Columbia Return, Crew Compartment, Kennedy Space Center, 1985

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First Fleet

NASA's Space Shuttle Program 1981–1986

Photographs by John A. Chakeres

Daylight

This book is dedicated to my wife, Holly, my daughter, Liz,
and my grandson, Jackson.

Atlantis Arrival, Side View Shuttle Carrier Aircraft, Kennedy Space Center, 1985

First Flight Atlantis

John Chakeres and I met at a photography conference called FotoFest in 2008. Our mutual good friend, Melissa Noble, introduced us over lunch, not knowing that very separate paths would come together one day for a common destiny. I have always loved photography. My mother gave me a red leather-clad Petri rangefinder camera in fourth grade for my tenth birthday, and ever since I have been painting with light. I would never have imagined that forty-four years later it would provide a powerful connection to bind friends together, as we shared our very different perspectives of both photography and space.

After Neil and Buzz set foot on the moon on July 20, 1969, my childhood friends all wanted to be astronauts. For days they pestered me about their new dreams of riding rockets into space. It seemed that every youngster who had witnessed the amazing technological feat on a rabbit-eared black-and-white TV set wanted to be the next Neil Armstrong, but I had a different hero. I wanted to be tennis great Arthur Ashe. He was a champion, and to a skinny black kid in Lynchburg, Virginia, he was the giant step—leaping over barriers for all humankind. It was only years later, through a strange twist of fate, that my dreams turned to space and I began to set my own sights, my own lenses—on gaining an orbital perspective.

The Moon Landing and the preceding missions were punctuated with discovery, magnificence, and failure as the United States pushed beyond existing limits to send a human to the moon. More than an act of reckless courage, the space program was a resounding victory over our Cold War adversaries. The Sputnik beep, the first score in the space race, caused fear in many, but it did not crush our hope. We hardened our resolve, galvanized our sense of national pride, worked harder, and gave birth to the Space Coast and a program of never-ending discovery.

The modern workhorse of our space program, the Space Shuttle, flew 135 missions, persevering through setbacks and tragedy to inspire countless men and women to dream of new horizons. These powerful birds deployed satellites, served as a test bed for scientific and medical research, and made it possible to build our orbital outpost, the International Space Station. Without this space wonder we, as an earthbound civilization, would not have worked together, living off-planet as one family, in our orbital outpost. I had the privilege to live and work aboard the ISS for twenty-three days—twenty-three days I will never forget. I first flew to space on the Shuttle Atlantis in February 2008. The mission was STS-122, and after Atlantis flawlessly docked with the ISS, I used her Canadian robotic arm to install the Columbus Laboratory from the cargo bay, growing the station by one more research module. In November 2009, on STS-129, I returned to space on Atlantis for my final voyage to the cosmos, when we installed and pre-positioned spare parts so that the mission of exploration would continue, even though NASA had announced that the last planned Shuttle Journey would be STS-135 in July 2011. The Shuttle program was coming to an end; our birds would be flying no more.

I feel a sense of pride and gratitude at having been a Shuttle astronaut and was inspired every time I watched Discovery, Columbia, Atlantis, or Endeavour launch and rocket off-planet, leaving a magical trail of exhaust for all to follow to the heavens. That star-dusted trail carried our dreams and our realities. It was just as exciting to hear the double sonic boom announcing a return flight. There was joy in knowing that fellow astronauts and friends, my space family, were coming home after orbiting the planet at 17,500 miles per hour every 90 minutes.

First Fleet captures the glory of the early flights of the Space Shuttle program. Similar to the engineers who developed new procedures and systems to send humans to space in a reusable rocket turned glider, John developed ingenious systems and techniques to capture her magnificence on the pad, during launch, and returning back to Earth upon landing. This compilation of images inspires me to believe again in the power of people coming together to create things bigger than themselves to help advance our civilization. It inspires me to continue exploring, to leap over barriers and discover our next great mission.

Godspeed on your journey.

Astronaut and S.T.E.A.M. Explorer
Leland Melvin

Columbia, OV-102, 1982

Challenger, OV-099, 1984

Rocket Man

—W.M. Hunt

And I think it's gonna be a long long time

Till touch down brings me round again to find

I'm not the man they think I am at home

Oh no, no, no, I'm a rocket man

Rocket man burning out his fuse up here alone . . .

John A. Chakeres is a Rocket Man, and *First Fleet: NASA's Space Shuttle Program 1981–1986* is his "message in a bottle" love story.

Space travel has been the intoxicating stuff of science fiction since the late nineteenth century, when Jules Verne wrote his novels *From the Earth to the Moon* (1865) and *Around the Moon* (1870). H. G. Wells' *The First Men in the Moon* (1901) was probably the basis for Frenchman George Méliès' early film *Le Voyage dans la Lune* (1902), with a title that translates as *A Trip to the Moon.* This cleared the way for twentieth-century characters such as Flash Gordon, Buck Rogers, and, even later, Luke Skywalker.

Reality caught up with fiction on October 4, 1957, when the Russians launched Sputnik, the first Earth-orbiting satellite. This event was both chilling and exhilarating. Soon enough, dogs, monkeys, and then men went off into space. The first human to orbit the earth was Yuri Gagarin, on April 12, 1961. A month later, in May, Alan Shepard became the first U.S. astronaut to make a suborbital flight, and a year after that, on February 20, 1962, NASA astronaut John Glenn orbited the earth three times.

In 1966, *Star Trek*, with its introductory reference to the "final frontier," aired on television, but man had indeed already gone "where no man has gone before."

Initially, these real space programs and actual missions had mythological names such as Apollo and Mercury. These gave way to Challenger, Discovery, and Endeavour, named for the historic ships that pioneered world navigation. Look for Chakeres' portraits of Columbia OV-102, Challenger OV-99, Discovery OV-103, and Atlantis OV-104 with their handsome, god-like, monolithic "otherness."

The United States prevailed in the 1960s space race with six Apollo missions to the moon. Astronauts Virgil "Gus" Grissom, Edward White, and Roger Chaffee were killed in a launch-pad fire in 1967, but Neil Armstrong and Edwin "Buzz" Aldrin successfully landed on the moon on July 20, 1969.

Congress pulled the plug on the program and the first era of human space exploration closed when the Apollo missions ended in 1972. The space program resumed when the Columbia took off on April 12, 1981—the first flight of NASA's Space Shuttle program.

John A. Chakeres with model rocket, circa 1965

Some boys like to build model airplanes and rockets. In that way, fifty years ago, John Chakeres fell in love with travel into space. He became obsessed, looking at pictures in *Life* magazine, staying home from school to watch launches on TV, using his father's camera to photograph them from the screen. He built a darkroom and learned how to print. He studied photography in college and ultimately saw an opportunity to actually photograph the Space Shuttle himself. He got permission from NASA to be on site for takeoffs at the Kennedy Space Center in Cape Canaveral Florida.

Between 1981 and 1986 Chakeres devoted himself to photographing the Space Shuttle program, even inventing remote triggers for motor-driven cameras to avoid the rocket thrust.

These pictures were fashioned with the single-mindedness of a nine-year-old model maker. Chakeres' awe of these gigantic, streamlined craft with their sharp modernity is evident. His affection and admiration—obsession—are visceral. He looks closely enough to see the wear and tear on the shuttle's nose. He sees the solid mother-and-child form nestled in scaffolding. Ultimately the hulking parent lofts the shuttle child off into space.

Chakeres sights the rockets precisely on the pad across perfect lagoons. After liftoff, he exults. The camera chases the missiles into the sky, the scene enveloped in plumes of steam and exhaust.

Look at his portrait *Challenger, Sunrise, 1984*, p.37. This ship is heroic, its iconic silhouette kissed by a hazy, glorious ball of sun, a pink line of dawn along the horizon. Three decades after its creation, it is still a handsome tribute to the successes and failures of the shuttle program.

His *Discovery Mission 51A, Pad 39A Remote Site 1, 1984*, p.59, works as a striking counterpoint. The setup is similar, but what is still and quiet in the latter is here all force, with the combustion and exhilaration of liftoff, his "decisive moment" of exaltation.

In his words:

> The technical tour de force was designing a housing to protect the camera and building a remote mechanism to start the camera at the moment of launch. Preparation was building fail-safe camera systems to insure getting the picture. Creative vision was studying sun angles and knowing where the sun would be at the moment of launch, and placing the camera to get the most compelling image. And luck, having a storm front moving in at the moment of launch shrouding the scene in a dramatic grey background.

These are parts of a love story.

But tragedy struck again. Just before noon on January 28, 1986, astronauts were killed in flight for the first time. The NASA Space Shuttle Orbiter mission (the tenth flight of Space Shuttle Challenger) broke apart seventy-three seconds after takeoff. All seven crew members perished, and nearly one in five Americans witnessed it on television.

Top: John A Chakeres, *Columbus, Ohio, Painted Windows, 2008*

Bottom: John A Chakeres, *Medellin, Colombia, Museum Wall, 2014*

John Chakeres was at the Cape and saw it in person. He and the astronauts' families and President and Nancy Reagan watched as the spacecraft disintegrated off the coast over the Atlantic Ocean.

The explosion had a particularly devastating impact on Chakeres. He put away his work and didn't look at it for almost thirty years. Five years of material with thousands of negatives, and he set it all aside. It was not until the summer of 2013 that the photographer returned to it and began scanning the negatives and making prints. The good news is that in the Space Shuttle project he found himself again spiritually: his creativity, his passion, and his fascination with technology as a means of fulfilling his vision. He felt whole.

It is more than ironic—and revealing—that a young man captivated by space travel and the systems for conquering it, fascinated by the idea of entering into the infinity of it, would then begin to work so differently. In the past dozen years, John Chakeres has become best known as an artist for his color photographic studies of walls and doors, their shapes and surfaces. Two dimensions.

His obsession with rockets and the beyond seems to have been sublimated or supplanted by a need to close himself off with barriers or walls, to literally shut the door on the kind of seeing that had so consumed him.

Chakeres dealt with his trauma artfully, consciously or unconsciously. He finds meditative primal force in his *Grey, Structure, and Concrete* series, "where order is beauty, beauty is order, and everything necessary to comprehend a given image is contained within the image."

But going back to these "First Fleet" photographs from the 1980s has been an act of redemption for the photographer. This work was something rare and special, even exalted. It certainly rewards the fresh look offered in this book.

In the *Pre-flight* photographs you can see Chakeres' respect for the shuttle itself. His images of the shuttle don't show a slick, idealized spacecraft, but, more simply, a good-looking, massive and weathered machine—a noble machine.

After takeoff, in the series *The Launch*, the artist captures swirling and streaming clouds in a celebration of spiritual transcendence. Skies are darkened in the late afternoon, evening skies are deep black, and the only lighting is from the spacecraft.

The *Landing* images, the return to Earth, are delivered in the light of a hopeful early-morning sun. All is calm. Return to ground control.

The last Shuttle mission took place in 2011. *First Fleet* is the artist's "Rosebud," a unique time capsule and testament to this Rocket Man's love and healing as he returns to his experience of this special shining moment in the modern era.

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1 Elton John and Bernie Taupin, "Rocket Man," 1972. © Universal Music Publishing Group.

2 This line is taken from the opening voice-over for the 1960s television series *Star Trek*: "Space: the final frontier. These are the voyages of the starship Enterprise. Its five-year mission: to explore strange new worlds, to seek out new life and new civilizations, to boldly go where no man has gone before."

