy

For the previous 13 years, since America’s first astronaut Alan Shepard had retired in 1974, Gemini, Apollo and Shuttle veteran John Young had been in the coveted post of Chief of the Astronaut Office in Building 4 at JSC. Young had flown a

record six missions into space; two on Gemini, two on Apollo and two on the Shuttle. If his launch from the Moon during Apollo 16 was included, he had experienced seven rocket launches in his 25-year career at NASA. In the wake of the *Challenger* accident, having written some direct and critical memos, Young was removed from the Chief Astronaut position and reassigned to an administrative role as Special Assistant to the JSC Center Director. He was replaced in the short-term by Acting Chief Hank Hartsfield (Class of 1969, USAF). [19]

According to author Michael Cassutt, there was now a desire to have a Chief Astronaut from the ‘new generation’ of astronauts, and the most senior group of this ‘new era’ were the TFNG. [20] The chosen candidate had to be a pilot astronaut and an experienced commander, while both of the previous incumbents had come from the USN (Shepard 1963–1974; Young 1974–1987). With these criteria in mind, George Abbey shortlisted four candidates who he knew would make good office leaders at some point in their careers: Dan Brandenstein, Hoot Gibson, Rick Hauck (all USN) and Brewster Shaw (USAF).

Of the four, Hauck was already in training for STS-26, while Shaw was also lined up, but not yet formally announced, for an important DOD mission, leaving only Brandenstein and Gibson available. Brandenstein had been in the post of Deputy Director for Flight Crew Operations for the past year. After deliberating, and with other plans in mind for Gibson, Abbey called Brandenstein on the evening of Sunday, April 22 and asked him to come into JSC for a meeting, where he was told he was to be the new Chief Astronaut. The Deputy Chief would be Steve Hawley, the first civilian non-pilot to hold such a position in the Office, making it clear that the rookies from less than a decade earlier were now not just veteran astronauts but showing talents for leadership and mentoring. Such characteristics would be demonstrated through their future careers, not only during their years at NASA, but also once they left the agency.

Brandenstein chaired his first Monday Morning Pilots’ Meeting the following day, April 23, but the formal announcement of the new Chief Astronaut was made a few days later, on April 27. The official announcement also confirmed that Hank Hartsfield would replace Brandenstein as Deputy for Flight Crew Operations. [21]

Brandenstein explained the role of Chief of the Astronaut Office over a decade later. “You’re responsible for the office. You assign the crews. You ensure that they’re getting trained. You sign off that they’re trained and ready to fly when the time comes. You work all the issues. Once again, the crew has input into a lot of the technical decisions that have to be made, and you get involved in those. You have to develop an ‘office position.’ Trying to get 100 people to agree to a position... well, you never do, but ultimately it’s your job that you take the inputs from the folks in the office and establish a position. Somebody’s got to make the ‘Okay, this is the way we’re going forward [decision]’. So you let everybody have their say, then you use your best judgment and say, ‘Okay, this is the way we’ll carry the office position forward. This is what it’s going to be and here’s why’. I made the decision. Like I say, you’ll never get everybody to agree, or very seldom.

Every once in a while you might find something that’s so outrageous that they’ll all agree on it, but that rarely happens.

“So that was it, and taking care of the care and feeding of 100 [or so] astronauts and stuff. So that’s another full-time job. They’re human like anybody else. They come in and they have problems here, and this and that, and they go out and every once in a while... do some dumb things, and you have to try and keep them on the straight and narrow. If you have to have a heart to heart with them, every once in a while you have to do that. If they get blindsided with something, you try and protect them from that. And there’s a lot of people tugging and pulling at folks in that position from a lot of different directions. You try and let them go off and do their job and not be tugged and pulled by extraneous sources (see sidebar: *The Max Q Band*). That’s part of your job to help with some of that. It was altogether a pretty interesting job.” [22]

“The Chief [of the Astronaut Office] and the Deputy are responsible for a lot of the technical issues the astronauts get involved with; all of the individual astronauts in one way or another are involved in their various program issues,” explained Steve Hawley in 2002. “Usually there comes a time when the office itself as a group needs to take a position on some technical issue or program issue, and we would orchestrate that. Of course, we would make recommendations for job assignments for people: who would get to go work as a Capcom [Capsule Communicator], who would get to work down in Florida, who would go work at SAIL [Shuttle Avionics Integration Laboratory]. We made recommendations about crew assignments, and basically just running the administration of the office. Now, when I came in as Deputy to Dan Brandenstein, who was the Chief, I felt that it was my job to be the guy that was available for people to come talk to, because the Chief is pretty busy, and he’s involved in lots of stuff that takes him away from the office, and maybe he doesn’t have as much time to spend listening to the people in the office. And so I felt like it was my job to sit there with the door open and I actually did that. I sat at the end of the hall, and I’d always leave my door open, and I sat there with my desk facing the hallway, so people could see if I was in. Painful as that was, I felt it was my job to be the guy that was there, that if people wanted to come and say something or vent or ask for something, that they had somebody to go to. So I remember, for whatever reason, I remember that being something that I thought was very important in the job.” [23]

Seventeen years after his Oral History contribution, Steve Hawley was asked about his move from an operational position in the Astronaut Office to a management role, and commented on managing the people he used to work with. “Some people were able to do that well and others not so much. I felt that there were a lot of advantages, I think, to having very experienced astronauts in some of these positions because of their experience and perspective, but not everybody is well suited to be a manager. Flying in space doesn’t make you a good manager, but I know George [Abbey] felt that the experience the flown astronauts had was advantageous for the program in a variety of different ways. [24]



Fig. 11.3: (top) The former STS-61H, now STS-61M (T) crew take breakfast in advance of their April 1987 ground simulation as part of the preparations for the Return-to-Flight mission of STS-26. An ongoing joke played on the crew by the trainers involved carrots and their symbolic role as a reward (“carrot and stick”), including the carrot-related decorated cake shown here. The banner above Fisher and Coats proclaims the room as the 61MT Dining Hall, with the ‘H’ crossed out and ‘MT’ added. (bottom) Inside the motion-based version of the STS, the 61M (T) crew enjoys more lighthearted banter with the bunch of carrots suspended between the CDR and PLT station. [l-r] Coats, Blaha, Fisher, Springer and Buchli (standing).

A week prior to the announcement of Steve Hawley’s appointment, a new simulation ‘crew’, STS-61M (T – for training), was named. In command of the former STS-61H five-person crew was Mike Coats, with his colleagues Anna Fisher and Jim Buchli from the 1978 selection as MS. They were joined by PLT John Blaha and MS Robert Springer, both from the 1980 selection. [25] Designed to support the efforts to return the Shuttle to flight, this 61M (T) team would participate in a simulation of the first 56 hours of the planned STS-26 mission, while remaining firmly on the ground at JSC. The mission timeline and payload would be used during the sim, held between April 28 and 30, with the Coats crew replicating the roles that Hauck’s crew would perform during the real mission. The primary objective of this sim was to “exercise the people and the processes necessary” to support the next mission. Termed an integrated simulation, a team of flight controllers supported the test around-the-clock from their consoles in MCC Building 30 as if it was a real mission, although the flight crew did not remain in the Shuttle Mission Simulator (SMS) over in Building 5 at JSC during sleep periods. The simulation began at 09:00 am Central Daylight Time (CDT) on Tuesday April 28, picking up at the T-9 minutes mark and followed by the simulated launch nine minutes later. Six hours and six minutes later, the crew initiated the simulated deployment of the TDRS. The simulation ended by 17:00 pm on Thursday April 30.

“We were down for two and a half years between *Challenger* and Rick Hauck’s flight [STS-26], so they wanted to keep the crew trainers and instructors sharp,” recalled Mike Coats. “The crew goes through a long syllabus getting ready for a flight. We had just been through the syllabus [and] were ready to fly. So when *Challenger* happened, they said, ‘Well, we need a couple of crews to go through the training syllabus again’, more to keep the trainers sharp than anything else and knowing full well that we’d have to go through it again when we were finally assigned to another mission. So that was what we did. I think Brewster [Shaw] did it with his crew, and I did it. He had a classified syllabus and we had an unclassified syllabus to go through. So we went through the whole training syllabus again, which was good. It’s fun to get as good as you can get in a simulator. We had the opportunity to do that. Then we were assigned another mission and essentially went through that again. So essentially for three missions I went through the training syllabus five times. We’d flown a mission. We’d gone through the training syllabus. We were about ready to fly when *Challenger* happened. Then we went through just the exercise syllabus. Then we went through again to fly the second mission. Then we went through a fifth time to fly my last mission. So it’s a lot of simulations if you will. But you feel like you get pretty good in the simulator when you’ve done all those things. Kind of fun, but after my third mission I thought ‘Man, I don’t know if I can go through that syllabus again.’” [26]

THE MAX Q BAND

The post-*Challenger* period was tough for NASA, the contractors, the astronauts and their families, and it was difficult to come to terms with the loss of the crew, proceed through the enquiry and implement its recommendations, and look forward to resuming the program. To help get through these dark days, a variety of diversions were explored, one of which was to turn to music.

Formed in early 1987 by three of the TFNG (Robert Gibson, George Nelson and Brewster Shaw), the band was named by Gibson after the engineering term Max Q, used to denote the maximum dynamic pressure experienced by an ascending spacecraft, although the joke description was that, like the Shuttle, the band “makes a lot of noise but no music.” Over the years, the members of the band rotated between active duty astronauts, due to training commitments, crew assignments and retirements. The band was established during the down period following the loss of *Challenger*, when morale in the office was pretty low. As Shaw explained years later, “We weren’t flying again yet [and] we weren’t really sure when we were going to be able to fly again because they were redesigning the Solid Rocket Boosters. [So we thought] we ought to come up with some way to pick people up a little bit. So I got talking with Hoot Gibson and we decided ‘let’s have a sock hop’. And not only let’s have a [50s style] Saturday night sock hop, but let’s put together a little band that could play at this sock hop, and the band would be all astronauts. Hoot declared [that] he could play lead guitar. Hoot and I had played guitars a little bit together before. I could play rhythm guitar. And we got Pinky [Nelson] to play bass guitar, which he didn’t play, really, but he learned. He learns everything in a heartbeat, so he picked that up overnight. And it turns out that [Jim] Wetherbee had been a drummer. So we got the four of us together and we practiced a bunch and learned, I don’t know, three or four songs, and we played at this sock hop down in the pavilion down at the park in League City on Highway 3... it was a great time. Everybody had a lot of fun, and it absolutely did what we’d hoped it would do. It gave people a diversion and they quit thinking about not flying and how we were grounded. So I was real glad we did it, and then the band just kept going, and the band is still going today [with different members].” [27]

Steve Hawley was another of the TFNG who joined the band, as a keyboard player, shortly after its formation. As they were doing this on their own time away from NASA and the Astronaut Office, they did not need permission or approval to carry on, although it did help that the sponsor of the Fajita Festival they played at in the early days was one George Abbey, their boss at JSC. As Hoot Gibson observed, “We weren’t good, but we weren’t bad.”