3 Correspondence with the author, February 21, 2018.

4 The artist, quoted from his website. http://johnchakeres.com. Accessed April 30, 2018.

Discovery, OV-103, 1984

Atlantis, OV-104, 1985

PREFLIGHT

Atlantis Arrival, Crew Compartment, Kennedy Space Center, 1985

Columbia Return, Shuttle Landing Facility, Kennedy Space Center, 1985

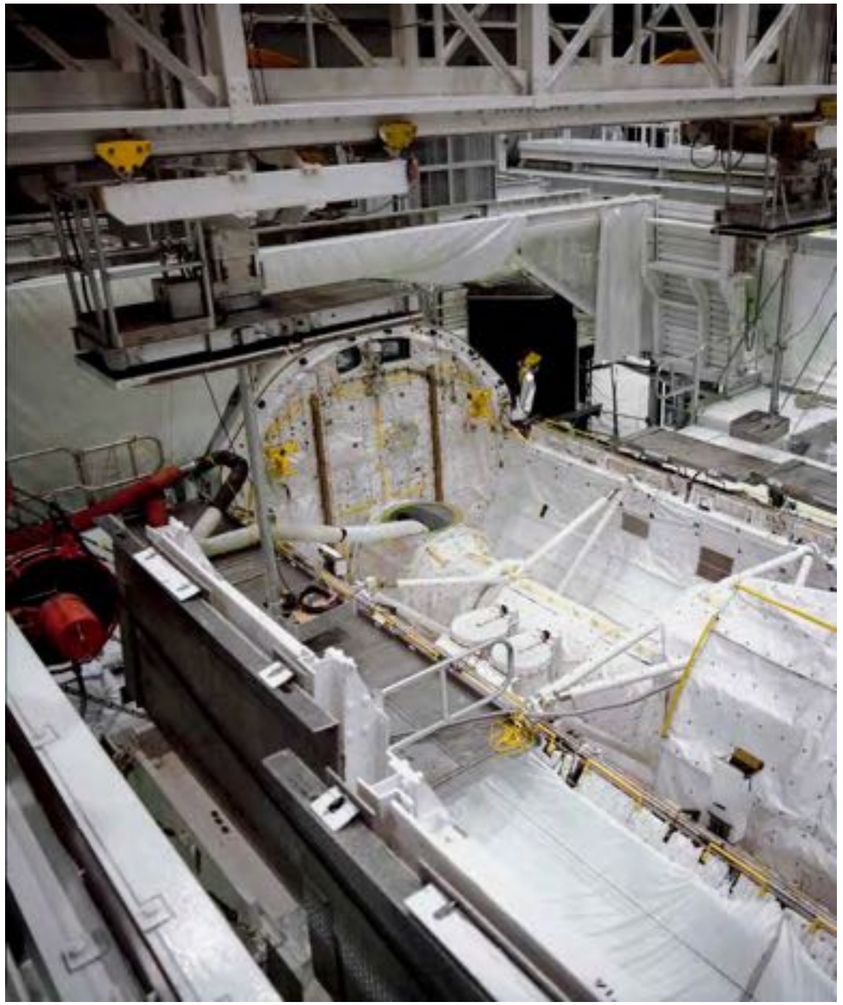
Columbia Return, Quarter View Shuttle Carrier Aircraft, Kennedy Space Center, 1985

Atlantis Arrival, Vertical Stabilizer, Kennedy Space Center, 1985

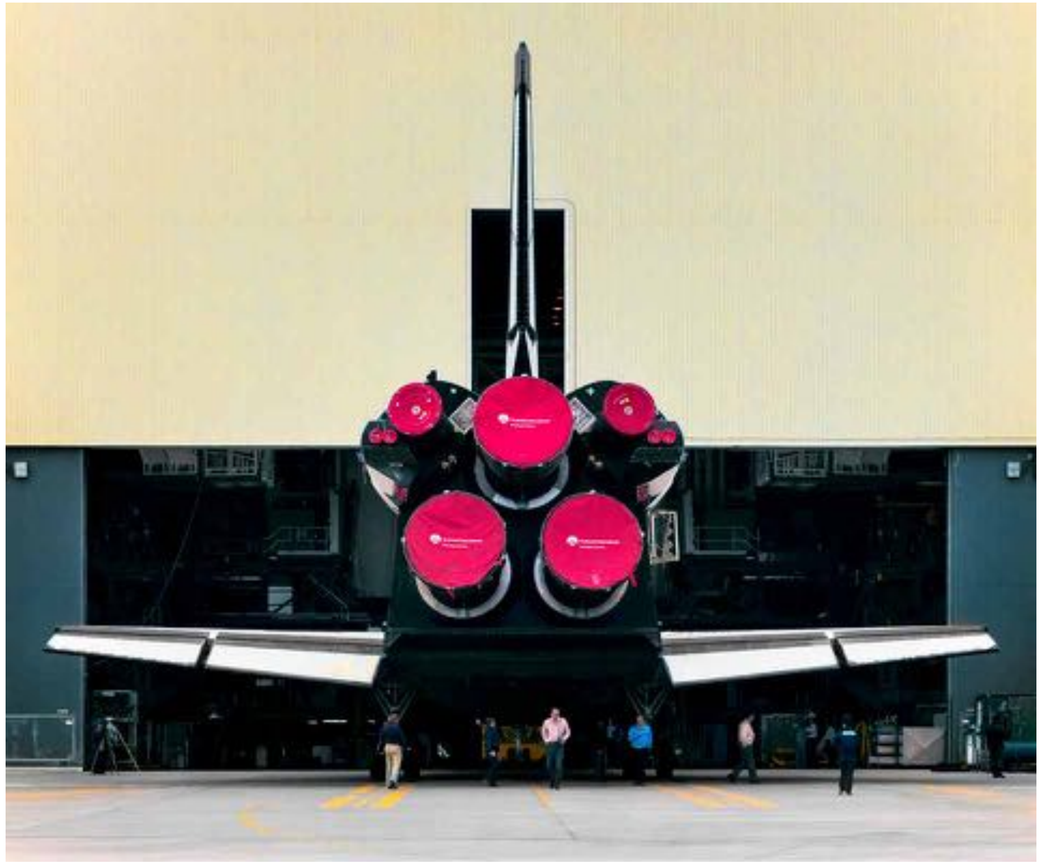
Shuttle Carrier Aircraft, Shuttle Mate-Demate Device, Kennedy Space Center, 1984

Challenger, Shuttle Mate-Demate Device, Kennedy Space Center, 1984

Discovery, Shuttle Preperation Vehicle Assembly Building, 1983



Challenger, SpaceLab Orbiter Processing Facility, 1985



Challenger, Roll Over Orbiter Processing Facility, 1985

Challenger, Roll Over Head On View, 1985

Challenger, Roll Out Vehicle Assembly Building, 1985

Challenger, Roll Out Crawlerway, 1985

Challenger, Sunrise, 1985

Discovery, Crawler Way Pad 39A Entrance, 1984

Crawler Transporter, Crawlerway Kennedy Space Center, 1985

Discovery, Pad 39A Cherry Picker, 1985

Discovery, Shuttle Preparations Launch Complex 39A, 1985

Atlantis, OV-104, 1985

Challenger, Closed Service Structure Launch Complex 39A, 1984

Launch Complex 39A, Water Tower, 1984

Discovery, Sunset Launch Complex 39A, 1984

Atlantis, Roll Back Launch Complex 39A, 1985

Columbia, Xenon Lights Pad 39A, 1983

Challenger, Xenon Lights Launch Complex 39A, 1984

Launch Complex 39A, Xenon Lights Press Site, 1985

LAUNCH

Discovery Mission 51A, Launch Complex 39A Remote Site 1, 1984

Discovery Mission 51A, Launch Complex 39A Remote Site 2, Frame 8, 1984

Discovery Mission 51A, Launch Complex 39A Remote Site 2, Frame 18, 1984

Discovery Mission 41G, Shoreline Cape Road, 1985

Challenger Mission 41B, Mosquito Lagoon, 1984

Challenger Mission 51B, Remote Site Complex 41, 1985

Discovery Mission 51A, Climb Out Press Site, 1984


















Discovery Mission 41D, Launch Sequence, 1984

Discovery Mission 51A, Climb Out, 1984

Challenger Mission 41B, Climb Out, 1984

Challenger Mission 41G, Launch Press Site, 1984

Challenger Mission 41G, Launch Complex 39A Remote Site 2, 1984

Discovery Mission 51G, Launch Sunrise Lagoon, 1985

LANDING

Discovery Mission 51C, Approach Runway 15, 1985

Challenger Mission 41G, Approach Runway 33, 1984

Challenger, Final Approach KSC Shuttle Landing Facility Runway 15, 1984

Discovery, KSC Shuttle Landing Facility Runway 15, 1984

Challenger, KSC Shuttle Landing Facility Runway 15, 1984

Challenger, Post Landing Inspection KSC Shuttle Landing Facility Runway 33, 1985

Challenger, Tow Back Kennedy Space Center, 1984

Discovery, Tow Back Quarter View Kennedy Space Center, 1984

Challenger, Tow Back Orbiter Processing Facility, 1984

DEBRIEF

Mission 51D, Remote Camera Setup Shuttle Landing Facility, Kennedy Space Center, 1985

A Front-Row Seat

—John A. Chakeres

The *First Fleet* book project began over thirty years ago with the launch of the first Space Shuttle Columbia in 1981. But my story began much earlier, on May 5, 1961, when I watched Alan Shepard become the first American to travel in space. I was eight years old, sitting in my third grade class watching the launch on TV. I was mesmerized by the thought of witnessing something that had never been done before. The excitement of that day never left me, and many years later I realized that day was the seed for this book.

As a young boy I was fascinated with the idea of humans going into space. I would spend hours looking at pictures of the astronauts in *Life* magazine and *National Geographic*. When there was a launch I convinced my mother to let me stay home from school and watch the coverage on TV. Space travel also inspired my interest in photography. I would set my father's Rolleiflex camera in front of the television set and photograph the launches. From that point forward, photography became my lifelong passion. After I graduated from high school in 1970, I went to college, and in 1975 I got my BFA degree in photography.

As I got older, I never lost my love for or fascination with space travel. By the time I graduated from college, NASA had completed Project Apollo, Skylab, and the Apollo-Soyuz programs. There were no manned spaceflights for six years, until the launch of the first Space Shuttle in 1981. I saw an opportunity for a photographic project about the Space Shuttle and I contacted NASA with my proposal. I eventually got permission to photograph the Shuttle operations at the Kennedy Space Center and in 1981 I began my five-year project photographing the Space Shuttle. The first couple of launches I tried, I didn't get any usable photographs. Having never photographed anything like this before, I had to basically reinvent myself as a photographer and artist to get the images I wanted. The learning curve was steep, and I soon realized this project was bigger and more complex than anything I had ever done. It became obvious to me that to do it properly would require many years of dedication.

CBS News Space Center, TV, 1965

Gemini 5 Astronauts, TV, 1965

Transfer Van Gemini 5, TV, 1965

First Test Flight Saturn 1B, TV, 1966

As an artist, I wanted to create images that were both majestic and symbolic, and that gave the viewer a sense of what was required to fly such a complex piece of technology. The idea was to do more of a portrait of the Space Shuttle. I have always been interested in technology and how it is used to create things. The fact that the Space Shuttle was the most complex machine ever created compelled me to photograph it. The Space Shuttle, in one sense, was a piece of sculpture to me. I was intrigued by how its design created a unique-looking vehicle, and its final form was determined by its function. As I developed my technique for photographing the Space Shuttle and crafting my vision, I discovered I needed to select the right cameras and invent tools to capture the photographs I envisioned.

My camera of choice for the project was Hasselblad. At the time I began the project, I only shot with large-format view cameras. Those types of cameras were not practical for shooting at the space center, so I chose Hasselblad EL/Ms because they were motor driven, had the best lenses, and provided the highest image quality. To protect my remote cameras from the harsh Florida environment, I designed custom housings for them. The housings were made of aluminum and painted white to reflect heat. I installed what I called a trop-

ical roof on them, to help keep the inside of the housings cool, an idea I got from a Land Rover. They were sealed with O-rings to keep the weather out. To keep things dry on the inside I used silica gel dehumidifiers. The housing worked very well to protect both the cameras and the color film I was shooting.

I also designed special equipment to capture many of the photographs I did of the Space Shuttle. The first piece of equipment I designed was a remote camera trigger. NASA would allow the press to set cameras within a thousand feet of the Space Shuttle. Cameras this close to the Shuttle needed to be started using a remote trigger. I came up with the idea of building a trigger that could activate a motor-driven camera using the sound of the rocket engines or the light the engines produced. If the cameras were set up close to the Shuttle, sound would be used as the trigger; if they were set up farther away, light would be used. My friend Jeff Weaver and I designed and tested several versions of the trigger, and when we came up with a final circuit design, I used the original Apple Macintosh computer to lay out the circuit design using the MacPaint program. Once the design was complete, I printed it onto overhead transparency film. I then took the film into my darkroom and produced printed circuit boards. Once the boards were etched, I used Dremel tools to cut and drill them out to accommodate all the components. I hand soldered all the components to the boards, sealed them with urethane, and placed the finish boards in a small box complete with camera ports, ports for the sound and light sensors, and status lights. I called the trigger Omni Trigger, because it could be adapted to work with any camera. It was small and very reliable. As it turned out, the one I designed was the best remote camera trigger at the space center, and soon many of the major news organizations wanted one. I never set out to be in the camera trigger business. I had a creative problem in search of a solution, and the only solution was to design and build the tools I needed. When the news organizations wanted to buy my triggers, I had to make a decision: be in the trigger business or continue to work on my Shuttle project. I chose to continue working on my project, but I did see an opportunity. As an artist, NASA gave me limited access to many of the facilities at the space center, access the major news organization had. So I worked out a deal with many of them, on a per-launch basis, to lease them my triggers and provide technical support for their remote photography. In return I asked for their access and to be allowed to set up my own cameras and keep my film. This arrangement worked out well, and I ended up working for a number of news organizations and magazines, including *National Geographic*, Associated Press, United Press International, *Newsweek*, and the *New York Times*.

NASA had always planned to land the Space Shuttle at the Kennedy Space Center. Up until the tenth mission, the Shuttle would land at Edwards Air Force Base in California and be ferried back to Kennedy on the back of the 747 Shuttle Carrier Aircraft. Mission 41B was the first to land at the space center, and the landing presented new photographic challenges. NASA allowed us to set remote cameras along the Shuttle runway, but the triggers we used for launch would not work. Since the Shuttle was a glider when it returned to Earth, there was no sound or light to activate the triggers. The only solution was to hard-wire the cameras and trip them using a manually operated switch. I partnered with one of the newspapers covering the Shuttle missions and designed the hardware needed to trip the cameras. The solution I came up with was a major undertaking. The shuttle runway at the Kennedy Space Center was three and a half miles long, and the shuttle could land from either direction. This required running four miles of wire and building signal-amplified triggers to trip the cameras when the shuttle landed. We had four triggers on the line and had to set cameras aimed in both directions, because NASA wouldn't decide until the morning of the landing which direction the shuttle would land. The four miles of wire terminated in a simple box with a power supply and a push button that was pressed to trip the cameras.

As I look back, I see the development of this hardware, the triggers, and the camera housing was essential to the success of this project. Having never done a project of this scope and scale before, I was constantly presented with problems to solve. One thought that always stayed with me while working at the Space Center was a quote from Dr. Land I learned in art school; If you are able to state a problem, it can be solved. I realize now that building this hardware was an extension of my creative process. For me to get the pictures I envisioned, I needed to use the available technology and create the hardware to capture the images. And I think the seed for this way of thinking was planted when I was a young boy watching astronauts go into space. NASA's mandate in 1961 was to land people on the moon and safely return them to Earth, something that had never been done before. In the 1960s the technology and hardware did not exist to send men into space; it needed to be created and built to achieve this. I think this made an impression on me as a kid, and I believe this same thinking is at the core of my creative process.

John A. Chakeres, left, Lief Ericksenn, right. Mission 51C, Press Site Kennedy Space Center, 1985

My Shuttle project was never finished. It ended with the Challenger accident in 1986. It was hard to continue the work after witnessing this accident, and I decided to set the project aside. For more than twenty-five years these negatives were kept in storage and never printed. Shuttle flights resumed in 1988, and the last Shuttle mission was launched in 2011. With the program now part of history, I was encouraged by friends and colleagues to revisit the project. In the summer of 2013 I decided to bring the negatives out of storage and begin scanning them and making prints.

John A. Chakeres, STS 7, Press Site Kennedy Space Center, 1983

As I scanned the negatives and rediscovered these photographs, I began to think about what had compelled me to make them. I think what captured my imagination the most about the early days of manned spaceflight was the fact that every mission did something that had never been done before. Every spaceflight seemed to be the first at something: the first American in space, the first American to orbit the earth, the first American to walk in space, the first person on the moon. And with the Space Shuttle, the firsts continued. The Space Shuttle was the first reusable manned spacecraft, the first to launch and retrieve satellites while in space, the first to launch an American woman into space. And between 1981 and 1986 NASA had four operational Space Shuttles: Columbia, Challenger, Discovery, and Atlantis. Those four vehicles comprised the first fleet of manned spacecraft, hence the title for the book.

I see these photographs as a time capsule of a unique moment in the history of the U.S. space program. Between 1981 and 1986, the Shuttle went from an R&D to a fully operational commercial space program. Those early years were filled with excitement and optimism about the future of space travel. With every launch I witnessed, it felt as if I had a front-row seat to the future. It was this excitement I hoped to capture in these photographs. The same excitement I felt when I was a little kid watching Alan Shepard and John Glenn go into space. *First Fleet* is my way of paying homage to all the men and women who built and flew the Space Shuttle—and how they inspired me to live a creative life.

PREVIEW OF A REMOTE TRIGGERING DEVICE

OMNI TRIGGERS

The design and production of an electronic trigger.

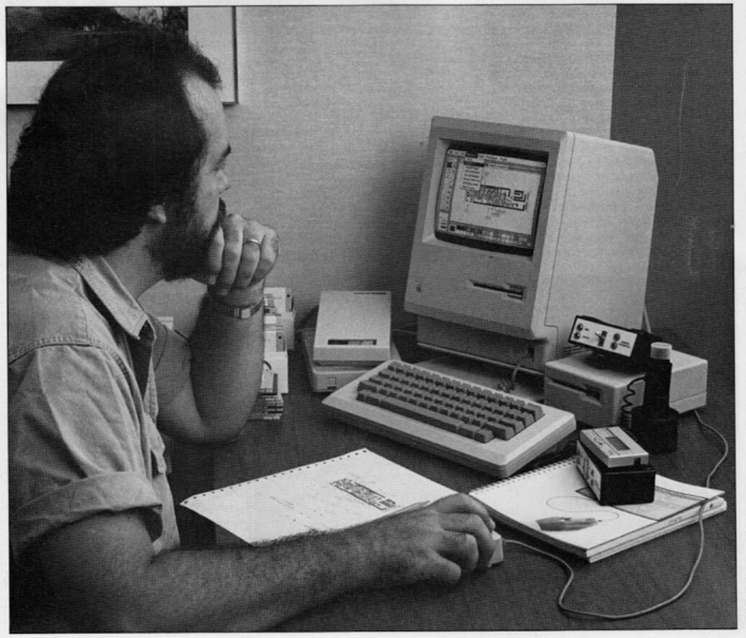
LIEF ERICKSENN

Photographer John A. Chakeres working at his Fat Mac to design a circuit for the triggers. The Macintosh computer along with the MacPaint software turned out to be invaluable for the project. Many of the circuit designs were written on Jeff Weaver's 128 (Thin Mac) Macintosh computer and then sent via a modem to Chakeres for photoprinting and etching.

I believe it was Samuel Johnson who said, "Nothing so much sharpens a man's wits as the threat of a hanging." True or false, when you consider that each time a photographer sets forth on a self-assignment for a long-term project, he or she is gambling money and resources. So with this in mind photographers must needs anticipate and try to eliminate sources of possible failure.

Someone once asked me to differentiate between an amateur and a professional photographer. The best I could come up with was: "An amateur photographer will often say, 'I hope it comes out'; a professional photographer will say, 'It had damn well better.' "

John A. Chakeres is an Ohio-based photographer who caught the space bug early in



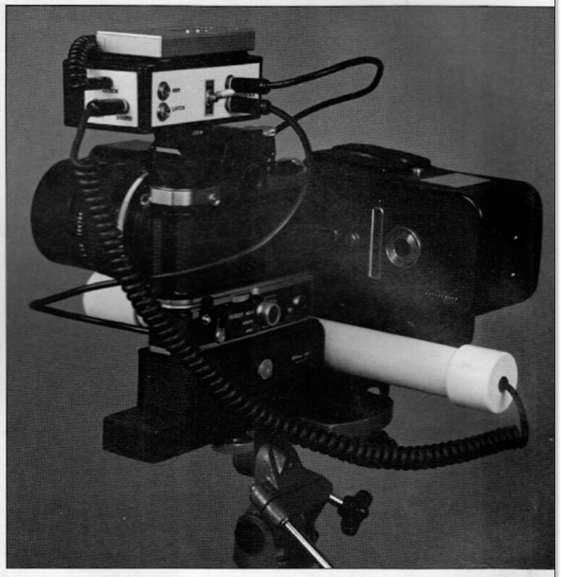
life. Latterly, as all things tend to do, it matured into an abiding interest in extracting the maximum photographic potential from those 18-odd seconds after the countdown clock hits zero and the flame and thunder from the rocket exhausts shake the somewhat primordial environs of the Kennedy Space Center at Cape Canaveral.

A lot of excellent photography is done with super-tele lenses from the press center site some four miles from Pad A. On the other hand, the old photo adage that "the closer you are the better the picture" is born out by the ingenious ways that photographers at the Cape continually come up with devices that will arm and start the cameras set out at the remote sites often no farther away than half a mile from the awful power of those engines. Certainly no one would care to be that close; even the alligators in the swamp are known to take cover. What is called for is a remote triggering device.

Basically, remote camera triggers fall into three categories: sound, light and vibration (such as seismic) operated. Although there are now quite a number of proprietary remote-triggering systems available, a whole cottage industry has developed around the design, proving and refining of remote triggers, many photographers preferring to design and produce their own. It is out of this trial-and-error gestation period that Omni Triggers was born. Chakeres insists, quite rightly, that a lot of the credit for the realization of his concepts go to Jeff Weaver, a fellow Ohian, who designed the electronics and who is reputed to lock himself in his basement for days on end when working on one of John's ideas.

The early versions of the Chakeres triggers were "one-off" hand-built systems. Of late, the circuit boards are computer-designed and then photo-reproduced and etched. In fact, the circuits were designed with the help of a stock version of the Macpaint program of Jeff Weaver's 128K Macintosh computer. They were then transmitted via modem communications to John Chakere's Fat Mac (512K), oftentimes to be found at his Cocoa, FL, base. The local electonics-components stores do a land-office business at the time of launches at Kennedy Space Center.

Most of the components are stock components. The circuit boards are, as stated, custom-designed and etched in John's darkroom. The sequence for producing a circuit board is as follows: The design is produced and completed using Macpaint. It is then printed out on an Apple Imagewriter printer. A Kodalith line negative is made, inspected, spotted and retouched as needed, and then printed onto a photosensitive copper board. This is processed and etched. The final board is tin-plated and drilled. The components, IC's, resistors, capacitors, relays and assorted switches and plugs are soldered onto it. The circuits are then tested, and if satisfactory, the back of the board is sealed to exclude the elements. The whole system is then mounted in a small casing that carries the jack plug sockets, indicator lights and appropriate switches.

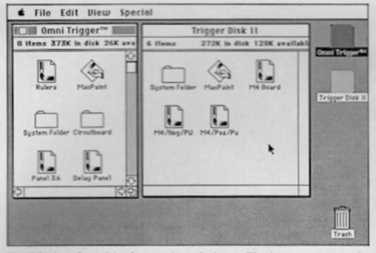


The Omni trigger shoe-mounted atop a Nikon F2 35mm SLR. The companion camera is a Hasselblad ELM 6X6 SLR with a 70mm back. Both cameras are controlled by the one trigger, which is multi-ported and is capable of being "cascaded" for more-than-one camera triggering. The white tube is the microphone housing. Note that the microphones found to be best suited to this application are, in fact, inexpensive crystal types. The arming clock is mounted to the top of the trigger housing by self-adhesive Velcro strips. The equipment is protected from the weather either by use of special housings or, more simply, with the aid of plastic garbage bags, with the front lens element protruding and protected by a haze filter or similar device. If you must use plastic bags, use the white variety for better heat-load shedding. (All photos by John A. Chakeres.)

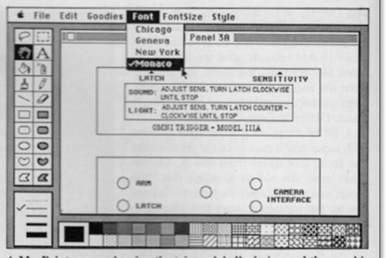
The requirements for a good trigger are as follows: It must work reliably (a lot of the others don't); it must be selective in what it looks at or listens to; it must be rugged and small and treat the climate, hot or cold, with a high degree of nonchalance. It must also be readily adaptable to firing almost any type of motor-driven still camera a photographer elects to use. It must be capable of arming and tripping not-so-conventional cameras, such as panoramic slit cameras, as well as movie and video systems. It must be parsimonious of battery power and stand-to for days without attention.