On July 30, Jon McBride was named as Assistant Administrator for Congressional Relations at NASA Headquarters, a role he occupied from September 1987 until March 1989. The following month, Sally Ride finally left NASA to join the Stanford University Center for International Security and Arms Control.

On September 15, NASA named the STS-27 crew, which would be commanded by Robert ‘Hoot’ Gibson. He would be joined by fellow TFNG Mike Mullane as MS, alongside Group 9 astronauts Guy Gardner (PLT) and Jerry Ross (MS), as well as Group 10 MS William ‘Bill’ Shepherd. [28] The classified DOD mission was targeted for early fall 1988 on the Orbiter *Atlantis*. This crew was mainly derived from the former STS-62A crew, which was due to be commanded by Bob Crippen and to fly *Discovery* on the first launch out of Vandenberg. However, following *Challenger*, both the mission and any operations from the West Coast were cancelled. In April 1987, Crippen was reassigned as Deputy Director for Shuttle Operations at NASA KSC in Florida, effective July that year. [29] When Crippen was moved to KSC, Hoot Gibson was assigned as the crew’s new CDR, with Bill Shepherd added to make up the five-person crew requirement. George Abbey had lined up Gibson, who had been shortlisted for Chief Astronaut earlier, to command the mission as he was the only one of the seven flown commanders still active and available. Gibson was told of the assignment over a beer in a bar by Abbey one evening and was surprised when first informed of the decision as it was not his ‘turn’ to command, having recently commanded the last flight prior to *Challenger*, STS-61C. Gibson thought that there were plenty of other TFNG pilots to command the mission in front of him, but there was another reason for the decision. The payload was a new imaging radar system, for which the customer required an experienced veteran commander to lead the crew on this important mission of national security. As all of the pre-1978 veterans who had commanded a mission in 1984 and 1985 had now been reassigned, retired or moved to management, that left Brandenstein (now Chief Astronaut), Hauck (in training for STS-26), Shaw (in training for STS-28) and Gibson, who got the seat². [30]

The year had ended positively with the assignment of two Shuttle crews and the completion of several important simulations, together with step-by-step progress towards resuming flight operations, hopefully within the next year. On the down side, this became the first year since 1980 that American astronauts had not flown in space, and all hopes rested on preparations to try to ensure that 1988 would also not be devoid of American missions.

²At one point, Manned Spaceflight Engineer (MSE) Kathy Roberts was being considered to fly on STS-27 with this crew. Her payload specialty was the Lacrosse Imaging Radar Satellite, which was the prime payload for this mission. However, when NASA instigated a rule that its astronauts would be the only ones to fly the first five post-*Challenger* missions (STS-26, 27, 28, 29 and 30), Roberts lost her place on the crew and the chance to fly into space.

With the Shuttle still grounded, only a few crews beginning to resume mission training, and new astronauts from the 1984 and 1985 selections available, the planned 1986 selection was deferred for a year. This was also the time that a number of veteran astronauts left the office, while others chose to remain and perform a wide variety of assignments or collateral duties, hopefully waiting for the call to resume mission training. One of those associated duties, which most astronauts perform at some point in their careers, was recorded in one of the final news releases of the year. [31] Dave Griggs was appointed as Chairman of an incident investigation committee, charged with examining an incident that had occurred on December 17, and due to report its findings to JSC Director Aaron Cohen by January 31, 1988. The incident under investigation centered upon one of NASA's high-altitude research aircraft, a General-Dynamics WB-57, which had run off the runway at Ellington Field, Houston. It had been piloted by Michael Corbett and Albert Crews, a former X-20 and MOL astronaut who had missed the age limit for selection to NASA's Group 7 in 1969 and had joined the JSC aircraft division instead. No one was injured and minimal damage was inflicted on the aircraft, which had been operating in conjunction with Project Airstream, a long-term NASA/Department of Energy multi-disciplinary study of the upper atmosphere, and was also used to collect 'cosmic dust' samples for the Solar Exploration Division at JSC. Griggs's TFNG colleagues Kathy Sullivan and Pinky Nelson both had experience as crewmembers on previous WB-57 flights.

A DECADE ON

On January 16, 1988, the Class of 1978 celebrated the tenth anniversary of their selection as astronauts. By now, they had all flown in space at least once, with eleven of them having flown a successful second mission, though another four who had embarked on that feat had perished in the attempt. Of the 35 who began the first Ascan training program back in July 1978, six had now departed the Astronaut Office, and four had died on *Challenger*. At the start of their astronaut careers they were naturally space rookies, mostly out of their depth in the hallowed halls of the Astronaut Office, but that soon changed, and ten years later those who remained now numbered among the most experienced and senior of the astronaut detachment, with very few of the pre-1970 astronauts left on the active list. So much had changed, not only in the group, but also in the office, in the program and in NASA itself. The NASA they now worked for was very different as the requirements of the program changed, particularly in the preparation of the next phase of human space flight in America, the creation of a large space station. But this would only proceed if the Shuttle could be certified safe to fly again.

Critical in ensuring that there were astronauts ready to fly the missions once the program resumed was the selection of crews. Initially at least, these would still be formed from those who had been in training prior to the loss of *Challenger*. On February 4, 1988, therefore, TFNG Brewster Shaw was finally named to command the STS-28 DOD mission aboard *Columbia*, targeted for a late 1988 launch. [32] Two of the remaining four members of the crew, PLT Richard Richards and MS Dave Leestma, came from the class of 1980, with the remaining two, MS James Adamson and Mark Brown, from the Class of 1984. This was the former STS-61N crew, apart from Richard Richards replacing Mike McCulley, with the latter having been reassigned during the hiatus to serve as technical assistant to Don Puddy, the Director of Flight Crew Operations.

Astronaut Science Support Group

A NASA news release in February 1988 reported that “Astronauts at NASA’s Johnson Space Center have created an Astronaut Science Support Group to provide direct interaction with prospective experimenters on Space Shuttle and Space Station missions.” [33] This group included MS members of Group 8 and 9, with each focusing on a specialty area. From the TFNG, Jeff Hoffman focused upon astrophysics and remote sensing and Rhea Seddon on life sciences. They were joined by Group 9 (Class of 1980) astronauts Franklin Chang Díaz (plasma and space physics), Mary Cleave (biological materials processing), Bonnie Dunbar (material processing), Jerry Ross (Extra-Vehicular Activity (EVA), satellite servicing and space construction).

Using the experience gained from their Shuttle missions, the group strongly believed that increasing the involvement of crewmembers in the design, development and operation of experiments would both improve the return of data and simplify the repair of faulty equipment. The primary goal of the group was to transmit their operational experience to the science and technology user community, in order to make best use of the Orbiter as a testbed for scientific and engineering research by utilizing the crew as a critical element both on the ground and during the mission. This would provide more efficient experiment operations and flexibility in real-time repairs and fine tuning of equipment. They also acted as advisors to the Shuttle and Space Station programs for issues of science and technology. Both Hoffman and Seddon commented on the group in their respective Oral Histories.

“As scientist astronauts, several of us were often asked to work with scientists who were preparing experiments for space,” Hoffman explained. “For instance, I got assigned at one point [to] a combustion science working group at the Glenn [Research Center, Cleveland, Ohio]. At that point it was the Lewis Research Center, so I was basically their astronaut contact. I went up there periodically when they would have their investigators meetings and tried to give them advice: ‘You’re trying to design this, but you’re asking the crew to do this. In weightlessness, that’s going to be very difficult. We should change things around...’ and so on. It was nice, actually. On my last space flight we had a glove box, and we

actually performed some of the combustion experiments that I had been working on. This was early on. This may have even been in the early '80s while I was still getting ready in the early days of my training. I don't exactly remember, but it was kind of typical.

"All of us would have similar experiences, where we would be presented with experiments that people thought were ready for flight, but clearly there were aspects of the space environment that they didn't understand. We could often see ways in which things could fail or just ways to make them more efficient, so we came up with the idea [that] maybe the scientists in the [Astronaut] Office should form an advisory group so that we could work with people who were designing experiments. At the same time we thought, 'They're always having lectures to the Astronaut Office about various aspects of aircraft safety and space operations. Maybe we can invite some science people in to give maybe a monthly lecture to the office about something of interest'. So those were the two motivations.

"Franklin [Chang Díaz], Bonnie Dunbar, I, Rhea Seddon, a couple of other people were the founding members. Actually we had a fair bit of success in the first few years, but as often happens then we all got assigned to flights. You get so busy that we couldn't really continue it, but I think some of the payload people took over that kind of philosophy with the idea that we really have to look at these experiments from a user's point of view. The only difficulty is that when it's not the users or people who are really scientifically knowledgeable, but instead they tend to be the engineering contractors who do this, they tend to go very strictly by the book. That again often ends up making life more difficult for the experimenters rather than less difficult, but that's the way things evolved. We were active for a couple of years. Then after Return-to-Flight, everybody got busy doing lots of different things, and we really couldn't keep it up just as astronaut scientists." [34]

"As we got into a more mature phase of the Shuttle Program, we came to realize that scientists who either wanted to propose experiments, or had proposed experiments, frequently designed both the hardware and the experiment itself before they ever had crewmembers that they could work with," added Rhea Seddon. "We likened it to saying, 'Well, they've designed this experiment to be a 'flying brick'. In other words, the only switch on there is the on/off switch, and the only indicator on there is a light that comes on when it's on. If you take it to space and you flip the switch and the light doesn't come on, there's nothing you can do. It's sealed up. They didn't design it to be repaired. There's no way to understand what went wrong, no insight into the mechanisms. We felt that was unfortunate, because crewmembers are more than willing to learn everything there is to know about an experiment. They take the responsibility for it. For instance, scientists I knew were designing life sciences experiments, and they were told, 'We can't guarantee that you'll have any physicians on the flight or anyone that knows anything about life sciences'. So again, they would dumb-down the experiment or they would worry about it, or they wouldn't propose it. Or they would do something that they ordinarily wouldn't do, in order that any person could do it.

“So we wanted to go out and tell them the capabilities that people had. Even if you were an astronomer, you could learn to draw blood. Even if you didn’t understand a lot of the complexity of the payload that you were operating, you had the opportunity to talk to the ground. A lot of times you could do the mechanics of it and do it very well, and understand how it could go awry without understanding how the telescope was built or what the internal workings were. So being a resource to scientists was something that we felt was useful for us to be doing. I think in the time after *Challenger*, all of us were trying to look at not only how to recover from the mechanical problem that happened on *Challenger*, but how we could use this time to improve the product of our office. We could make ourselves available to scientists who didn’t understand, for instance, how to work in zero gravity.

“Scientists would say, ‘All this experiment requires is that you draw blood and that you collect urine’. We would remind them that we didn’t have a lab centrifuge on board, and we frequently didn’t have a lab refrigerator on board. So something that sounded pretty simple, [and] would have been very simple here on the ground, like collecting urine, was hard to do with the things that we had in the space environment. But we would let them know there are flights that you could stow the urine-monitoring system on board. They might want to group their experiment with some other people’s so that they could assure that that equipment could go on board to support several experiments. So it was that kind of interaction, and we all enjoyed it. Most of us that were working on the support group had flown, so we understood what weightlessness was like, what you could and couldn’t do, what equipment you had or could have. So it was earning our keep as good scientists to go and share some of what we had learned and what we knew about the Shuttle Program.” [35] This was another example of how members of the TFNG participated in wide-ranging issues which would have later application in future programs, in this case in developing the coordination between the Astronaut Office and the science programs conducted aboard the ISS.

The last before the first

The pace of the Return-to-Flight program increased as the months rolled on, and with growing confidence that the Shuttle would indeed return to orbit that year, in March 1988 NASA issued the names of three new crews, which were all scheduled to fly during 1989. [36] It was also made clear in the release that these would be the last crew selections announced prior to the first mission in the resumption of Shuttle flights later that year (STS-26). Among the crews announced, there were seven members of the TFNG.

STS-29, commanded by Mike Coats, included MS Jim Buchli and was set for launch in January 1989 on *Discovery* carrying the third TDRS (TDRS-D) to be deployed. The crew also included three members of the 1980 selection, with John Blaha as PLT and Robert Springer and James Bagian as MS. Due to the changes in the manifest following *Challenger* and the cancellation of previously named

crews in the down time, Anna Fisher decided to have a second child and stood down from the former STS-61H crew to be replaced by Bagian. At the time she was on maternity leave, but following the birth of her second child she would return to the Astronaut Office in 1991, initially in a part-time role, to work on Space Station *Freedom* training issues.

STS-30, commanded by Dave Walker, included Norman Thagard as MS. They were joined by Group 9 PLT Ron Grabe and MS Mary Cleave, with Group 10 MS Mark Lee rounding out the crew. The mission was planned for launch in April 1989 on board *Atlantis*, a four-day flight to deploy the Magellan Venus radar mapping orbiter.

STS-31 would be commanded by Loren Shriver (replacing John Young, the original CDR of what was then called STS-61J). This mission was to fly in June 1989 to deploy HST. Steve Hawley and Kathryn Sullivan had been named to the original mission and now resumed their training, along with Group 6 veteran Bruce McCandless. At the time of the announcement, Hawley was serving as Deputy Chief of the Astronaut Office, a position he would stand down from in the spring of 1989 to begin active mission training.

As the news release pointed out, STS-29 (the 28th STS mission) would now fly after STS-27 (the 27th STS mission) but before STS-28, based on the current Shuttle flight manifest, reflecting the still-confusing sequence of Shuttle missions and the delays in preparing *Columbia* for its return to operational status.

“Goooooooood Morning Discovery!”

Excitement built as the countdown entered the final hours on September 29, 1988, with more than 250,000 people and 2,400 news media gathered in the KSC area. *Discovery* lifted off flawlessly, and President Ronald Reagan declared, “America is back in space.” Six hours into the flight, the astronauts deployed the TDRS-C satellite, similar to the one destroyed in the *Challenger* accident, and they also operated 11 middeck science experiments. During their four days in orbit, the crew tested more than 200 design changes made to the Shuttle. A day before returning, they paid an emotional tribute to the *Challenger* astronauts.

On Flight Day 2 (FD2, September 30) the crew were woken up, not by the expected call from the duty Capcom Kathy Sullivan, but by the unmistakable voice of actor Robin Williams with a variation of his 1987 “*Good Morning Vietnam*” radio wake-up call from the comedy-drama war film of the same name. Producer and radio KKBQ DJ Mike Cahill had approached Williams about creating the tape. Apparently, NASA knew nothing about it until Cahill offered it to the agency as a gift. He had heard previous wake-up calls and found some of them awful, so he thought it would be nice to write, produce and design songs for the astronauts. He sent the tapes to Pat Mattingly who worked in Mission Control, who in turn passed them on to Kathy Sullivan on the Capcom Console. His desire was to show that the people at NASA had a sense of humor. [37]

The crew were also the first American astronauts to wear pressure suits for launch and landing since STS-4 in 1982, and the first all-veteran American crew since Apollo 12 back in 1969.

STS-26 (September 29 – October 3, 1988)

Flight Crew: Frederick H. HAUCK (CDR), Richard O. COVEY (PLT), J. Michael Lounge (MS-1), David C. Hilmers (MS-2), George D. NELSON (MS-3)

Spacecraft: Discovery (OV-103) 7th mission

Objective: 26th Shuttle mission; Return-to-Flight mission; TDRS-C deployment

Duration: 4 days 1 hour 0 minutes 11 seconds

Support Assignments: For this mission, John CREIGHTON served on the ascent and entry ‘Gray’ team Capcom console, while Kathy SULLIVAN was on console for the ‘Indigo’ planning team. [38] Assigned to SPAN were Brewster SHAW (ascent/entry) and Don WILLIAMS (planning). Hoot GIBSON took the first shift in the SMS, with Mike COATS taking the second. Fred GREGORY was sent to Edwards AFB for any Abort Once Around (AOA) situation, then went to the Dryden Contingency Action Center. Chief Astronaut Dan BRANDENSTEIN was Weather Pilot (WX) and Steve NAGEL was one of the Family Escorts. Jeff HOFFMAN worked as a media representative of the Astronaut Office for the TV networks. [39]

Four new crews were announced in late November 1988, scheduled to fly in late 1989 or early 1990, with each commanded by pilots from Group 8. [40] Fred Gregory would command the STS-33 crew. He was returning to flight duty in December after completing a number of administrative and managerial appointments in recent years³. Gregory would be joined by Group 8 astronaut Dave Griggs as PLT, together with MS Story Musgrave (Class of 1967), Kathy Thornton and Sonny Carter (both from the Class of 1984). STS-33 was planned for an August 1989 launch using *Discovery* and carrying a classified DOD payload.

Don Williams was named as CDR of STS-34, which was planned for October 1989 on *Atlantis* and featured the deployment of the Jupiter probe Galileo, using an Inertial Upper Stage (IUS) rather than the cancelled Centaur, and with an increased transition time to reach Jupiter. Mike McCulley (Class of 1984) was assigned as PLT following his temporary managerial assignment at JSC, together with three MS: TFNG Shannon Lucid, Franklin Chang Díaz (Class of 1980) and Ellen Baker (Class of 1984).

The STS-32 mission in November 1989 was to be commanded by TFNG and Chief of the Astronaut Office Dan Brandenstein, with PLT Jim Wetherbee (Class of 1984) and MS Bonnie Dunbar (Class of 1980), David Low and Marsha Ivins (both from the 1984 selection). This mission would use *Columbia* and featured the

³Gregory’s administrative assignments included: Chief of Operational Safety at NASA HQ; Chief of Astronaut Training; and member of both the Orbiter Configuration Control Board and of the Space Shuttle Program Control Board.

deployment of the Syncom IV-5 satellite and the much-delayed retrieval of the LDEF that had been deployed from STS-41C in 1984. Brandenstein would not begin full time training for this mission until the spring of 1989, when he temporarily stood down from the position of Chief Astronaut.

The CDR for STS-35 was confirmed as TFNG Jon McBride, with Guy Gardner (Class of 1980) as PLT and TFNG Jeff Hoffman, Robert Parker (Class of 1967) and Mike Lounge (Class of 1980) as MS. Due to launch in March 1990 on *Columbia*, the mission was manifested to carry the Astro-1 astronomy payload. This crew had originally been assigned to the STS-61E mission which would have been the 26th Shuttle mission had *Challenger* succeeded. In this new manifest, it was to be the 35th.

This brought the total number of crews in training to nine and reflected a number of changes due to crew reassignments and departures.

STS-27 (December 2 – 6, 1988)

Flight Crew: Robert L. GIBSON (CDR), Guy S. Gardner (PLT), R. Michael MULLANE (MS-1), Jerry L. Ross (MS-2), William M. Shepherd (MS-3)

Spacecraft: Atlantis (OV-104) 3rd mission

Objective: 27th Shuttle mission; 3rd classified DOD satellite deployment

Duration: 4 days 9 hours 5 minutes 35 seconds

Support Assignments: Capcoms on this mission included John CREIGHTON ('Gray' ascent and 'Aquila' entry teams) and Kathy SULLIVAN (Orbit 1). Three of the four SPAN shifts were covered by Group 8 astronauts Brewster SHAW (08:00–14:00), Loren SHRIVER (14:00–20:00) and Don WILLIAMS (02:00–08:00). The remaining shift (20:00–02:00) was fulfilled by members of Group 9. Steve NAGEL was originally intended to be at Edwards AFB covering any AOA incident and as a member of the Dryden Flight Research Facility (DFRF) Contingency Action Center, but was replaced in both positions by one of the newer astronauts. Mike COATS served on the first shift in the SMS and Fred GREGORY replaced the originally assigned Dave WALKER. Chief Astronaut Dan BRANDENSTEIN again served as WX pilot, both at KSC for launch and at Edwards for landing, while Anna FISHER was at the JSC Contingency Action Center. [41]

During this flight, an initially secret DOD payload, later identified as a radar imaging satellite called Lacrosse (also known as Onyx) was successfully deployed for the National Reconnaissance Office (NRO). According to some sources, this required a rendezvous with the deployed payload to release the solar arrays when they failed to open as planned. The nature of this flight meant that most of the mission and the activities of the crew remained secret, so suggestions that Mike Mullane operated the RMS to save the payload, or that Jerry Ross and Bill Shepherd performed an unannounced contingency EVA have been neither acknowledged nor denied, even more than 30 years after the mission. What is known is that the crew operated a number of secondary payloads and a range of experiments aimed at

defining the human role as a military observer in space. As most details of the flight of STS-27 remain classified, the mission is remembered for almost becoming the second fatal Shuttle mission in less than three years, though the classified nature of the mission meant that it took some time for the details of this to emerge.

A FRIGHTENING CLOSE CALL

Eighty-five seconds after *Atlantis* launched, insulation material from the nose cap of the right-hand SRB struck the Orbiter, inflicting extensive damage to the Thermal Protection System (TPS) tiles. The crew had reported seeing white material on the windows during the eight-minute ascent to orbit, but they had no idea of the extent of the damage until the next day when, unusually, the flight controllers asked them to use the RMS cameras to inspect the starboard side of *Atlantis*.

When the crew positioned the arm over the right side of the Orbiter, they were surprised and shocked to discover the worst tile damage yet recorded during a Shuttle mission. It was so severe that Gibson thought the crew were going to die during re-entry. Mike Mullane wrote about the incident in his 2006 autobiography (devoting two chapters to his account of the events) noting that, from the RMS inspection, it looked as though hundreds of tiles had been damaged and at least one tile had been completely ripped off, with scars extending right across the leading edge of the right wing. Mullane feared that if the damage had penetrated the carbon composite panels at that point, then they were “dead men floating.” [42] Gibson contacted Houston through the closed [to the public] channel, giving Mission Control a detailed verbal description of the damage they had seen. He was asked to send images down on the secure TV channel, and here is where the fate of the crew hung in the balance.