In order that the system is not "at standby" and consuming power from its internal 9V battery until required, a clock is used to arm the system a few moments before the event to be photographed takes place. For example, if a launch (say) is scheduled for 8 A.M., the clock may be set to arm the system at 7:58 A.M. Similarly, the clock may be set to disarm the system after an appropriate time after the launch or event. The clock presently favored is the Olympus TM-2, a compact, easy-to-program device with seven-day capability. It has proven totally reliable.

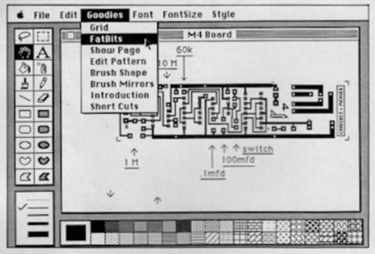
The triggers are capable of tripping an appropriate piece of equipment (in this case motor-driven still cameras) by reading a light source via a photo-transistor, hearing a sound or sequence of sounds via a microphone or sensing seismic vibrations picked up through a conventional geophone. To accomplish this, the following groups of components must interface: timer, sensing device, trigger and the appropriate patch



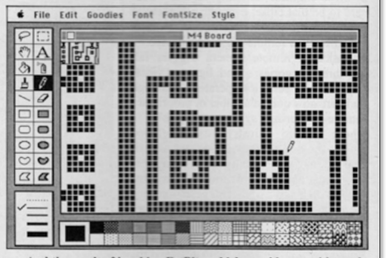
The Macintosh and its famous icon desktop. The icons represent the files created and application programs stored on the disk.



A MacPaint screen showing the trigger label's design and the graphic tools available.



The problem with circuit designs on computer screens is often their small size, which makes them difficult to correct. Here you see FatBits selected from one of the pull-down menus.



. . .And the result of invoking FatBits, which provide you with much-enlarged views of selected areas of the screen image for fine editing and correction.

cords to send the commands to the camera. Essentially, the command to the camera is nothing more than a simple "go" signal such as you might send through an electrical cable release. Please note that these systems are designed around camera components that are electrically operated. Mechanical systems can be interfaced by designing a special module, such as an electrical solenoid that pushes a latch or release button. For example, the weather doors on the remote camera housings are unlatched by a solenoid but the power to release the door is a simple spring.

However, there are special sequences for the operation of a trigger dictated by the subject itself. It may not be desirable to have the camera start up at the moment the microphone or the photo transistor (etc.) sends a signal to the system. For example, in a sound-triggering mode at K.S.C., the trigger is set up so as to switch off almost immediately if it only hears a transitory signal, thunderclaps, helicopters flying by, van doors slamming—or even a S.W.A.T. team stomping through the brush! A sustained signal (the roar of the actual shuttle engines themselves) will keep the trigger circuits closed and thus the equipment running.

Triggering by light is a better proposition for greater range or for ambient noise. Besides, sound travels at approximately 600 mph at sea level and if the subject is fairly distant, say a mile away, it can often be out of frame by the time the trigger hears it and starts the camera, especially if the lens in use is set for tight subject framing and composition. Light, traveling at a speed of approximately 186,000 miles/sec is, to all intents and purposes, instantaneous and the trigger must latch and go immediately.

The requirements for a good trigger are that it must work reliably; it must be selective in what it looks at or listens to; it must be rugged and small and treat the climate, hot or cold, with a high degree of nonchalance.

Omni Triggers, although currently designed around certain specific applications, are nevertheless readily adaptable to almost any remote operation requirements with very little modification. Current design updates will include an electronic flash port for tripping high-speed strobe systems and a remote tone recognition system that would enable the trigger to listen for and obey coded "touch-tone" signals sent to it either by wire or radio. Omni Triggers are still hand-assembled and tested and are available on an "as-ordered" basis. Chakeres states that "the whole concept was to build a simple, easy-to-use trigger that would accept custom interfaces." Omni Triggers does not currently think in terms of mass marketing, but in terms of specific, tailored-to-need items for precise photographic requirements.

A few seconds into lift-off, this picture of mission 51A was made using a Hasselblad ELM with a 250mm Sonnar and a 70mm long roll back. The Omni Trigger was sound-activated. Exposure was predetermined, largely by experience.

Flight Manifest

Order	Launch date	Mission	Shuttle	Mission Patch	Crew	Duration	Landing site	Notes
1	12 April 1981 12:00:04 UTC 07:00:04 EST	STS-1	Columbia		Young Crippen	02d 06h	Edwards	*First reusable orbital spacecraft flight* *First flight of Columbia*
2	12 November 1981 15:10:00 UTC 10:10:00 EST	STS-2	Columbia		Engle Truly	02d 06h	Edwards	*First reuse of a manned orbital space vehicle* *First test of Canadarm robot arm* *Truncated due to fuel cell problem*
3	22 March 1982 16:00:00 UTC 11:00:00 EST	STS-3	Columbia		Lousma Fullerton	08d 00h	White Sands	*Shuttle R&D flight* *First and only landing at White Sands, New Mexico*
4	27 June 1982 15:00:00 UTC 11:00:00 EDT	STS-4	Columbia		Mattingly Hartfields	07d 01h	Edwards	*Last shuttle R&D flight* *First Department of Defense (DoD) payload*
5	11 November 1982 12:19:00 UTC 07:19:00 EST	STS-5	Columbia		Brand Overmyer Allen Lenoir	05d 02h	Edwards	*Multiple comsat deployments* *First extravehicular activity of program canceled due to suit problems*
6	4 April 1983 18:30:00 UTC 13:30:00 EST	STS-6	Challenger		Weitz Bobko Peterson Musgrave	05d 00h	Edwards	*Tracking and data relay satellite (TDRS-A) deployment* *First flight of Challenger* *First Space Shuttle extravehicular activity*
7	18 June 1983 11:33:00 UTC 07:33:00 EDT	STS-7	Challenger		Crippen Hauck Fabian Ride Thagard	06d 02h	Edwards	*First US woman in space, Sally Ride* *Multiple comsat deployments* *First deployment and retrieval of a Shuttle Pallet Satellite*
8	30 August 1983 06:32:00 UTC 02:32:00 EDT	STS-8	Challenger		Truly Brandenstein Gardner Bluford Thornton	06d 01h	Edwards	*Comsat deployment* *First flight of an African American in space, Guion Bluford* *Test of robot arm on heavy payloads with Payload Flight Test Article* *First night landing*
9	28 November 1983 16:00:00 UTC 11:00:00 EST	STS-9	Columbia		Young Shaw Garriott Parker Merbold Lichtenberg	10d 07h	Edwards	*First Spacelab mission* *Flight of Ulf Merbold (first European Space Agency astronaut on a shuttle mission)*
10	3 February 1984 13:00:00 UTC 08:00:00 EST	STS-41B	Challenger		Brand Gibson McCandless McNair Stewart	07d 23h	Kennedy	*Deployed two comsats* *First untethered spacewalk by Bruce McCandless II with Manned Maneuvering Unit* *First landing at Kennedy Space Center* *Dry run of equipment for Solar Max rescue*

Order	Launch date	Mission	Shuttle	Mission Patch	Crew	Duration	Landing site	Notes
11	6 April 1984 13:58:00 UTC 08:58:00 EST	STS-41C	Challenger		Crippen Scobee Nelson van Hoften Hart	06d 23h	Edwards	*Solar Max servicing (first satellite rescue by astronauts)* *Long Duration Exposure Facility deployment*
12	30 August 1984 12:41:50 UTC 08:41:50 EDT	STS-41D	Discovery		Hartsfield Coats Mullane Hawley Resnik C. Walker	06d 00h	Edwards	*Multiple comsat deployments* *First flight of Discovery* *Test of OAST-1 Solar Array*
13	5 October 1984 11:03:00 UTC 07:03:00 EDT	STS-41G	Challenger		Crippen McBride Sullivan Ride Leestma Garneau Scully-Power	08d 05h	Kennedy	*Earth Radiation Budget Satellite deployment* *First flight of two women in space, Sally Ride and Kathryn Sullivan* *First spacewalk by US woman, Sullivan* *First Canadian in space, Marc Garneau*
14	8 November 1984 12:15:00 UTC 07:15:00 EST	STS-51A	Discovery		Hauck D. Walker Fisher Gardner Allen	07d 23h	Kennedy	*Multiple comsat deployments* *Retrieval of two other comsats (Palapa B2 and Westar VI), which were subsequently refurbished on Earth and reflown*
15	24 January 1985 19:50:00 UTC 14:50:00 EST	STS-51C	Discovery		Mattingly Shriver Onizuka Buchli Payton MSE	03d 01h	Kennedy	*First classified Department of Defense (DoD) mission* *Magnum satellite deployment*
16	12 April 1985 13:59:05 UTC 08:59:05 EST	STS-51D	Discovery		Bobko D. E. Williams Seddon Griggs Hoffman C.Walker Garn	06d 23h	Kennedy	*Multiple comsat deployments* *First flight of a sitting politician in space, Jake Garn* *First impromptu extravehicular activity of program to fix Syncom F3 (Leasat 3)*
17	29 April 1985 16:02:18 UTC 12:02:18 EDT	STS-51B	Challenger		Overmyer Gregory Lind Thagard W. Thornton van den Berg Wang	07d 00h	Edwards	*First mission with Spacelab module in a fully operational configuration* *Conducted experiments in microgravity*
18	17 June 1985 11:33:00 UTC 07:33:00 EDT	STS-51G	Discovery		Brandenstein Creighton Lucid Fabian Nagel Baudry Al Saud	07d 01h	Edwards	*Multiple Comsat deployments* *Flight of first member of royalty, Saudi, Muslim, and Arab in space, Sultan bin Salman Al Saud*

Order	Launch date	Mission	Shuttle	Mission Patch	Crew	Duration	Landing site	Notes
19	29 July 1985 22:00:00 UTC 18:00:00 EDT	STS-51F	Challenger		Fullerton Bridges Musgrave England Henize Acton Bartoe	07d 22h	Edwards	*Spacelab mission* *Abort to Orbit. Faulty temperature sensor incorrectly indicated that fuel turbine discharge temperature exceeded the limit. Therefore, one main engine was shut down at T+345 s, resulting in a much lower orbit than planned.* *All mission objectives achieved*
20	27 August 1985 10:58:01 UTC 06:58:01 EDT	STS-51I	Discovery		Engle Covey van Hoften Lounge W. Fisher	07d 02h	Edwards	*Multiple comsat deployments* *Rescue of Syncom F3 (Leasat-3)*
21	3 October 1985 15:15:30 UTC 11:15:30 EDT	STS-51J	Atlantis		Bobko Grabe Hilmers Stewart Pailes MSE	04d 01h	Edwards	*Second classified DoD mission* *Defense Satellite Communications System satellite deployment* *First flight of Atlantis*
22	30 October 1985 17:00:00 UTC 12:00:00 EST	STS-61A	Challenger		Hartsfield Nagel Dunbar Buchli Bluford Furrer Messerschmid Ockels	07d 00h	Edwards	*Largest crew on a spaceflight* *Third flight of Spacelab* *Spacelab-D1 microgravity experiments* *Mission funded by West Germany* *Last successful mission of Challenger* *First Dutchman in space, Wubbo Ockels*
23	26 November 1985 24:29:00 UTC 19:29:00 EST	STS-61B	Atlantis		Shaw O'Connor Ross Cleave Spring Neri C. Walker	06d 21h	Edwards	*Multiple comsat deployment* *EASE/ACCESS experiment* *First Mexican in space, Rodolfo Neri Vela*
24	12 January 1986 11:55:00 UTC 06:55:00 EST	STS-61C	Columbia		Gibson Bolden Chang-Diaz Hawley G. Nelson Cenker B. Nelson	06d 02h	Edwards	*Comsat deployment* *Flight of US Representative Bill Nelson*
25	28 January 1986 16:38:00 UTC 11:38:00 EST	STS-51L	Challenger		Scobee M. Smith Onizuka Resnik McNair McAuliffe Jarvis	00d 00h 01m 13s	Did not land	*Planned tracking and data relay satellite (TDRS-B) deployment* *SRB explosion killed crew and destroyed the orbiter* *Teacher in space flight*