Because STS-27 was a classified mission, the crew were not allowed to use the standard methods of downlink and instead could only rely on the much slower encrypted transmission – one frame at a time – in which each single frame of the TV ‘movie’ took three seconds to send. When received at JSC and reassembled into the TV images the crew had seen on orbit, they were of such poor quality that the NASA engineers misinterpreted the damage as just “lights and shadows,” commenting that the TPS did not appear to be any worse than on previous missions and that poor lighting conditions had led the astronauts to draw the wrong conclusions. Astonished, to say the least, Gibson and his crew were well aware of what they had seen in the crystal clear images from the RMS cameras – though there was little they could do about it – and Gibson was fuming. Despite stressing what they were seeing on orbit, Gibson was told that the engineering assessment of the damage was that it was not that severe. The crew could not believe what they were hearing. Between them, Gibson, Mullane and Ross had flown four previous missions in space and had been around the Shuttle program since well before it had started flying, so they had plenty of knowledge of all the missions to date, and the effects of space flight on the tiles. They naturally disagreed with the evaluation on the ground,

but there was nothing to be done except fly the mission. Though it looked bad to them, they had to defer to the ‘experts’ on the ground, but as Gibson later admitted while up on orbit, it looked as though “we’re in deep doo-doo.” They were aware that there was no immediate problem, but without tools to repair the damage, no methods in place or trained for to get an EVA astronaut to the damaged area, no space station to use as a safe haven, and no second Shuttle sitting on the pad that could come and rescue them, their re-entry would be tense to put it mildly. In fact, mounting a rescue using a second Shuttle would have been challenging in the time available, as the other two orbiters, *Discovery* and *Columbia*, were in the Orbiter Processing Facility (OPF) at the time of the STS-27 mission.

As the time for entry approached on December 6, Gibson and Gardner initiated the re-entry to commence the fiery descent to Edwards AFB. On the flight deck, Gibson knew exactly how *Atlantis* would behave if the damage was indeed terminal, his eyes glued to the gauges to look for any deflections in the wing elevon. Any excess drag on the right wing would record right elevon trim, and the left and right wing elevon positions would differ as the automatic system tried to trim out the variances. Even a half degree of trim would indicate that something was wrong, and if he saw that, Gibson knew that he would have about 60 seconds to tell Mission Control what he thought of the assessment of the damage before *Atlantis* broke apart in the upper atmosphere.

Fortunately, *Atlantis* did not suffer a burn through and Gibson skillfully guided the Orbiter to a safe entry and landing on Runway 17 at Edwards, much to the relief of all onboard, and no doubt the controllers as well. As this was a ‘secret’ mission, nothing was mentioned publicly for some time after the flight. As soon as the crew exited the Orbiter, they hurried to the right side of *Atlantis* to see the damage for themselves. Post-flight examinations by a review team set up to investigate the incident reported over 700 damaged tiles, with the missing tile being over the steel mounting plate for the L-band antenna. Fortunately, this was a less critical area, which probably prevented a complete burn through similar to the one which sealed the fate of *Columbia* and her crew 14 years later in 2003.

The official STS-27 Mission Report stated: “Initial post-flight inspections of the exterior surface of the Orbiter revealed significant tile damage, with 298 damage sites greater than 1 inch [2.54 cm] in area, and a total of 707 damage sites on the lower surface of the vehicle. The area of major damage was concentrated outboard of a line from the bi-pod attachment to the External Tank liquid oxygen umbilical. One tile was missing on the right side slightly forward of the L-band antenna. Also, there were many damage sites consisting of long narrow streaks with deep gouges. *The damage noted is the most severe of any mission flown yet* [authors’ italics].” The report also recorded that “the tin plating on the [L-band antenna] aluminum door was melted, with aluminum appearing to be halfway between hardened and annealed. The door also had a small buckle.” [43]

In a 2009 interview with *Spaceflight Now*, former Shuttle Program Manager Wayne Hale stated that the engineers were “caught off guard” when the severity

of the damage was seen on *Atlantis* standing on the runway at Edwards. He recalled that back in 1988 it was a struggle to maintain security, and that the controllers had to ask the ‘payload customer’ if they could view the images because TV from classified missions was forbidden. This was only agreed providing the slow-scan system was used. [44]

The STS-27 mission has been recorded as having the most damaged launch-entry vehicle to return to Earth successfully. Had *Atlantis* been lost, re-entering over the Pacific Ocean, most of the debris would have sunk without trace, and without debris the exact cause may never have been determined. Gibson thought that Congress would have cancelled the whole program if there had been another disaster just two missions after *Challenger*. He and his crew had been lucky, but that luck ran out for the *Columbia* crew on February 1, 2003.

Playing catch-up

As it was a classified mission, the near-miss of STS-27 was not initially revealed, and so the new year 1989 came with an apparently renewed confidence in the Shuttle system after the difficulties of the previous three years. Though there still remained much to accomplish before the whole fleet returned to flight and the recommendations and improvements made to the hardware, systems and infrastructure were fully implemented, there was a feeling of catching up with delayed missions while progressing steadily and, publicly at least, ensuring safety with each step. But within NASA, the seriousness of the damage sustained by *Atlantis* on STS-27 was a stark warning of how close they had come to a second disaster so soon after recovering from the first. The mission announcements during this year revealed a shift towards space science missions rather than the commercial satellite deployments that had been a feature of previous years. Of course, many planned commercial satellite payloads had been shifted to ELV in the down time following the loss of *Challenger*, removing some of the revenue from those planned missions but allowing NASA to launch the delayed science missions and to look towards a new era of Shuttle orbital operations, hopefully focusing upon building the Space Station.

On February 24, NASA announced that John Creighton would command STS-36, a dedicated DOD mission aboard *Atlantis* scheduled for February 1990. Creighton would continue to serve as head of the Mission Support Branch in the Astronaut Office prior to starting full-time training for his upcoming flight. Fellow TFNG Mike Mullane was assigned as an MS on the flight, together with PLT John Casper (Class of 1984) and MS David Hilmers (Class of 1980) and Pierre Thuot (Class of 1985). In the same release, Rhea Seddon was named as an MS on STS-40, the first dedicated Spacelab Life Sciences (SLS, formerly Spacelab 4) mission, together with James Bagian (Class of 1980). *Columbia* was manifested to carry the Spacelab Long Module on a mission scheduled for June 1990. The two MS joined the two PS named to the mission back in April 1985 and this partial crew assignment enabled long-lead crew participation for payload training and experiment integrations, with the rest of the flight crew being assigned at a later date. [45]



Fig. 11.4: (top) A much-relieved STS-27 crew descends the steps after exiting *Atlantis* at the end of their eventful mission. Leading is CDR Hoot Gibson, followed by PLT Guy Gardner and then MS Mike Mullane, Jerry Ross and Bill Shepherd. This image of the left side of *Atlantis* does not reveal the extensive damage to the Thermal Protection System on the right-hand side, which came close to costing the crew their lives and the probable termination of the Shuttle program. (bottom) The experienced TFNG continued to support the Return-to-Flight program. Here, John Creighton, in shirt sleeves, and Frank Culbertson (Class of 1984 next to him), are at the Capcom console in MCC during the STS-29 mission.

STS-29 (March 13 – 18, 1989)

Flight Crew: Michael L. COATS (CDR), John L. Blaha (PLT), Robert C. Springer (MS-1), James F. BUCHLI (MS-2), James P. Bagian (MS-3)

Spacecraft: Discovery (OV-103) 8th mission

Objective: 28th Shuttle mission; TDRS-D deployment

Duration: 4 days 23 hours 38 minutes 50 seconds

Support Assignments: For this mission, John CREIGHTON served as Capcom on the ‘Aquila’ team for ascent and the ‘Phoenix’ team for entry, while Kathy SULLIVAN was on console for the ‘Altair’ Orbit 2 team. [46] Assigned to SPAN were Loren SHRIVER (08:00-14:00), Hoot GIBSON (20:00-02:00) and Dick COVEY (02:00-08:00). Dave WALKER worked the first shift in SMS and Fred GREGORY the second. Dan BRANDENSTEIN returned to his WX pilot role at both KSC and Edwards. Steve NAGEL was contingency landing support for AOA and Alternative End of Mission (EOM) support, both at Northrup, though neither were required. Pinky NELSON provided PAO support. [47]

Six hours into this mission, the crew deployed the TDRS-D satellite, while later on the middeck they focused upon an array of science investigations and photography using the large format IMAX camera. STS-29 was one of the smoothest missions of the program.

During March 1989, Jon McBride officially returned to the Astronaut Office from Washington to resume training as CDR of the Astro-1 mission, while Jim Buchli was assigned as Deputy Chief of the Astronaut Office after flying STS-29, replacing Steve Hawley who was reassigned to active mission training as MS for STS-31. At the same time, Mike Coats, (Buchli’s CDR on STS-29) became the Acting Chief of the Astronaut Office while Dan Brandenstein returned to active mission training as CDR of STS-32. Following his success in commanding the important Return-to-Flight mission six months earlier, Rick Hauck, a veteran of three Shuttle missions and one of the leading figures in the Class of 1978, announced on March 24 that he would leave NASA on April 3 to assume the post of Director of Navy Space Programs Division, Staff of Chief Naval Operations, The Pentagon, Washington D.C., effective the end of May. “My eleven years with NASA have been extremely rewarding,” Hauck said at the time. “I’ll miss the challenging environment and the people. I am looking forward to continuing my career in the Navy and to the new challenges it provides.” [48]

Just two days after the departure of Hauck from the Astronaut Office came the news that Steve Nagel was to take command of STS-37, with a crew comprising PLT Ken Cameron (Class of 1984), and MS Jerry Ross (Class of 1980), Jay Apt and Linda Godwin (both from the Class of 1985). This mission was to be flown on *Discovery* in April 1990, deploying the Gamma Ray Observatory, one of NASA’s Great Observatories, into orbit. In the same announcement, NASA assigned three

other crewmembers to STS-40 (SLS-1) from the Classes of 1980 (Bryan O'Connor and John Blaha) and 1985 (Tammy Jernigan, who replaced the retired TFNG John Fabian), joining Rhea Seddon and Jim Bagian who were already in training. [49]

STS-30 (May 4 – 8, 1989)

Flight Crew: David M. WALKER (CDR), Ronald J. Grabe (PLT), Mark C. Lee (MS-1), Norman E. THAGARD (MS-2), Mary L. Cleave (MS-3)

Spacecraft: Atlantis (OV-104) 4th mission

Objective: 29th Shuttle mission; Magellan Venus orbiter probe deployment

Duration: 4 days 0 hours 56 minutes 27 seconds

Support Assignments: John CREIGHTON was the sole Group 8 representative in the MCC, assigned to the 'Phoenix' team for ascent and entry. This was the last Capcom assignment for Group 8 astronauts for some time, as other astronauts from more recent selections were given the chance to gain experience of working in MCC Houston (MCC-H). [50] Continuing their roles in SPAN were Loren SHRIVER (02:00-08:00), Hoot GIBSON (08:00-14:00) and Dick COVEY (20:00-02:00). Fred GREGORY and Don WILLIAMS took the two shifts in SMS. Dan BRANDENSTEIN provided weather support for launch and landing and Pinky NELSON was on call at the Weightless Environment Training Facility (WETF) to support any contingency EVA. Mike MULLANE was one of the Family Escorts. [51]

During this four-day mission, the crewmembers deployed the radar-mapping Magellan Venus exploration spacecraft (the first U.S. planetary science mission in nine years). This was the first planetary probe to be deployed from a Shuttle Orbiter, demonstrating another capability of the Shuttle system. In addition, the crew worked on secondary payloads involving fluid research in chemistry and electrical storm studies. This mission should have used the more powerful Centaur upper stage to boost Magellan towards the shrouded planet in a shorter timescale, and using the lesser powerful IUS meant that Magellan would not reach Venus for 16 months. However, when it did finally enter the orbit of Venus on August 10, it not only completed its planned one-year primary mission but had its mission extended through October 1994, over five years after being deployed from *Atlantis*. In that time, Magellan radar-mapped 98 percent of the surface and recorded 95 percent of the planet's gravity data.

The deployment of Magellan from *Atlantis* was seen as a significant achievement, so much so that President George H. W. Bush called first-time Shuttle commander Dave Walker onboard *Atlantis* to congratulate him and his crew and invite them to the White House after the mission. While flying his T-38 jet trainer to those ceremonies on May 5, 1989, Walker inadvertently came within 100 feet (30.5 meters) of a Pan Am jetliner just outside Washington, D.C., an error that would cost him his next command.

Assignments, retirements and another tragedy

May and June 1989 was a busy period in the Astronaut Office, with Mike Coats named as Acting Chief of the Astronaut Office until March 1990, standing in for Dan Brandenstein while the latter trained as CDR for STS-32. On May 11, Dick Covey was named as CDR of STS-38, another classified DOD mission aboard *Atlantis* in May 1990. He would lead a crew consisting of PLT Frank Culbertson (Class of 1984) and MS Robert Springer (Class of 1980), Carl Meade and Charles ‘Sam’ Gemar (both from the Class of 1985). The same announcement listed Guion Bluford as one of three MS for STS-39, also a DOD mission, scheduled for July 1990. He was named together with members of the 1984 (Charles Lacy Veach) and 1985 (Richard Hieb) selections. Once again, the early naming of this partial crew would provide them with plenty of lead time to participate in payload training and integration. [52]

The following day, Jon McBride became the latest member of the TFNG to leave NASA. He also announced his intention to retire from the USN with the rank of Captain and pursue a career in politics. His intention to retire had been announced the previous month (April 24), shortly after he had returned from his assignment at NASA Headquarters in Washington D.C. to resume training as CDR for STS-35 (Astro-1). He would be replaced on that mission by veteran astronaut Vance Brand. “I’ve spent an extremely rewarding 25 years with NASA and the Navy,” McBride commented at the time. “This move has been a very difficult decision for me, but in the final analysis, I felt it was time to make a career change and return to West Virginia. I’ll continue to follow developments in the space program with keen interest.” [53]

On June 9, it was announced that George ‘Pinky’ Nelson would also be leaving the agency, effective June 30, to accept academic and administrative posts at the University of Washington in Seattle, Washington State. He was named both Assistant Provost of Astronomy and Associate Professor of Astronomy at the institute. “I am excited with the prospects of a new challenge at the University,” Nelson said. “At the same time, I know that I will miss NASA and the Johnson Space Center, especially the people. I don’t think there is a more dedicated, motivated and skilled group around. Thanks to everyone for making the past 11 years so enjoyable. I hope to continue to promote the space program in my new career, because I believe that the exploration of space and the development of new technology is key to the future success of our civilization.” [54] At just 27 in 1978, Nelson was one of the youngest candidates NASA had selected for astronaut training. Now, turning 39 the following month, he was one of the most experienced astronauts from the TFNG to leave the office, having amassed over 411 hours on three space flights, flown on three different Orbiters, and accumulated over ten hours of EVA time, as well as experience in a range of ground support and technical assignments.

Just over a week after the news that Nelson was leaving the agency, the TFNG remaining in the Astronaut Office reeled from the shock of losing another of their brethren when news came in that former naval aviator and test pilot S. David Griggs had been killed on June 17 in the crash of the North American AT-6 vintage trainer he was flying near Earle, Arkansas, while practicing for an upcoming air show. [55] He was just 39 years old and had been at NASA in Houston since 1970, initially as a research pilot in the Aircraft Division at JSC and later as Chief of the Shuttle Training Aircraft Operations Office before being selected as an astronaut in 1978. Having flown in space aboard STS-51D in 1985, he was in training as PLT for the STS-33 classified DOD mission aboard *Discovery* that was scheduled for November 1989.

The Astronaut Office had strict rules to prevent astronauts who were assigned to flight crews from participating in potentially dangerous extracurricular activities, with extreme sports and risky recreational activities, and even softball and skiing, deemed off limits to reduce the risk of accidents so close to launch. Questions were asked as to why Griggs, an experienced and talented pilot, would spend the weekend doing acrobatics so close to his scheduled launch date, clearly against these rules. As it turned out, Griggs had not sought permission for the out-of-hours flying, which for a while reflected badly on the management at JSC, who clearly were unaware of the event. While the enforcement of these rules was often criticized, there were clear reasons behind them, but as this case demonstrated, sometimes members of the office simply overlooked the rules they were expected to adhere to.

With the STS-33 mission just five months away, a recently-flown replacement had to be assigned to the mission quickly to prevent a break in the training flow or delay to the flight. The seat was given to Group 9 astronaut John Blaha (Class of 1980), who had flown his first mission as PLT on STS-29 just three months earlier and was just beginning training as PLT on STS-40. By now, he would have recovered from his first flight and his performance level would still be at a peak, and his assignment was not expected to impact the planned launch date. Blaha's place on STS-40 would be fulfilled by Sydney M. Gutierrez (Class of 1984), and a further flight crew assignment was announced in the same news release. TFNG Norman Thagard and Mary Cleave (Class of 1980) were named as MS for the first International Microgravity Laboratory (IML-1) mission, again enabling long term crew participation in payload training and experiment integration. IML-1 was planned as a nine-day flight on *Columbia* in December 1990. [56]

In a packed program

By the close of June 1989, NASA had flown four missions in nine months and had a further dozen crews, or partial crews, in various stages of training for missions planned to fly over the coming 18 months (see Table 11.2).

TABLE 11.2: NAMED SPACE SHUTTLE CREWS IN TRAINING AS OF JUNE 30, 1989 [NASA ASSIGNMENTS ONLY]

STS	Primary Payload	Launch date	Commander	Pilot	Mission Specialists
SHUTTLE MISSIONS MANIFESTED FOR CALENDAR YEAR 1989					
28	DOD	Jul 31	SHAW	Richards R.	Adamson Leestma Brown M.
34	Galileo Jupiter probe	Oct 12	WILLIAMS D.	McCulley	LUCID Chang-Diaz Baker E.
33	DOD	Nov 19	GREGORY F.	Blaha	Carter Musgrave Thornton K.
32	Intelsat; LDEF retrieval	Dec 18	BRANDENSTEIN	Wetherbee	Dunbar Low Ivins
SHUTTLE MISSIONS MANIFESTED FOR CALENDAR YEAR 1990					
36	DOD	Feb 1	CREIGHTON	Casper	Hilmers MULLANE Thuot
31	Hubble Space Telescope deployment	Mar 26	SHRIVER	Bolden	HAWLEY SULLIVAN McCandless
35	ASTRO 1	Apr 26	Brand	Gardner G.	Lounge HOFFMAN Parker
37	Gamma Ray Observatory deployment	Jun 4	NAGEL	Cameron	Ross Apt Godwin
38	DOD	Jul 9	COVEY	Culbertson	Springer Meade Gemar
40	Spacelab Life Sciences 1	Aug 16	O'Connor	Gutierrez	SEDDON Bagian Jernigan
39	Infrared Background Signature Survey	Nov 1	TBD	TBD	BLUFORD Hieb Veach TBD TBD
42	International Microgravity Laboratory 1	Dec 6	TBD	TBD	THAGARD TBD Cleave

Of the 25 members of the Class of 1978 in the Astronaut Office at the start of the year (14 PLT and 11 MS), two pilots (Hauck and McBride) and one MS (Nelson) had retired, while a third pilot (Dave Griggs) had been killed, all within three months. That left 21 TFNG in the office (11 PLT and 10 MS). Of these, 16 were in training for new missions as the group embarked on their second decade at NASA. Despite all the departures and fatalities, at least one member of the 1978 selection was present on every named crew through to the end of 1990... at least for now.

STS-28 (August 8 – 13, 1989)

Flight Crew: Brewster H. SHAW (CDR), Richard N. Richards (PLT), James C. Adamson (MS-1), David C. Leestma (MS-2), Mark N. Brown (MS-3)

Spacecraft: Columbia (OV-102) 8th mission

Objective: 30th Shuttle mission; 4th classified DOD satellite deployment

Duration: 5 days 1 hour 0 minutes 9 seconds

Support Assignments: Flight control assignments were not announced for this mission, but SPAN was occupied by Hoot GIBSON (08:00-14:00), Dave WALKER (20:00-02:00) and Jim BUCHLI (02:00-08:00). Don WILLIAMS worked the first shift in SMS and Fred GREGORY the second. Mike COATS was the WX pilot for both launch and landing. Loren SHRIVER was at Ben Guerir Air Base in Morocco for Transoceanic Abort Landing (TAL) support, while Jim BUCHLI was dual assigned as WETF support. [57]

This fourth fully-classified Shuttle flight was also the Return-to-Flight mission for *Columbia*, completing the post-*Challenger* program to re-qualify all three remaining Orbiters for operational flights. The crew deployed the KH-12 advanced reconnaissance satellite.

On September 29, six weeks after the return of STS-28, NASA announced astronauts to no less than five Shuttle missions expected to fly in late 1990 and early 1991. [58] What was evident was the changing make-up of the Astronaut Office, as many of the TFNG were assigned to what would become their final missions and members of the later groups began to take over the majority of assignments. What was not mentioned was that the emphasis on academic qualifications over more traditional piloting skills, the inclusion of female and minority selectees, the selection of representatives of other military services and even foreign-born astronauts trained as fully qualified MS, a process which began with the selection of the Group 8 astronauts in 1978, was now becoming commonplace in recent astronaut selections and assignments. It was all pointing towards preparing the first international crews for the Space Station program, providing its funding and designs could be sorted out. The assignments announced in the September news release included the first astronauts from the Class of 1987 (Group 12), the

first U.S. Coast Guard astronaut to fly (Bruce Melnick), the first European Space Agency (ESA) astronaut to be named as an MS (Claude Nicollier, Switzerland) and the first black female (Mae Jemison) to be selected for space flight.