Space Shuttle Chronology 1972-1986

1972

Aug. 9 Rockwell receives authority to proceed, Space Shuttle orbiter

1974

June 4 Start structural assembly crew module, Enterprise (OV-101)
July 17 Start long-lead fabrication (MPTA-098)
Aug. 26 Start structural assembly aft fuselage, Enterprise (OV-101)

1975

Jan. 6 Start long-lead fabrication aft fuselage (STA-099)
March 27 Mid fuselage on dock, Palmdale, Enterprise (OV-101)
March 27 Start long-lead fabrication aft fuselage, Columbia (OV-102)
May 23 Wings on dock, Palmdale-less elevons, seals and main gear doors-Enterprise (OV-101)
May 27 Vertical stabilizer on dock, Palmdale (main fin box only), Enterprise (OV-101)
June 24 Start structural assembly (MPTA-098)
Aug. 25 Start final assembly and closeout system installation, Enterprise (OV-101)
Sept. 5 Aft fuselage on dock, Palmdale, Enterprise (OV-101)
Oct. 17 Space shuttle main engine first main stage test at NSTL
Oct. 31 Lower forward fuselage on dock, Palmdale, Enterprise (OV-101)
Nov. 17 Start long-lead fabrication of crew module, Columbia (OV-102)
Dec. 1 Upper forward fuselage on dock, Palmdale, Enterprise (OV-101)
Dec. 20 First SSME 60-second duration test, NSTL
Dec. 31 1/4-scale model ground vibration test facility construction complete, Downey, Building 288

1976

Jan. 16 Crew module on dock, Palmdale, Enterprise (OV-101)
Jan. 23 MPTA-098 truss on dock, Downey
Feb. 16 Start fabrication forward fuselage (STA-099)
March 3 Payload bay doors on dock, Palmdale, Enterprise (OV-101)
March 12 Complete final assembly and closeout system installation, Palmdale, Enterprise (OV-101)
March 15 Start functional checkout, Enterprise (OV-101)
March 17 Complete premate MPTA test structure, Downey, and deliver to Palmdale
April 2 Crew escape system test sled on dock, Downey
April 3 Complete assembly and deliver MPTA structure on dock, Lockheed test site, Palmdale
April 22 Body flap on dock, Palmdale, Enterprise (OV-101)
May 3 Complete MPTA-098 proof load test setup, Lockheed test site, Palmdale
June 14 Start aft fuselage assembly (STA-099)
June 24 Complete MPTA-098 proof load test, Lockheed test site and on dock, Palmdale
June 25 Complete functional checkout, Enterprise (OV-101)
June 28 Start assembly of crew module, Columbia (OV-102)
June 28 Start horizontal ground vibration tests and proof load tests, Enterprise (OV-101)
June 29 MPTA-098 truss assembly, Palmdale, Building 294 to Building 295
June 30 SSME dummy set on dock, Palmdale, Enterprise (OV-101)
July 8 MPTA-098 on dock, Downey, without truss assembly
July 12 Start installation secondary structure (MPTA-098)
Aug. 2 Start final assembly forward fuselage (STA-099)
Aug. 2 Start carrier aircraft modification
Aug. 20 Complete horizontal ground vibration tests and proof load tests, Enterprise (OV-101)
Aug. 23 Start Delta F modification, Enterprise (OV-101)
Aug. 27 Reaction control system/orbital maneuvering system pods (simulated), approach and landing tests, on dock, Palmdale, Enterprise (OV-101)
Aug. Start overland roadway construction from Palmdale to Edwards Air Force Base
Sept. 10 Complete Delta F modifications, Enterprise (OV-101)
Sept. 13 Start preparations for first rollout, Enterprise (OV-101)
Sept. 13 Start assembly aft fuselage, Columbia (OV-102)
Sept. 17 Rollout Enterprise (OV-101)
Sept. 17 Complete on-stand construction, NSTL
Sept. 20 Start Delta F retest, Enterprise (OV-101)
Oct. 1 Start final assembly, vertical stabilizer (STA-099)
Oct. 1 Start final assembly, wing (STA-099)
Oct. 15 Midfuselage on dock, Palmdale (STA-099)
Oct. 26 Escape system test assembly sled ship from Downey to Holloman, N.M.
Oct. 29 Deliver ejection seats, Enterprise (OV-101)
Oct. 29 Complete Delta F retest, Enterprise (OV-101)
Oct. 31 Solid rocket booster 1/4-scale model (burnout configuration) on dock, Downey
Nov. 4 Complete 747 shuttle carrier aircraft modification, rollout, Boeing
Nov. 18 Start escape system sled test, Holloman, N.M.
Nov. 26 Complete integrated checkout, Enterprise (OV-101)
Nov. 28 Complete orbiter transporter strongback
Dec. 7 Tail cone fairing on dock, Palmdale
Dec. 10 Complete overland roadway construction, Palmdale to Edwards Air Force Base
Dec. 13 Start assembly upper forward fuselage, Columbia (OV-102)
Dec. 17 External tank 1/4-scale model on dock, Downey

1977

Jan. 3 Start assembly vertical stabilizer, Columbia (OV-102)
Jan. 14 Complete postcheckout, Enterprise (OV-101)
Jan. 14 Boeing 747 shuttle carrier aircraft delivered to DFRF
Jan. 25 Complete aft fuselage assembly on dock, Palmdale (STA-099)
Jan. 28 Simulated crew module on dock, Palmdale (STA-099)

Jan. 31 SRB 1/4-scale model (lift-off configuration) on dock, Downey

Jan. 31 Enterprise (OV-101) transported overland from Palmdale to DFRF (36 miles)

Jan. 31 Mass simulated SSMEs on dock, Palmdale, Enterprise (OV-101)

Feb. 7 Enterprise (OV-101)/shuttle carrier aircraft mate start

Feb. 10 Mid fuselage on dock, Palmdale, Columbia (OV-102)

Feb. 15 Complete Enterprise (OV-101)/shuttle carrier aircraft mated ground vibration test and taxi tests

Feb. 18 Conduct first inert captive flight, DFRF (2 hours, 5 minutes), Enterprise (OV-101)

Feb. 22 Conduct second inert captive flight, DFRF (3 hours, 13 minutes), Enterprise (OV-101)

Feb. 25 Conduct third inert captive flight, DFRF (2 hours, 28 minutes), Enterprise (OV-101)

Feb. 28 Conduct fourth inert captive flight, DFRF (2 hours, 11 minutes), Enterprise (OV-101)

March 2 Conduct fifth inert captive flight, DFRF (1 hour, 39 minutes), Enterprise (OV-101)

March 16 Wings on dock, Palmdale (STA-099)

March 21 Orbiter 1/4-scale model on dock, Downey

April 1 Lower forward fuselage on dock, Palmdale (STA-099)

April 6 Upper forward fuselage on dock, Palmdale (STA-099)

April 6 Vertical stabilizer on dock, Palmdale (STA-099)

May 20 Nose landing gear doors on dock, Palmdale (STA-099)

May 26 Aft payload bay doors on dock, Palmdale (STA-099)

May 27 Complete systems installation/final acceptance, MPTA-098, transport from Downey to Seal Beach

May 31 SRB 1/4-scale model, burnout and maximum q configuration, on dock, Downey

May 31 SRB 1/4-scale model, lift-off configuration, on dock, Downey

May 31 Body flap on dock, Palmdale (STA-099)

June 3 Ship MPTA-098 from Seal Beach, Calif., to NSTL

June 7 Complete integrated checkout and hot-fire ground test, DFRF, Enterprise (OV-101)

June 18 Conduct first manned captive active flight, Enterprise (OV-101)/shuttle carrier aircraft, DFRF (55 minutes, 46 seconds)

June 23 Deliver first SSME to NSTL (MPTA-098)

June 24 Deliver MPTA-098 to NSTL

June 28 Conduct second manned captive active flight, Enterprise (OV-101)/shuttle carrier aircraft, DFRF (1 hour, 2 minutes)

July 5 Start long-lead fabrication aft fuselage, Discovery (OV-103)

July 8 Deliver second main engine to NSTL (MPTA-098)

July 14 Deliver third main engine to NSTL (MPTA-098)

July 18 Conduct 2-minute firing of SRB at Brigham City, Utah, Thiokol (2.4 million pounds of thrust)

July 22 Deliver forward payload bay doors, on dock, Palmdale (STA-099)

July 26 Conduct third manned captive active flight, Enterprise (OV-101)/shuttle carrier aircraft, DFRF (59 minutes, 50 seconds)

Aug. 12 Conduct first free flight, ALT, tail cone on, DFRF (5 minutes, 21 seconds), Enterprise (OV-101), lake bed Runway 17

Aug. 26 Deliver wings on dock, Palmdale, Columbia (OV-102)

Sept. 7 Lower forward fuselage on dock, Palmdale, Columbia (OV-102)

Sept. 10 Deliver external tank MPTA-098 (Martin Marietta) to NSTL

Sept. 13 Conduct second free flight, ALT, tail cone on, DFRF (5 minutes, 28 seconds), Enterprise (OV-101), lake bed Runway 17

Sept. 23 Conduct third free flight, ALT, tail cone on, DFRF (5 minutes, 34 seconds), Enterprise (OV-101), lake bed Runway 15

Sept. 30 Complete mate vertical stabilizer, Palmdale (STA-099)

Oct. 12 Conduct fourth free flight, ALT, first tail cone off, DFRF (2 minutes, 34 seconds), Enterprise (OV-101), lake bed Runway 17

Oct. 26 Conduct fifth free flight, ALT, final tail cone off, DFRF (2 minutes, 1 second), Enterprise(OV-101), concrete Runway 04

Oct. 28 Lower forward fuselage on dock, Palmdale, Columbia (OV-102)

Nov. 4 Start forward reaction control system development tests, White Sands Test Facility, N.M.

Nov. 4 Deliver aft fuselage on dock, Palmdale, Columbia (OV-102)

Nov. 7 Forward RCS on dock, Palmdale (STA-099)

Nov. 7 Start final assembly and closeout system installation, Palmdale, Columbia (OV-102)

Nov. 15 First ferry flight test, DFRF (3 hours, 21 minutes), Enterprise (OV-101)

Nov. 16 Second ferry flight test, DFRF (4 hours, 17 minutes), Enterprise (OV-101)

Nov. 17 Third ferry flight test, DFRF (4 hours, 13 minutes), Enterprise (OV-101)

Nov. 18 Fourth ferry flight test, DFRF (3 hours, 37 minutes), Enterprise (OV-101)

Dec. 9 Complete approach and landing flight tests, including ferry flights, Enterprise (OV-101)

Dec. 12 Start removal for mated vertical ground vibration test modification at DFRF, Enterprise (OV-101)

Dec. 13 Complete propellant load testing, NSTL (MPTA-098)

Dec. 31 Deliver SSME envelope/electrical simulators on dock, Palmdale, Columbia (OV-102)

1978

Jan. 10 Vertical stabilizer on dock, Palmdale, Columbia (OV-102)

Jan. 18 Second SRB firing, Thiokol

Feb. 10 Complete final assembly, STA-099, Palmdale

Feb. 14 STA-099 on dock, Lockheed facility, Palmdale

Feb. 17 Crew module on dock, Palmdale, Columbia (OV-102)

Feb. 24 Body flap on dock, Palmdale, Columbia (OV-102)

March 3 Complete modification for mated vertical ground vibration test, DFRF, Enterprise (OV-101)

March 6 Upper forward fuselage on dock, Palmdale, Columbia (OV-102)

March 10 Ferry Enterprise (OV-101) atop shuttle carrier aircraft from DFRF to Ellington Air Force Base, Texas (approximately 3 hours, 38 minutes)

March 13 Ferry Enterprise (OV-101) atop shuttle carrier aircraft from Ellington AFB to Marshall Space Flight Center, Huntsville, Ala. (approximately 2 hours)

March 19 Aft payload bay doors on dock, Palmdale, Columbia (OV-102)

March 31 External tank for mated vertical ground vibration tests arrives at MSFC from Martin Marietta, Michoud, La.

March 31 Operational readiness date, solid rocket booster refurbishment and subassembly, Kennedy Space Center. Fla.

April 14 Complete ground vibration test modification at MSFC; deliver Enterprise (OV-101) for mated vertical ground vibration test

April 21 First static firing, MPTA-098, NSTL (2.5 seconds; stub nozzles)

April 23 Complete final assembly and closeout system installation, ready for power-on, Columbia (OV-102)

April 24 Start precombined systems test, Columbia (OV-102)

April 28 Forward payload bay doors on dock, Palmdale, Columbia (OV-102)

May 19 Second static firing MPTA-098, NSTL (15 seconds, 70% thrust; stub nozzles)

May 19 Start forward RCS thermal tests, WSTF

May 26 Start development test aft RCS, WSTF

May 26 Complete forward RCS structure, Columbia (OV-102)

May 26 Upper forward fuselage mate, Columbia (OV-102)

May 30 Start Enterprise (OV-101)/ ET mated vertical ground vibration test, MSFC

May 31 Loaded SRBs (2) arrive at MSFC for mated vertical ground vibration test

June 15 Third static firing, MPTA-098, NSTL (50 seconds, 90% thrust, last 5 seconds 70% thrust; stub nozzles)

July 3 Deliver left-hand OMS/RCS pod to WSTF

July 7 Fourth static firing, MPTA-098, NSTL (No. 2 engine 70% thrust for 90 seconds, simulated one engine out at 90 seconds, then No. 1 and No. 3 to 90% thrust-then to 70% thrust, then to 90% for 100 seconds; stub nozzles)

July 7 Complete mate forward and aft payload bay doors, Columbia (OV-102)

July 13 Complete forward RCS development tests, WSTF

July 13 Reconfigure from boost to launch, mated vertical ground vibration test, MSFC, Enterprise (OV-101)

July 15 Deliver SRBs (2) empty to MSFC for mated vertical ground vibration test

July 21 First firing development test, OMS, WSTF

July 31 Operational readiness date, Orbiter Processing Facility Bay 1, shuttle landing facility, and Hypergolic Maintenance Facility, KSC

Aug. 11 Complete forward RCS, Columbia (OV-102)

Aug. 11 Complete test preparation, STA-099, Lockheed facility, Palmdale

Aug. 11 Complete forward RCS thermal test, WSTF

Aug. 14 Start coefficient tests, STA-099, Lockheed facility, Palmdale

Aug. 31 Operational readiness date, Vertical Assembly Building High Bays 3 and 4, KSC

Sept. 8 Start OMS left-hand development test, WSTF

Sept. 20 Start launch configuration test lift-off configuration, Enterprise (OV-101)/ ET/SRBs mated vertical ground vibration test at MSFC

Sept. 20 Start acoustic test, forward RCS, WSTF

Sept. 25 Start precombined system test, Columbia (OV-102)

Sept. 29 Complete coefficient tests, STA-099, Lockheed facility, Palmdale

Sept. 30 Operational readiness date, mobile launcher platform, KSC

Oct. 19 Third SRB firing, Thiokol

Nov. 11 Complete forward RCS acoustic test, WSTF

Nov. 15 Complete OMS development test

Nov. 15 Complete aft RCS development test, WSTF

Nov. 30 Operational readiness date, Pad A, KSC

Dec. 9 Start OMS Phase I qualification tests, WSTF

Dec. 15 Start aft RCS Phase I qualification tests, WSTF

Dec. 15 Complete pre-combined system test, Palmdale, Columbia (OV-102)

1979

Jan. 2 Start long-lead fabrication crew module, Challenger (OV-099)

Jan. 30 Start orbiter/ET/SRB burnout mated vertical ground vibration test, MSFC

Jan. 31 Deliver shuttle carrier aircraft to DFRF for ferry operations

Jan. 31 Start left-hand OMS Phase I qualification test, WSTF

Jan. 31 Mission Control Center-Houston/Goldstone ready for operational flight test early operations

Feb. 3 Complete combined systems test, Palmdale, Columbia (OV-102)

Feb. 16 Airlock on dock, Palmdale, Columbia (OV-102)

Feb. 17 Fourth SRB firing, Thiokol

Feb. 26 Complete mated vertical ground vibration test program at MSFC, Enterprise (OV-101)

Feb. 28 Operational readiness date, shuttle landing site, DFRF (Edwards AFB) Runway 23, for first manned orbital flight

March 5 Complete post checkout, Palmdale, Columbia (OV-102)

March 8 Complete closeout inspection, final acceptance, Palmdale, Columbia (OV-102)

March 8 Columbia (OV-102) transported overland from Palmdale to DFRF (38 miles)

March 9 Shuttle carrier aircraft/Columbia (OV-102) test flight at NASA DFRF

March 17 Space shuttle main engine 2005, first flight engine delivered to NSTL for acceptance test firings

March 20 Ferry flight, shuttle carrier aircraft/Columbia (OV-102) from DFRF to Biggs Army Air Base, El Paso, Texas (3 hours, 20 minutes)

March 22 Ferry flight, shuttle carrier aircraft/Columbia (OV-102) from Biggs Army Air Base to Kelly AFB, San Antonio, Texas (1 hour, 39 minutes)

March 23 Ferry flight, shuttle carrier aircraft/Columbia (OV-102) from Kelly AFB to Eglin AFB, Fla. (2 hours, 12 minutes)

March 24 Ferry flight, shuttle carrier aircraft/Columbia (OV-102) from Eglin AFB to KSC (1 hour, 33 minutes)

March 30 Space shuttle main engine 2007, flight engine delivered to NSTL for acceptance test firing

April 6 Complete Phase I qualification tests, aft RCS, WSTF

April 10 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101) from MSFC to KSC (1 hour, 52 minutes)

April 16 Space shuttle main engine 2006, flight engine delivered to NSTL, for acceptance test firing

April 18 Complete left-hand OMS/RCS Phase I qualification, WSTF

May 1 Enterprise (OV-101)/ ET/SRBs mated on mobile launcher platform, transported to Launch Complex 39-A from Vehicle Assembly Building at KSC

May 4 Start forward RCS Phase I qualification tests, WSTF

May 4 Fifth static firing, MPTA-098, NSTL, flight nozzles 1.5 seconds

May 10 Deliver right-hand OMS/RCS from McDonnell Douglas, St. Louis, to KSC, Columbia (OV-102)

May 15 Deliver left-hand OMS/RCS from McDonnell Douglas to KSC, Columbia (OV-102)

May 30 Deliver ET used in mated vertical ground vibration test from MSFC to Martin Marietta for refurbishment

June 12 Fifth static firing, MPTA-098, NSTL, flight nozzles (54 seconds, early cutoff, accelerometer filters)

June 15 First SRB qualification firing, Thiokol, Utah, 122 seconds; nozzle extension severed at end of run as in actual mission; full cycle gimbal

June 21 Start assembly crew module, Challenger (OV-099)

July 2 Sixth static firing, MPTA-098, NSTL, flight nozzles (19 seconds, early cutoff-main fuel valve rupture)

July 23 Enterprise (OV-101), ET, SRBs transported on mobile launcher platform from Launch Complex 39-A to Vehicle Assembly Building at KSC

Aug. 1 Start long-lead fabrication crew module, Discovery (OV-103)

Aug. 6 Complete limit test (STA-099), Lockheed facility, Palmdale

Aug. 10 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), KSC to Atlanta (1 hour, 55 minutes)

Aug. 11 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), Atlanta to St. Louis (1 hour, 50 minutes)

Aug. 12 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), St. Louis to Tulsa (1 hour, 35 minutes)

Aug. 13 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), Tulsa to Denver (2 hours)

Aug. 14 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), Denver to Hill AFB, Ogden, Utah (1 hour, 30 minutes)

Aug. 15 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), Ogden to Vandenberg AFB (2 hours, 20 minutes)

Aug. 16 Ferry flight, shuttle carrier aircraft/Enterprise (OV-101), Vandenberg AFB to DFRF (1 hour, 10 minutes)

Aug. 23 Enterprise (OV-101)/ shuttle carrier demate, DFRF

Aug. 27 Start long-lead fabrication crew module, Discovery (OV-103)

Aug. 31 Complete OMS Phase II qualification tests, WSTF

Aug. Second SRB qualification firing, Thiokol

Sept. 5 Complete forward RCS Phase I qualification tests, WSTF

Sept. 12 Start forward RCS Phase II qualification tests, WSTF

Sept. 21 Start aft RCS Phase II qualification tests, WSTF

Oct. 5 Complete setup and thermal tests (STA-099), Lockheed facility, Palmdale

Oct. 24 Sixth static firing, MPTA-098, NSTL, flight nozzle (scrubbed, hydrogen detector oversensitive)

Oct. 30 Move Enterprise (OV-101) from DFRF overland to Rockwell Palmdale facility (38 miles)

Nov. 2 Start OMS left-hand pod Phase II qualification, WSTF

Nov. 3 Complete Columbia (OV-102) auxiliary power unit hot fire tests, Orbiter Processing Facility, KSC

Nov. 4 MPTA-098 static firing, NSTL (10 seconds, flight nozzles, SSME liquid oxygen turbine, seal cavity pressure, high-cutoff steerhorn failure)

Nov. 7 Deliver STA-099 from Lockheed facility, Palmdale to Rockwell Palmdale for rework as second operational orbiter (redesignated Challenger (OV-099))

Nov. 12 Complete qualification test OMS engine at WSTF

Dec. 7 De-mate payload bay door, Palmdale, Challenger (OV-099)

Dec. 14 Complete demate body flap, Palmdale, Challenger (OV-099)

Dec. 16 Orbiter integrated test start, Columbia (OV-102), KSC

Dec. 17 Sixth static firing, MPTA-098, NSTL, 554 seconds (340 seconds at 100% rated power level, then 90% at 385 seconds, 80% at 450 seconds, 70% at 505 seconds; 1 engine shut down-other 2 continued at 70% until 554 seconds; pogo and gimbaling tests accomplished; stub nozzles)

Dec. 21 Complete demate elevons, Palmdale, Challenger (OV-099)

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Jan. 14 Complete orbiter integrated test, Columbia (OV-102), KSC

Jan. 18 Vertical stabilizer on dock, Fairchild, N.Y., for rework, Challenger (OV-099)

Jan. 25 Body flap on dock, Downey, Challenger (OV-099)

Jan. 25 Payload bay doors on dock, Rockwell, Tulsa, Okla., for rework, Challenger (OV-099)

Jan. 28 Start instrumentation removal and prepare midfuselage for modification, Palmdale, Challenger (OV-099)

Feb. 1 Complete aft fuselage demate Palmdale, Challenger (OV-099) for rework on dock, Downey

Feb. 1 Elevons on dock, Grumman, N.Y., for rework, Challenger (OV-099)

Feb. 1 Complete aft RCS Phase II qualification tests, WSTF

Feb. 4 Start instrumentation removal and prepare wing for modification, Palmdale, Challenger (OV-099)

Feb. 8 Demate forward RCS module, Palmdale, Challenger (OV-099)

Feb. 14 Final qualification firing SRB, Thiokol, Utah

Feb. 15 Complete demate upper forward fuselage, Palmdale, Challenger (OV-099)

Feb. 18 Complete left-hand OMS Phase II qualification test, WSTF

Feb. 20 Complete forward RCS module qualification test, WSTF

Feb. 23 Upper forward fuselage on dock, Downey for rework, Challenger (OV-099)

Feb. 28 Seventh static firing, MPTA-098, NSTL, 555 seconds (No. 2 engine planned shutdown at 520 seconds, throttle down to 70% from 100%. Pogo and gimbaling tests; stub nozzles)

March 3 Start detail fabrication, crew module, Discovery (OV-103)

March 20 Eighth static firing, MPTA-098, NSTL, 539 seconds (started at 100%, two engines throttled to 70%, then up to 100%, two other engines throttled to 70%, then up to 100%; all three engines throttled to simulate 3-g mission profile, then to 70% and shutdown; simultaneous pogo and gimbal tests; stub nozzles)

March 21 Forward RCS module on dock, Downey, for rework, Challenger (OV-099)

March 31 Complete 1/4-scale model tests, Downey

April 16 Ninth static firing, MPTA-098, NSTL (No. 2 engine, 4.6 seconds, shut down due to discharge. Overtemperature on high-pressure fuel turbopump; No. 1 and No. 3 shut down at 6 seconds; stub nozzles)

May 30 Complete preparation lower forward fuselage modification, Palmdale, Challenger (OV-099)