Most notable was the crew originally named to STS-41, the first not to include any members of the 1978 selection since 1985, although five TFNG were named to other crews in the same announcement. In a partial crew assignment, Mike Coats was named to command *Discovery* for STS-39, a now unclassified DOD mission scheduled for November 1990. Also named were PLT Blaine Hammond (Class of 1984) and MS Gregory Harbaugh and Donald McMonagle (both from the Class of 1987), to join the previously named MS Hieb, Veach and TFNG Guion Bluford. Kathy Sullivan was named to the STS-45 Astro-1 mission scheduled for March 1991 aboard *Columbia*, together with C. Michael Foale (Class of 1987). In another partial crew assignment, Hoot Gibson was named to command STS-46, along with TFNG Jeff Hoffman, Franklin Chang Díaz (Class of 1980) and ESA astronaut Claude Nicollier as MS. This mission on *Atlantis* would deploy the Eureka ESA-sponsored free-flying satellite and demonstrate the Tethered Satellite System (TSS). The final assignment was for the science MS for STS-47, flying the Spacelab J (Japanese) life science and material processing experiments. Though no Group 8 astronaut was initially assigned to this mission, it would feature later in the story of one of the group.

STS-34 (October 18 – 23, 1989)

Flight Crew: Donald E. WILLIAMS (CDR), Michael McCulley (PLT), Shannon W. LUCID (MS-1), Franklin R. Chang Díaz (MS-2), Ellen S. Baker (MS-3)

Spacecraft: Atlantis (OV-104) 5th mission

Objective: 31st Shuttle mission; Galileo Jupiter entry probe/orbiter deployment

Duration: 4 days 23 hours 39 minutes 21 seconds

Support Assignments: For this mission, Dave WALKER was assigned to SPAN (08:00-14:00), along with Steve NAGEL (20:00-02:00). Fred GREGORY worked the first shift in SMS and John CREIGHTON the second. Mike COATS again served as weather coordinator for launch and landing and Jeff HOFFMAN was one of the immediate Family Escorts. Dick COVEY was on hand at Ben Guerir, Morocco, for any TAL situation during launch. [59]

During this four-day mission, the crew successfully deployed the Galileo spacecraft, the second planetary probe from a Shuttle Orbiter, on its long journey to explore Jupiter. On board *Atlantis*, the crew also operated the Shuttle Solar Backscatter Ultraviolet Instrument (SSBUV) to map atmospheric ozone, and performed numerous secondary experiments involving radiation measurements,

polymer morphology, lightning research, microgravity effects on plants and a student experiment on ice crystal growth in space. STS-34 lasted less than five days and remained one of the shortest Shuttle missions in the series, but the mission of Galileo lasted far longer. Originally planned to be carried on a Centaur upper stage, it was also reassigned to an IUS upper stage and therefore, like Magellan and Ulysses, would require a far longer trajectory to its target planet. The journey took six years to complete, arriving on December 7, 1995, and the results from Galileo re-wrote the textbooks on Jupiter. Once again, Group 8 astronauts played their part in a significant milestone in American space flight and planetary exploration.

Also in October, having completed his STS-28 post-flight obligations, Brewster Shaw became the latest member of the 1978 selection to leave the Astronaut Office at JSC, to take a position as Deputy Director of Space Shuttle Operations at KSC.

STS-33 (November 22 – 27, 1989)

Flight Crew: Frederick D. GREGORY (CDR), John L. Blaha (PLT), Manley L. ‘Sonny’ Carter (MS-1), F. Story Musgrave (MS-2), Kathryn C. Thornton (MS-3)

Spacecraft: Discovery (OV-103) 9th mission

Objective: 32nd Shuttle mission; 5th classified DOD satellite deployment

Duration: 5 days 0 hours 6 minutes 48 seconds

Support Assignments: Very few Group 8 astronauts were assigned to support roles on this flight. Chief Astronaut Dan BRANDENSTEIN worked the first shift in SMS, with John CREIGHTON taking the second shift. Mike COATS again served as WX for launch and landing. [60]

Compared to the previous three years, 1989 had seen a significant increase in Shuttle missions to five, with *Columbia* returning to flight to join the other two surviving Orbiters, the deployment of a third TDRS and two planetary probes, and two DOD missions including the deployment from STS-33 of a SIGINT electronics signals intelligence satellite.

SCHEDULES, SCIENCE COMMANDERS AND THE SOVIETS

The new year of 1990 opened with the assignment of the Orbiter flight crew (CDR, PLT and MS-2) for STS-42 carrying the IML-1 payload. While none of these were from the 1978 selection, they did join the previously named Norman Thagard who was already in training for the mission. It was expected to be a busy year for Shuttle operations, but the gremlins were gathering once again to cause havoc with the schedules and scupper even the best laid plans.

There were ten Shuttle missions manifested at the beginning of 1990, but early in the year a 24-hour weather delay in getting *Columbia* off the ground for STS-32, together with problems with the SRB assigned to the STS-31 HST deployment mission, necessitated the latter launch being moved from March to April. STS-37 therefore slipped from July to November and STS-39 was rescheduled from its November slot to no earlier than January 1991.

STS-32 (January 9 – 20, 1990)

Flight Crew: Daniel C. BRANDENSTEIN (CDR), James D. Wetherbee (PLT), Bonnie J. Dunbar (MS-1), Marsha S. Ivins (MS-2), G. David Low (MS-3)

Spacecraft: Columbia (OV-102) 9th mission

Objective: 33rd Shuttle mission; Comsat deployment; LDEF retrieval

Duration: 10 days 21 hours 0 minutes 36 seconds

Support Assignments: In SPAN, Don WILLIAMS worked on the 21:00–03:00 shift, while Kathy SULLIVAN and Dave WALKER both supported the 09:00–15:00 shift. Guion BLUFORD was in SAIL, while SMS support was provided by John CREIGHTON on the first shift and Loren SHRIVER on the second. Mike COATS continued his role as WX pilot at both KSC and Edwards, while Jim BUCHLI fulfilled the role of WETF support. [61]

STS-32 was the first mission since STS-61A in October 1985 to log a duration of over seven days and the first since STS-9/Spacelab 1 in 1983 to surpass 10 days, demonstrating that the Shuttle was beginning to return to its pre-1986 flight capabilities. Most of the Shuttle flights between 1988 and 1990 were planned to catch up with the delayed manifest following the loss of *Challenger*, and STS-32 played its part in this plan by retrieving the LDEF that had been deployed by STS-41C. Originally intended to be in orbit for a year, LDEF was finally retrieved after six years, or 2,093 days in free flight. Its retrieval came too late for some of the experiments, but was useful for analyzing how materials and samples deteriorated in space over time, an important source of knowledge for designing a large space station that was planned to be in orbit for up to 30 years. On a more personal note, Dan Brandenstein became the first of the TFNG to celebrate the anniversary of their selection in space (January 16) and followed that up with his 47th birthday the very next day, which he celebrated with an inflatable cake complete with imitation candles. His piloting skills were called for at the end of the mission, as he landed *Columbia*, with the LDEF secured on board, at an overall mass of 228,376 lbs. (103,572 kg), the heaviest landing weight in the program to date.

On January 25, less than a week after the return of STS-32, NASA announced its first Science Payload Commanders (PC) as Norman Thagard (STS-42/IML-1), Kathy Sullivan (STS-45/Atlas-1), Jeff Hoffman (STS-46/EURECA/

TSS-1) and Group 10 astronaut Mark Lee (STS-47/Spacelab J). [62] The intention was to provide long term leadership in the development and planning of payload crew science activities. According to the news release, “the Payload Commander will have overall responsibility for the planning, integration and on-orbit coordination of payload/Space Shuttle activities on their mission, though the crew commander retains overall responsibility for mission success and safety of flight.”

A visit to the Soviet Union

On February 1, 1990, NASA announced it had accepted an invitation extended earlier in the year by Soviet cosmonaut Alexei Leonov, through the cosmonaut chapter of the Association of Space Explorers (ASE), for a group of Shuttle astronauts to attend the launch of the next Soviet manned space launch and to tour facilities in the Soviet Union. Members of the U.S. delegation included JSC Deputy Director and astronaut Paul J. Weitz (Class of 1966), and Chief Astronaut and TFNG Dan Brandenstein, together with Ron Grabe and Jerry Ross (both from the Class of 1980). The group travelled to Moscow on February 9, and the following day were taken to the Baikonur Cosmodrome in Kazakhstan to witness the launch of Soyuz TM-9 carrying Mir EO-6 cosmonauts Anatoly Y. Solovyov and Aleksandr N. Balandin to the Mir space station at the start of their 180-day mission. They also took the opportunity to view the Buran Space Shuttle before returning to Moscow to visit the nearby Cosmonaut Training Center named for Yuri A. Gagarin. Here, the American pilot astronauts were invited to try out the Soyuz simulator, while Jerry Ross evaluated the Soviet version of the Manned Maneuvering Unit (MMU), the UPMK (Cosmonaut Transference and Maneuvering Unit – 21KS) flight tested by cosmonauts on Mir earlier that month. The group also visited the Soviet Manned Spaceflight Control Center in Kaliningrad before returning to the United States on February 14. [63]

Relations with the Soviets had remained good since the Apollo-Soyuz Test Project (ASTP) in 1975, despite the adverse political situation in the late 1970s which stifled future plans. This visit was to prove fortuitous in its timing, firstly because NASA was struggling to make progress in its complicated and expensive *Freedom* space station program, and secondly because serious domestic issues were developing within the Soviet Union. In fact, the following year would see the collapse of the Soviet Union and the near-cancellation of the *Freedom* project. This visit was a stepping stone which would later allow the new Russia to become a partner in the emerging International Space Station (ISS) program in 1993.

On February 20, three days before he was scheduled to fly on his third mission as an MS on STS-36, NASA announced that Richard ‘Mike’ Mullane would retire from NASA and the USAF effective July 1, 1990, to return to new opportunities in Albuquerque in his home state of New Mexico. However, it turned out that his

last space flight would not be as soon as he or anyone else expected. [64] On the very next day, February 21, NASA reported that STS-36 CDR John Creighton had developed an upper respiratory tract infection and was being treated with antibiotics. NASA Spokesman Kyle Herring stated: “It’s basically a sore throat with a little head congestion,” but with the astronaut medically grounded, the launch was postponed for at least 24 hours. Meteorologists also warned that the weather could further delay the launch. This was the first time since Apollo 9 in 1969 that a U.S. mission had been delayed by the illness of a prime crewmember, and 20 years since health had affected a prime crew so close to launch, when Command Module Pilot Ken Mattingly was replaced by Jack Swigert five days prior to the launch of Apollo 13 due to Mattingly’s exposure to German Measles. There were no plans to replace Creighton, however. While there had been no formal back-up crews since 1982, it could have been done, though it would have been difficult to choose someone from the pool of astronauts this close to launch. With the flight rate increasing, there were now a number of astronauts who were capable, if it was critical, of taking on the role. [65] The expected adverse weather did indeed delay the launch until the end of the month, allowing the astronaut to recover fully without needing to replace him.

On February 26, two days prior to the launch of STS-36, it was revealed that veteran of two Shuttle flights Don Williams would become the next member of the 1978 selection to leave the Astronaut Office, effective March 1, retiring from NASA and the USN to pursue a career in private industry. He would become a Senior Systems Engineer for Science Applications International Corporation in Houston. “I reached my goal as a pilot, which was to command a mission. Now it’s time to go on to other challenges. JSC and NASA have been a wonderful place to work and I’m proud to have been part of the team,” he said at the time. [66]

STS-36 (February 28 – March 4, 1990)

Flight Crew: John O. CREIGHTON (CDR), John H. Casper (PLT), R. Michael MULLANE (MS-1), David C. Hilmers (MS-2), Pierre J. Thuot (MS-3)

Spacecraft: Atlantis (OV-104) 6th mission

Objective: 34th Shuttle mission; 6th classified DOD satellite deployment

Duration: 4 days 10 hours 18 minutes 22 seconds

Support Assignments: Shannon LUCID worked in SPAN (12:00–18:00), while Guion BLUFORD was assigned to SAIL and Loren SHRIVER to the first shift in SMS. Mike COATS was again assigned as weather support at KSC and Edwards, and Hoot GIBSON served as one of the Immediate Family Escorts [67]

STS-36 carried a DOD payload, which included a digital imaging and electronics signals intelligence satellite and a number of secondary payloads, to a very high

inclination orbit of 62 degrees, about five degrees outside the prescribed safety limits for Shuttle launches from the Cape.

With Dan Brandenstein having completed his STS-32 post-flight duties, Mike Coats stepped down as Acting Chief of the Astronaut Office during March to allow Brandenstein to resume his position as Chief of the Astronaut Office. Coats began full time mission training for STS-39.

STS-31 (April 24 – 29, 1990)

Flight Crew: Loren J. SHRIVER (CDR), Charles F. Bolden (PLT), Bruce McCandless (MS-1), Steven A. HAWLEY (MS-2), Kathryn D. SULLIVAN (MS-3)

Spacecraft: Discovery (OV-103) 10th mission

Objective: 35th Shuttle mission; Hubble Space Telescope deployment

Duration: 5 days 1 hour 16 minutes 6 seconds

Support Assignments: Fred GREGORY continued his tour in SPAN (12:00–18:00) and was joined by Shannon LUCID (18:00–24:00). Guion BLUFORD was back in SAIL, while SMS support was provided by Dick COVEY on the second shift. Having completed his STS-32 assignments, Chief Astronaut Dan BRANDENSTEIN returned to the role of WX pilot for both KSC and Edwards. Hoot GIBSON again served as one of the Immediate Family Escorts. [68]

On this five-day mission, the crew deployed HST and conducted a variety of mid-deck experiments involving the study of protein crystal growth, polymer membrane processing, and the effects of weightlessness and magnetic fields on an ion arc. They also operated a range of cameras, including both the IMAX in-cabin and cargo bay cameras, for Earth observations from their record-setting altitude of 380 miles (600 km), the highest recorded on an Earth-orbital flight since the Gemini missions of 1966. As this was highest apogee ‘officially’ attained by any Shuttle mission, it meant that the crew, including TFNG Shriver, Hawley and Sullivan, had travelled further from Earth than any space explorer since Apollo 17. However, in 2009 Kathy Sullivan suggested that this may not have been the case: “The deployment altitude for Hubble was quite high for a Space Shuttle. I’m pretty sure it’s the highest altitude civilian flight. Every time I say that, KT [Kathryn Thornton] squints at me as if she went higher than that at some other point in time. Her first flight [STS-33] was a Defense Department flight, though, so if she did, she can’t say anything.” [69] Though the crew had successfully deployed Hubble, tests carried out after the crew had returned to Earth revealed the infamous error in the telescope’s optics, rendering HST relatively useless – much to the chagrin of NASA – until a solution to repair the distortion could be found, a task which would take the next three years to resolve and mount a mission to service and fix the telescope’s vision. [70]



Fig. 11.5: (top) Chief Astronaut and STS-32 CDR Dan Brandenstein celebrates his 47th birthday (January 17) in space with an inflatable cake, the very day after the 12th anniversary of the selection of the Class of 1978. (bottom) Dressed to impress. Education has always been a key element of the TFNG outreach program. On the aft flight deck of *Columbia*, while sporting a teacher’s apparel of shirt and tie rather than an astronaut’s spacesuit, STS-35 MS Jeff Hoffman prepares to conduct a lesson from space to school-children during the Astro-1 mission.

A fifth Orbiter at last

On May 7, 1991, a new Shuttle Orbiter arrived at KSC on top of the Shuttle Carrier Aircraft (SCA), 12 days after its rollout from Rockwell's Palmdale facility in California. Formally named OV-105, the new vehicle was more commonly known as *Endeavour*, named, via a national school competition, after the 18th century British ship *HMS Endeavour* which was captained by James Cook on his first voyage of discovery (1768–1771), hence the English spelling rather than the American version of the name (Endeavor). The U.S. Congress had approved the construction of OV-105 in 1987 as a replacement for *Challenger*, which would be fabricated from the structural spares built during the construction of *Discovery* and *Atlantis*, as it proved much cheaper to build a new vehicle from the spares rather than refit *Enterprise* or construct a brand new Orbiter from scratch. Of course, this meant that there were no structural spares left for what would have been OV-106, nor were additional spares requested to guard against a second Orbiter being seriously damaged or lost in another accident. This decision contributed to the end of the Shuttle program 11 years later, following the loss of *Columbia* and the STS-107 crew and the decision to retire the fleet rather than build another replacement Orbiter.

Due to its late construction, in addition to utilizing the available structural spares, *Endeavour* was assembled using new hardware designed to upgrade and improve its capabilities. Many of these upgrades were later incorporated into the other vehicles during their planned out-of-service maintenance periods. This included the capability to support Extended Duration Orbiter (EDO) missions of up to 28 days, though this duration was never attempted. *Columbia* flew the longest mission, of nearly 18 days, in 1996 (STS-80).

A mouthwatering mission

One year earlier, on March 14, 1990, the \$150 million Intelsat VI (603) satellite had been launched into orbit from Cape Canaveral using a Titan III. Intended to reach a geosynchronous orbit of 22,500 miles (36,200 km) above the Earth, at just 25 minutes into the mission the Orbus-21S upper stage that was designed to place the satellite in its transfer orbit failed to separate from the Titan's second stage and was thus unable to fire. Though controllers were eventually able to separate the satellite and upper stage, Intelsat remained stuck in an elliptical orbit of 96 by 214 miles (154.49 by 344.4 km). The failure was subsequently traced to faulty wiring in the launch vehicle, which had been programmed for two satellites instead of one. The onboard computer was programmed to launch the phantom first satellite while the electronics were wired to launch the second and as a result no signal reached the separation device to trigger the release of the upper stage. Rescue options were evaluated almost immediately, although some reports suggested that despite previous satellite retrievals by Shuttle astronauts, the potential rescue of Intelsat by a Shuttle crew was unlikely.

However, on March 22, Intelsat’s owners met with NASA officials at JSC to discuss whether it was indeed possible to mount a rescue flight. The positive response that it would be possible to deliver and install a new upper stage motor on the satellite came the following day. By May 15, NASA had agreed to mount the rescue mission and announced on June 13 that the new Orbiter *Endeavour* would attempt the rescue for its first mission, planned for February 1992. “It’s an exciting mission for NASA because it gives us a chance to exercise spacewalking capabilities that will be needed for the Space Station *Freedom* project,” said William Green, Payload Manager at NASA HQ in Washington D.C. Jeff Carr, NASA spokesman at JSC, added, “To have the first flight of a new Orbiter is a plum, but to have that and a sexy flight like going to pick up the Intelsat, fix it and re-boost it will just make any experienced crew commander’s mouth water.” [71] Exactly whose mouths would be watering back in the Astronaut Office was yet to be made clear.

New crew assignments

On May 24, 1990, NASA revealed the latest crew assignments for three missions in 1991, raising the number of crews in training to 12. The DOD mission of STS-44 was to be flown on *Atlantis* in March 1991 under the command of Dave Walker, along with PLT Tom Henricks (Class of 1985) and MS Story Musgrave (Class of 1967), Mario Runco and James Voss (both from the Class of 1987). The same announcement named Shannon Lucid as MS to STS-43 planned for May 1991 to deploy TDRS-E. The mission would be commanded by John Blaha (Class of 1980) and also included PLT Michael Baker (Class of 1985) and MS David Low and James Adamson (both from the Class of 1984). The final assignment was for the STS-45 Atlas 1 Orbiter crew, to join already-assigned PC Kathy Sullivan and the rest of the science crew on a mission projected to launch in April 1991. [72]

On June 7, just over a month after returning from STS-31, Steve Hawley left the Astronaut Office at JSC to join NASA’s Ames Research Center, Moffett Field, Palo Alto, California, as Associate Director. [73]

“I got asked to go to Ames [because] at the time there was sort of a dispute between life sciences at Ames and life sciences at JSC,” Hawley explained in 2019. “[Though] I wasn’t directly involved in this, Headquarters felt that somebody from JSC going out to Ames might be able to figure out what’s going on and get those different groups working together, and that is why they asked me to do it. So the guys at Ames had some ideas, but they didn’t have a lot of real knowledge of the astronauts’ experience.” Expecting his experience as an astronaut/manager would help, it was actually a challenge to suggest that Ames might want to follow a particular route. “When I was first out there I started to listen to them, saying, ‘Ok, here’s the problem, here’s what you guys need to do’. And that didn’t go over very well. I learned that it’s a little more complicated, with different groups pulling in

the same direction, so that was very useful. Ames [is] a research center and, at the time at least, it was both an aeronautical research center and a science research center, I think it was a 60/40 split, if I remember when I was there. It was totally different from JSC, in the sense that [at] JSC, it really felt like, regardless of what we did, we all had one mission and it was flying people in space successfully. At Ames, there was no common mission at all, and that was a real eye opener for me. Everybody was doing their own thing and [had been for several years].

“I learned a lot about how different parts of NASA work, how maybe they tried to bring different group perspectives together, I sort of had mixed success of that at Ames, but I think it was helpful when I returned to JSC. So one of the things that I tell people – and I learned this when I was Deputy Chief of the Astronaut Office – was that the job that Dan [Brandenstein] and I had for most part didn’t really have authority over anybody in the program. We had some authority over the astronauts, but if you wanted to get your way, you had to use influence, you had to make good arguments. You had to try the influence of the point of view, because you couldn’t just say ‘We’re not going to do [such and such] unless we do [‘X’ number of] tests of this nature’. You didn’t have that authority. You could try to influence someone by [suggesting that something] more than they were planning to do would be a good idea, so that was an important lesson too, as a manager.” [24]

LEAKING ORBITERS

In early May, problems were encountered with *Columbia* out on the launch pad during preparations for STS-35, when an old fuel line in the Main Propulsion System (MPS) leaked and required replacement. Already delayed due to the slips in the STS-31 launch, another issue arose with the flow of Freon™ through one of the Orbiter’s two coolant loops. Managers faced several options: Fly as is and hope everything worked for the duration of the mission, with the option of an early landing if trouble occurred; repair the problem on the pad, which had never been done before and would require about a week’s work; or roll the stack back to the VAB for de-stacking and repair the Orbiter horizontally, meaning a further delay to the launch. The decision was made to attempt the repair on the pad as it was felt that not enough was known about the problem to fly with it, though the two or three weeks repair estimation was a guess. The launch was set for May 30.