May 30 Ninth static firing, MPTA-098, NSTL (46 seconds into run, throttled to 70% for 18 seconds, then to 100%, to 95% at 375 seconds, to 85% at 400 seconds, 83% at 430 seconds, 75% at 460 seconds; No. 3 shut down at 480 seconds, remaining two to 60% at 490 seconds; No. 2 shut down at 565 seconds; No. 1 shut down by engine cutoff sensors at 575 seconds. Pogo and gimbal tests; stub nozzles)

June 1 Columbia (OV-102), engine 2005 SSME fired for 520 seconds, NSTL

June 1 Start fabrication/assembly wings, Discovery (OV-103)

June 5 Columbia (OV-102), engine 2006 SSME fired for 520 seconds at NSTL

June 16 Columbia (OV-102), engine 2007 SSME fired for 520 seconds at NSTL

June 20 Start fabrication lower forward fuselage, Discovery (OV-103)

July 12 Tenth static firing, MPTA-098, NSTL, shut down 105 seconds into firing due to burnthrough in engine No. 3 fuel preburner, 102% thrust, flight nozzles

July 28 Start detail fabrication aft fuselage, Atlantis (OV-104)

Aug. 3 Complete installation SSMEs, Columbia (OV-102), KSC

Sept. 1 Start body flap modification Downey, Challenger (OV-099)

Sept. 29 Start assembly crew module, Discovery (OV-103)

Oct. 1 Start fabrication/assembly midfuselage, Discovery (OV-103)

Oct. 1 Start fabrication/assembly midfuselage, Atlantis (OV-104)

Oct. 9-10 Removal of SSMEs from Columbia (OV-102), KSC, for modification

Oct. 11-12 Installation of OMS/RCS pods, Columbia (OV-102), KSC

Nov. 3 Start initial system installation crew module Downey, Challenger (OV-099)

Nov. 3 ET mated to SRBs in Vehicle Assembly Building, KSC, for STS-1

Nov. 3 Eleventh static firing, MPTA-098, NSTL, shut down 20 seconds into firing due to burnthrough in engine No. 2 nozzle, 102% thrust flight nozzles

Nov. 4 Structural integrity test aft fuselage, Columbia (OV-102), KSC

Nov. 5 ET mated to SRBs at KSC

Nov. 8-10 Reinstallation of SSMEs, Columbia (OV-102), KSC

Nov. 10 Start assembly aft fuselage, Discovery (OV-103)

Nov. 14 Complete modifications, Columbia (OV-102), KSC

Nov. 16 Complete thermal protection system installation, Columbia (OV-102), KSC

Nov. 21 Complete wing modification, Palmdale, Challenger (OV-099)

Nov. 21 Complete modification lower forward fuselage, Palmdale, Challenger (OV-099)

Nov. 24 Transfer Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building, for STS-1, KSC

Nov. 26 Mating of Columbia (OV-102) to ET and SRBs in Vehicle Assembly Building, for STS-1, KSC

Dec. 4 Space shuttle vehicle power-up in Vehicle Assembly Building, Columbia (OV-102), KSC

Dec. 4 Eleventh static firing, MPTA-098, NSTL, stub nozzles, 591 seconds simulated flight profile, started at 100%, then to 65% at 37 seconds, then to 102% at 65 seconds, then to 65% at 438 seconds. Engine No. 2 shut down at 442 seconds, remaining two to 65% at 508 seconds, then shut down gimbal test

Dec. 8 Start initial system installation aft fuselage, Discovery (OV-103)

Dec. 12 Complete rework aft fuselage, Downey, Challenger (OV-099)

Dec. 15-18 Columbia (OV-102) interface test in Vehicle Assembly Building, KSC

Dec. 19 Start preparations for Columbia (OV-102) rollout and ordnance installation, KSC

Dec. 29 Transfer Columbia (OV-102) aboard mobile launcher platform from Vehicle Assembly Building to Launch Complex 39-A for STS-1

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Jan. 5 Emergency egress test

Jan. 17 Twelfth static firing, MPTA-098, NSTL, flight nozzles, 625 seconds, 100% thrust, simulated abort mission profile, No. 1 engine shut down at 239 seconds, remaining two shut down at 625 seconds, pogo and gimbal tests. External tank test without anti-geyser line to verify feasibility of eventually removing it from later ET versions

Jan. 22 ET liquid hydrogen load, KSC, Columbia (OV-102)

Jan. 23 Auxiliary power unit confidence run, Columbia (OV-102), KSC, each APU serially run for 2 minutes

Jan. 24 ET liquid oxygen load, KSC, Columbia (OV-102)

Jan. 29 Hypergolic load, RCS, OMS, KSC, Columbia (OV-102)

Feb. 2 Start initial system installation forward RCS module, Downey, Challenger (OV-099)

Feb. 2 Wet countdown demonstration test simulations, KSC, Columbia (OV-102)

Feb. 4 Start series of countdown demonstration tests for flight readiness firing, Columbia (OV-102), KSC

Feb. 13 Left outboard elevon on dock, Palmdale, Challenger (OV-099)

Feb. 20 Flight readiness firing (20-second firing of all three SSMEs), Columbia (OV-102), KSC

Feb. 24-26 Start mission verification tests, Columbia (OV-102), KSC

March 1 Body flap from Downey to Palmdale, Challenger (OV-099)

March 2 Start fabrication/assembly payload bay doors, Discovery (OV-103)

March 14 Launch verification tests, Columbia (OV-102), KSC

March 27 Vertical stabilizer on dock, Palmdale, Challenger (OV-099)

March 30 Elevon rework complete, on dock, Palmdale, Challenger (OV-099)

April 12 Conduct STS-1, Columbia (OV-102), launch KSC, land Edwards AFB, Calif., Runway 23 dry lake bed on April 14, 54-hour, 20-minute, 32-second mission, landed on orbit 36

April 20 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Tinker AFB, Okla., 3.5-hour flight

April 20 SRB stacking began on mobile launcher platform for STS-2, KSC

April 21 Ferry flight, Columbia (OV-102) from Tinker AFB, Okla., to KSC, 3-hour, 20-minute flight

April 22 ET for STS-2 on dock, KSC

June 1 Start fabrication elevons, Atlantis (OV-104)

June 1 Start fabrication vertical stabilizer, Discovery (OV-103)

June 1 Start fabrication/assembly wings, Atlantis (OV-104)

July 2 Upper forward fuselage on dock, Palmdale, Challenger (OV-099)

July 10 Payload bay door on dock, Palmdale, Challenger (OV-099)

July 13 Start fabrication crew module, Atlantis (OV-104)

July 14 Crew module on dock, Palmdale, Challenger (OV-099)

July 17 Complete body flap modification, Downey, Challenger (OV-099)

July 21 Aft fuselage on dock, Palmdale, Challenger (OV-099)

July 24 Body flap on dock, Palmdale, Challenger (OV-099)

July 30 Began mating of ET to SRBs on mobile launcher platform for STS-2, KSC

Aug. 4 Transfer Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building, KSC

Aug. 26 Transfer space shuttle aboard mobile launcher platform from Vehicle Assembly Building to Launch Complex 39-A for STS-2, KSC

Sept. 6 Transport Enterprise (OV-101) overland from Palmdale, Calif., to NASA's DFRF at Edwards AFB, Calif.

Oct. 3 ET for STS-3 on dock, KSC

Oct. 19 Start detailed fabrication/assembly, body flap, Discovery (OV-103)

Oct. 19 Start detailed fabrication lower forward fuselage, Atlantis (OV-104)

Oct. 23 Complete airframe modifications, Palmdale, Challenger (OV-099)

Oct. 26 Start initial system installation, crew module, Downey, Discovery (OV-103)

Oct. 26 Start initial subsystems test power-on, Challenger (OV-099)

Nov. 2 Start initial subsystems test, Palmdale, Challenger (OV-099)

Nov. 12 Conduct STS-2, Columbia (OV-102), launch KSC, land Edwards AFB, Calif., Runway 23, lake bed, landed on orbit 36, Nov. 14, 54 hours, 13 minutes, 13 seconds

Nov. 23 Start SRB stacking on mobile launcher platform for STS-3, KSC

Nov. 23 Start assembly aft fuselage, Atlantis (OV-104)

Nov. 24 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Bergstrom AFB, Texas, 3.5-hour flight

Nov. 25 Ferry flight, Columbia (OV-102) from Bergstrom AFB, Texas, to KSC, 3-hour flight

Dec. 9 Start fabrication upper forward fuselage, Atlantis (OV-104)

Dec. 11 Spacelab-1 arrived KSC

Dec. 19 Start mating of ET to SRBs on mobile launcher platform for STS-3 at KSC

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Jan. 4 Start initial system installation upper forward fuselage, Discovery (OV-103)

Jan. 29 Complete initial subsystems test, including Delta F, Palmdale, Challenger (OV-099)

Jan. 31 Forward RCS module on dock, Palmdale, Challenger (OV-099)

Feb. 3 Transfer Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building at KSC for STS-3

Feb. 15 Start assembly crew module, Atlantis (OV-104)

Feb. 15 Right-hand OMS/RCS pod on dock at Palmdale for thermal protection system installation, Challenger (OV-099)

Feb. 16 Transfer Columbia (OV-102) from Vehicle Assembly Building to Launch Complex 39-A for STS-3

Feb. 28 Complete main propulsion test program, NSTL, Miss.

March 3 Left-hand OMS/RCS pod on dock at Palmdale for thermal protection system installation, Challenger (OV-099)

March 16 Mid fuselage on dock, Palmdale, Discovery (OV-103)

March 22 Conduct STS-3, Columbia (OV-102), launch KSC, land White Sands Missile Range, N.M., lake bed Runway 17, landed on orbit 130, March 30, 192 hours (8 days), 4 minutes, 45 seconds

March 30 Elevons on dock, Palmdale, Discovery (OV-103)

April 6 Ferry flight, Columbia (OV-102) from White Sands Missile Range, N.M., to Barksdale AFB, La., to KSC

April 7 Columbia (OV-102) at Orbiter Processing Facility, KSC

April 16 Complete mating of SRBs and ET for STS-4 in Vehicle Assembly Building, KSC

April 16 Complete subsystems test, Palmdale, Challenger (OV-099)

April 30 Wings on dock, Palmdale, Discovery (OV-103)

April 30 Lower forward fuselage on dock, Palmdale, Discovery (OV-103)

April 30 Complete final acceptance test, Palmdale, Challenger (OV-099)

May 16 Transfer Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building, KSC, for mating for STS-4

May 24 Start fabrication forward RCS module, Atlantis (OV-104)

May 25 Transfer Columbia (OV-102) from Vehicle Assembly Building on mobile launcher platform to Launch Complex 39-A for STS-4

June 4 Complete post checkout operations, Palmdale, Challenger (OV-099)

June 21 Complete configuration inspection, Palmdale, Challenger (OV-099)

June 27 Conduct STS-4, Columbia (OV-102), launch KSC, land Edwards AFB, Calif., concrete Runway 22, on orbit 113, July 4, 168 hours (7 days), 1 hour, 9 minutes

June 30 Challenger (OV-099) rollout, Palmdale

July 1 Transport Challenger (OV-099) overland from Palmdale to Edwards AFB, Calif., for ferry flight to KSC

July 2 Deliver mission kits for STS-5, KSC, Columbia (OV-102)

July 4 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Ellington AFB, Texas

July 5 Ferry flight, Challenger (OV-099) from Ellington AFB, Texas, to KSC

July 7 Start assembly payload bay doors, Atlantis (OV-104)

July 14 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Dyess AFB, Texas

July 15 Ferry flight, Columbia (OV-102) from Dyess AFB, Texas, to KSC

July 16 Upper forward fuselage on dock, Palmdale, Discovery (OV-103)

Aug. 5 Vertical stabilizer on dock, Palmdale, Discovery (OV-103)

Sept. 3 OMS/RCS pods on dock KSC, Challenger (OV-099)

Sept. 9 Transfer Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building for mating for STS-5

Sept. 21 Transfer Columbia (OV-102) from Vehicle Assembly Building on mobile launcher platform to Launch Complex 39-A at KSC for STS-5

Oct. 4 Start fabrication/ assembly vertical stabilizer, Atlantis (OV-104)

Oct. 15 Body flap on dock, Palmdale, Discovery (OV-103)

Nov. 11 Conduct STS-5, Columbia (OV-102), launch KSC, land Edwards AFB, Calif., concrete Runway 22 on orbit 82, Nov. 16, 120 hours (5 days), 2 hours, 14 minutes