By May 27, the issue was solved and May 30 was confirmed as the launch date for STS-35. However, a hydrogen leak was detected as fuel was being loaded into the Orbiter on the day before launch (May 29). Over the next few days, the problem remained elusive and threatened the chance to fly STS-35/Astro 1 before the end of the year. Workers continued to investigate the problem hoping that a roll-back to the VAB would not be necessary, but by June 6 this seemed likely. This

immediately had a knock-on effect on other missions planned for 1990, pushing STS-40/SLS (with Rhea Seddon) into 1991, and both STS-42/IML-1 (with Norman Thagard) and STS-45/ATLAS-1 (with Kathy Sullivan) back by four months each.

By June 12, *Columbia* was indeed back in the VAB to investigate the leak further. Two weeks later, on June 28, another blow to the manifest occurred when *Atlantis* suffered its own leak of liquid hydrogen during a test. As a result, the whole Shuttle fleet was grounded until the problem was understood and fixed, creating a ripple effect of delays extending into 1993. Investigations suggested that the Teflon™ seal used in the connections was the culprit, but when further examination revealed that the leaks had come from two different places on *Columbia* and *Atlantis*, further tests and delays became inevitable.

As a result, no Shuttles flew between April and October 1990, and months of detailed investigations continued throughout the summer, with test after test conducted. Having all the Orbiters at the Cape created a problem as there was a shortage of storage space to park them, resulting in a game of Shuttle chess as the vehicles were moved between the VAB, the pads and the OPF. Other problems continued to plague the fleet, pushing flights into 1991, with payload mishaps and the turbulent weather around the Cape delaying both STS-38 and STS-35 further into the year and allowing STS-41 on *Discovery* to fly before them. The sequence of launches in 1990 therefore looked like this: STS-36, STS-31, STS-41, STS-38, then STS-35. Although the confusing three-digit designations had been dropped after *Challenger*, it remained just as confusing to recall which mission flew in what order in this new system. [71]

Grounded

On July 9, 1990, two astronauts were temporarily removed from flight status due to violations of Flight Crew Operations Directorate (FCOD) guidelines. Hoot Gibson was removed from the command of STS-46 and from T-38 jet trainer flight status for one year due to a mid-air collision with a second racing aircraft on Saturday, July 7. The release stated that this was “in violation of a policy which restricts high risk recreational activities for astronauts named to flight crews.” The action was in response to Gibson’s participation in an airplane race at a civilian air show in central Texas.

Gibson’s stunt plane accidentally collided with another airplane during a race the previous Saturday, sending the second craft hurtling into a cornfield and killing its pilot, Henry W. Jones Jr., a retired fighter pilot from Virginia. Gibson was able to land his plane safely at the New Braunfels Municipal Airport, 25 miles northeast of San Antonio, Texas. Donald R. Puddy, Director of Flight Crew Operations, said “Our high risk activity policy defines plain and simple guidelines for astronauts assigned to flight crews. They are intended to preserve our crews as assigned and

apply regardless of the time prior to launch. There was a clear violation of the policy.” The high risk recreational activities defined by the policy included those which involve exposure to major or fatal injury. [74] A new CDR for STS-46, manifested to deploy the ESA Eureka free-flyers and evaluate the Italian TSS, would be announced “in the near future.” In the same release, it was reported that Fred Gregory would replace Dave Walker as CDR of the STS-44 DOD mission. Walker had also been suspended from T-38 flight status for 60 days for his own infraction of JSC aircraft operating guidelines in May 1989. Both would be eligible for Shuttle crew assignment once their T-38 flying status was reinstated.

Chief Astronaut and fellow TFNG Dan Brandenstein added at the time: “Dave [Walker] and Hoot [Gibson] have each made substantial contributions to the Shuttle and Space Station programs, and have performed in an outstanding manner on their respective Shuttle flights. The actions are unfortunate, but they are in the best interests of us all. These policies are vitally important and are to be taken seriously.”

Vandenberg makeover

On September 29, 1990, it was reported by *Florida Today* that the \$3.5 billion launch facilities at Vandenberg Air Force Station, California, intended to support Space Shuttle launches into polar orbit and mothballed after the loss of *Challenger*, were to be given a \$300–500 million makeover to convert the Space Launch Complex 6 (‘Slick 6’) into a launch pad for Titan 4 expendable rockets with the liquid-fueled Centaur upper stage. Four years after STS-62A (which originally included TFNG Mike Mullane) should have become the first mission to carry American astronauts from a launch pad outside of Florida, the facility and capabilities to accommodate this would no longer be available. [75]

Supporting but not flying

Sandwiched between STS-31 and STS 38 and flown from October 6–10, STS-41 was the 11th mission for Discovery and the 36th flight of the program. On the five-day flight, the crew deployed the Ulysses solar orbital probe. For the first time since STS-51F in July 1985, there was no representative of the TFNG on the flight crew, although several were assigned to bring their experience to the numerous support roles required for each mission. Loren Shriver worked the 12:00–06:00 shift and Shannon Lucid the 18:00–24:00 shift in SPAN, while Dick Covey was assigned to the first SMS shift. Chief Astronaut Dan Brandenstein was WX pilot at the Cape and Fred Gregory went to Ben Guerir in Morocco to support any TAL situation. [76]

It was around November 1990 that Jim Buchli returned to active mission training as MS for STS-48. He was replaced as Deputy Chief Astronaut, temporarily, by Dick Covey.

STS-38 (November 15 – 20, 1990)

Flight Crew: Richard O. COVEY (CDR), Frank L. Culbertson (PLT), Carl J. Meade (MS-1), Robert C. Springer (MS-2), Charles D. ‘Sam’ Gemar (MS-3)

Spacecraft: Atlantis (OV-104) 7th mission

Objective: 37th Shuttle mission; 7th classified DOD satellite deployment

Duration: 4 days 21 hours 54 minutes 31 seconds

Support Assignments: For the next mission, Fred GREGORY was back in Houston to work with Steve NAGEL on the 18:00–24:00 shift in SPAN, while John CREIGHTON covered the 24:00–08:00 shift. Mike COATS was in SMS during the second shift period, while Dan BRANDENSTEIN again fulfilled the role of WX pilot at KSC and Edwards. Loren SHRIVER was assigned as Mishap Representative at the Massachusetts Institute of Technology (MIT). [77]

During their five-day mission the crew conducted DOD operations, deploying an advanced data relay satellite. This was the seventh and final fully-classified Shuttle mission of the program.

STS-35 (December 2 – 10, 1990)

Flight Crew: Vance D. Brand (CDR), Guy S. Gardner (PLT), Jeffrey A. HOFFMAN (MS-1), J. Michael Lounge (MS-2), Robert A.R. Parker (MS-3), Samuel T. Durrance (PS-1, astronomer, John Hopkins University), Ronald A. Parise (PS-2, astronomer, Computer Sciences Corp.)

Spacecraft: Columbia (OV-102) 10th mission

Objective: 38th Shuttle mission; Astro-1 astronomical research program

Duration: 8 days 23 hours 5 minutes 8 seconds

Support Assignments: Hoot GIBSON and Loren SHRIVER worked the 24:00–06:00 shift in SPAN, while Kathy SULLIVAN covered the 06:00–12:00 shift. Mike COATS was again in SMS, this time on the first shift, with Steve NAGEL on the second. Dan BRANDENSTEIN once again fulfilled the role of WX pilot at KSC and Edwards. [78]

This Spacelab mission featured the pallet-only ASTRO-1 ultraviolet astronomy laboratory, a project on which Jeff Hoffman had worked since 1982. This mission would have flown in March 1986 to observe Comet Halley if the STS-51L mission had been successful, but it was not to be. The mission remained on the manifest over the next four years, and *Columbia* finally made it to orbit after its pad refueling problems at the end of the year. Almost immediately, the mission suffered a primary controller failure, requiring the crew to revert to manual procedures to allow the astronomical observation to continue. It became clear that if this had been an unmanned mission it would have failed. The presence

of the crew saved the mission and provided enough data to keep the scientists busy for years. Hoffman, one of four astronomers on board, conducted live classroom lessons from space with students in Alabama and Maryland during the flight.

On December 19, 1990, and with STS-35 safely on the ground before the approaching Christmas holidays, NASA announced its final crew assignments of the year for four missions: STS-48, carrying the Upper Atmosphere Research Satellite (UARS); STS-46, manifested for the deployment of Eureka and the TSS; STS-49, intended to capture, replace a failed engine and redeploy the stranded Intelsat satellite; and STS-50, flying the United States Microgravity Laboratory (USML-1). Of the 19 new NASA astronaut assignments announced, just four were from the 1978 selection, highlighting the significant changes in the make-up not only of the crewing of missions in a new decade, but also within the Astronaut Office itself. [79]

John Creighton was named to command the STS-48 UARS deployment mission and was joined on that crew by fellow TFNG Jim Buchli. Also named were PLT Ken Reightler (Class of 1987) and MS Mark Brown (Class of 1984) and Sam Gemar (Class of 1985).

Loren Shriver replaced the grounded Hoot Gibson as CDR of the STS-46 Eureka and TSS deployment mission, with PLT Jim Wetherbee (Class of 1984) and MS Andrew Allen (Class of 1987), joining the previously named Franklin Chang Díaz, TFNG Jeff Hoffman and ESA's Claude Nicollier.

Finally, the plum assignment as CDR of the maiden flight of the new Orbiter *Endeavour* (OV-105), scheduled to rescue and redeploy the stranded Intelsat, went to Chief Astronaut Dan Brandenstein, who assigned himself together with a hand-picked crew of PLT Kevin Chilton (Class of 1987) and MS Pierre Thuot (Class of 1985), Kathy Thornton (Class of 1984), Tom Akers and Bruce Melnick (both from the 1987 selection).

A NEW DECADE DAWNS

By the end of 1990, only half of the Group 8 astronaut selection (nine PLT and eight MS) remained active in the Astronaut Office. The other 18 had retired, were reassigned to managerial positions and out of crews, or were deceased.

The spring of 1991 would see a decade of Shuttle orbital operations completed, and hopefully the start of a more rigorous flight manifest, including plans to begin the construction of the long-awaited Space Station. Whether any of the TFNG would remain on the active flight list, visit a space station, or even remain in the program during the closing years of the 20th century, remained to be seen.

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