Nov. 12 Start fabrication OMS/RCS pods, Atlantis (OV-104)

Nov. 21 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Kelly AFB, Texas

Nov. 22 Ferry flight, Columbia (OV-102) from Kelly AFB, Texas, to KSC

Nov. 23 Columbia (OV-102) at Orbiter Processing Facility at KSC for modifications to support Spacelab-1, STS-9

Nov. 23 Transfer Challenger (OV-099) from Orbiter Processing Facility to Vehicle Assembly Building at KSC for mating for STS-6

Nov. 30 Transfer Challenger (OV-099) from Vehicle Assembly Building on mobile launcher platform to Launch Complex 39-A at KSC for STS-6

Dec. 18 Flight readiness firing, Challenger (OV-099), 20 seconds, Launch Complex 39-A, KSC

Dec. 28 Crew module on dock, Palmdale, Discovery (OV-103)

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Jan. 11 Aft fuselage on dock, Palmdale, Discovery (OV-103)

Jan. 25 Second flight readiness firing, Challenger (OV-099), 23 seconds, Launch Complex 39-A, KSC

Feb. 25 Forward RCS on dock, Palmdale, Discovery (OV-103)

Feb. 25 Complete final assembly and closeout installation, Palmdale, Discovery (OV-103)

Feb. 28 Start initial subsystems test, power-on, Palmdale, Discovery (OV-103)

March 14 Start fabrication/assembly body flap, Atlantis (OV-104)

April Rockwell under contract to NASA for structural spare program consisting of an aft fuselage, crew compartment, forward RCS, lower and upper forward fuselage, mid fuselage, wings (elevons), payload bay doors, vertical stabilizer (rudder/speed brake), one set of OMS/RCS pods

April 4 Conduct STS-6, first flight of Challenger (OV-099), launch KSC, land Edwards AFB, Calif., concrete Runway 22, April 9 on orbit 81, 120 hours (5 days), 23 minutes, 42 seconds

April 14 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Kelly AFB, Texas

April 16 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to KSC

April 17 Challenger (OV-099) at Orbiter Processing Facility, KSC

May 6 Midfuselage on dock, Palmdale, Atlantis (OV-104)

May 13 Complete initial subsystems testing, including Delta F, Discovery (OV-103)

May 21 Challenger (OV-099) from Orbiter Processing Facility to Vehicle Assembly Building for STS-7

May 26 Challenger (OV-099) from Vehicle Assembly Building to Launch Complex 39-A for STS-7

June 13 Wings on dock, Palmdale, Atlantis (OV-104)

June 17 Elevons on dock, Palmdale, Atlantis (OV-104)

June 18 Conduct STS-7, Challenger (OV-099), launch KSC, land Edwards AFB, Calif., lake bed Runway 15, June 24 on orbit 98, 144 hours (6 days), 25 minutes, 41 seconds

June 28 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Kelly AFB, Texas

June 28 Columbia (OV-102) at Orbiter Processing Facility for STS-9

June 29 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to KSC

June 30 Challenger (OV-099) at Orbiter Processing Facility for STS-8

July 26 Challenger (OV-099) from Orbiter Processing Facility to Vehicle Assembly Building for STS-8

July 26 Complete subsystems test, Palmdale, Discovery (OV-103)

Aug. 1 OMS/RCS pods on dock, Palmdale, Discovery (OV-103)

Aug. 2 Challenger (OV-099) from Vehicle Assembly Building to Launch Complex 39-A for STS-8

Aug. 12 Complete final acceptance test, Palmdale, Discovery (OV-103)

Aug. 19 Vertical stabilizer on dock, Palmdale, Atlantis (OV-104)

Aug. 30 Conduct STS-8, Challenger (OV-099), launch KSC, first night launch of space shuttle, land Edwards AFB, Calif., concrete Runway 22, Sept. 5 on orbit 98, first night landing, 144 hours (6 days), 1 hour, 8 minutes, 43 seconds

Sept. 9 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Sheppard AFB, Texas, to KSC

Sept. 9 Complete postcheckout, Discovery (OV-103), Palmdale

Sept. 11 Challenger (OV-099) at Orbiter Processing Facility, KSC

Sept. 20 Challenger (OV-099) power-down modification period begins at Orbiter Processing Facility, KSC

Sept. 23 Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building, KSC, for STS-9

Sept. 28 Columbia (OV-102) from Vehicle Assembly Building to Launch Complex 39-A, KSC, for STS-9

Sept. 30 OMS/RCS pods on dock, KSC, for Discovery (OV-103)

Oct. 16 Discovery (OV-103) rollout at Palmdale

Oct. 17 Columbia (OV-102) rollback from Launch Complex 39-A to Vehicle Assembly Building, KSC

Oct. 19 Columbia (OV-102) from Vehicle Assembly Building to Orbiter Processing Facility, KSC

Oct. 28 SSME on dock, KSC, Discovery (OV-103)

Nov. 3 Columbia (OV-102) from Orbiter Processing Facility to Vehicle Assembly Building for remate for STS-9 KSC

Nov. 5 Discovery (OV-103) overland transport from Palmdale to Edwards AFB, Calif.

Nov. 6 Ferry flight, Discovery (OV-103) from Edwards AFB to Vandenberg AFB, Calif.

Nov. 7 Lower forward fuselage on dock, Palmdale, Atlantis (OV-104)

Nov. 8 Columbia (OV-102) moved from Vehicle Assembly Building to Launch Complex 39-A for STS=9 KSC

Nov. 8 Ferry flight, Discovery (OV-103) from Vandenberg AFB, Calif., to Carswell AFB, Texas

Nov. 9 Ferry flight, Discovery (OV-103) from Carswell AFB, Texas, to KSC

Nov. 15 Discovery (OV-103) modification period starts, Orbiter Processing Facility, KSC

Nov. 17 Challenger (OV-099) modification period retest begins at Orbiter Processing Facility, KSC

Nov. 23 Challenger (OV-099) modification period retest ends at Orbiter Processing Facility, KSC

Nov. 28 Conduct STS-9 Columbia (OV-102), launch KSC, land Edwards AFB, Calif., lake bed Runway 17, Dec. 8, 240 hours (10 days), 7 hours, 47 minutes, 24 seconds

Dec. 2 Payload bay doors on dock, Palmdale, Atlantis (OV-104)

Dec. 9 Discovery (OV-103) start Vehicle Assembly Building storage, KSC

Dec. 11 Challenger (OV-099) crew equipment interface test, Orbiter Processing Facility, KSC

Dec. 14 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Biggs Army Air Base, El Paso, Texas, to Kelly Air Force Base, San Antonio, Texas

Dec. 15 Ferry flight, Columbia (OV-102) from Kelly AFB, San Antonio, Texas, to Eglin AFB, Fla., to KSC

Dec. 16 Columbia (OV-102) at Orbiter Processing Facility

Dec. 22 SSME on dock, KSC, Discovery (OV-103)

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Jan. 3 Discovery (OV-103) end Vehicle Assembly Building storage, transfer to Orbiter Processing Facility, KSC

Jan. 5 SSME on dock, KSC, Discovery (OV-103)

Jan. 6 Challenger (OV-099) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating for STS-11, KSC

Jan. 6 Upper forward fuselage on dock, Palmdale, Atlantis (OV-104)

Jan. 11 Challenger (OV-099) mated, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Jan. 20 Body flap on dock, Palmdale, Atlantis (OV-104)

Jan. 26 Columbia (OV-102) ferry flight from KSC to Kelly AFB, Texas

Jan. 26 Challenger (OV-099) confidence run, Launch Complex 39-A, KSC

Jan. 27 Columbia (OV-102) ferry flight from Kelly AFB, Texas, to Edwards AFB, Calif.

Jan. 30 Columbia (OV-102) overland transport from Edwards AFB, Calif., to Rockwell Palmdale assembly facility for STS-17 modification

Feb. 3 Conduct 41-B (STS-11), Challenger (OV-099), launch, KSC, 168 hours (7 days), 23 hours, 15 minutes, 55 seconds, landing Feb. 11, KSC, on Runway 15

Feb. 17 Left-hand OMS/RCS pod on dock, Palmdale, Atlantis (OV-104)

Feb. 24 Right-hand OMS/RCS pod on dock, Palmdale, Atlantis (OV-104)

March 14 Challenger (OV-099) from Orbiter Processing Facility to Vehicle Assembly Building for mating for 41-C (STS-13)

March 16 Aft fuselage on dock, Palmdale, Atlantis (OV-104)

March 19 Challenger (OV-099) moved from Vehicle Assembly Building to Launch Complex 39-A for 41-C (STS-13)

March 19 Challenger (OV-099) APU confidence run, Launch Complex 39-A

March 22 Enterprise (OV-101) ferry flight from Edwards AFB, Calif., to Vandenberg AFB, Calif.

March 27 Enterprise (OV-101) ferry flight from Vandenberg AFB, Calif., to Little Rock AFB, Ark.

March 29 Enterprise (OV-101) ferry flight from Little Rock, Ark., to Brookley Field, Mobile, Ala.

April 2 Enterprise (OV-101) overland transport to U.S. Coast Guard station at Mobile, Ala., for loading on barge

April 3 Enterprise (OV-101) barge transport from Mobile, Ala., to New Orleans, La.

April 5 Enterprise (OV-101) arrives at New Orleans, La., for World's Fair

April 6 Conduct 41-C (STS-13), Challenger (OV-099), launch KSC, land Edwards AFB, Calif., lake bed Runway 17, April 13, 144 hours (6 days), 23 hours, 40 minutes, 7 seconds

April 9 Crew compartment on dock, Palmdale, Atlantis (OV-104)

April 17 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Kelly AFB, Texas

April 18 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to KSC

April 19 Challenger (OV-099) at Orbiter Processing Facility, KSC

April 24 Upper forward fuselage on dock, Palmdale, Atlantis (OV-104)

April 27 Forward RCS on dock, Palmdale, Atlantis (OV-104)

May 12 Discovery (OV-103) from Orbiter Processing Facility to Vehicle Assembly Building at KSC, for mating for 41-D (STS-14)

May 19 Discovery (OV-103) moved from Vehicle Assembly Building to Launch Complex 39-A for 41-D (STS-14)

May 25 Complete final assembly and closeout installation, Palmdale, Atlantis (OV-104)

May 28 Start initial subsystems test, power-on, Palmdale, Atlantis (OV-104)

June 2 Discovery (OV-103) flight readiness firing at Launch Complex 39-A, 18 seconds

June 25 Conduct 41-D (STS-14), Discovery (OV-103) first flight, launch KSC, launch scrubbed at T-9 minutes due to general-purpose computer No. 5 disparity with primary set of general-purpose computers

June 26 Conduct 41-D (STS-14), Discovery (OV-103) first flight, launch KSC, launch postponed indefinitely due to shutdown of SSMEs 3 and 2 at T-4 seconds due to slow opening of SSME 3 main fuel valve. SSME 1 never received a start command.

July 14 Discovery (OV-103) rollback from Launch Complex 39-A to Vehicle Assembly Building, KSC, for remanifest of payloads

July 17 Discovery (OV-103) from Vehicle Assembly Building to Orbiter Processing Facility for r econfiguration of payload bay for remanifest of payloads

Aug. 2 Discovery (OV-103) from Orbiter Processing Facility to Vehicle Assembly Building for remate with original 41-D SRBs and ET, KSC

Aug. 9 Discovery (OV-103) moved from Vehicle Assembly Building to Launch Complex 39-A for 41-D, KSC

Aug. 10 Complete initial subsystems test, power-on, including Delta F, Palmdale, Atlantis (OV-104)

Aug. 28 Remanifest 41-D mission launch for Aug. 29, postponed for 24 hours for software verification

Aug. 30 Conduct 41-D (STS-14) remanifested payload, first flight of Discovery (OV-103), launch KSC, land Edwards AFB, Calif., lake bed Runway 17, Sept. 5, 144 hours (6 days), 56 minutes, 4 seconds

Sept. 8 Challenger (OV-099) from Orbiter Processing Facility to Vehicle Assembly Building for mating for 41-G, KSC

Sept. 9 Ferry flight, Discovery (OV-103) from Edwards AFB, Calif., to Altus AFB, Okla.

Sept. 10 Ferry flight Discovery (OV-103) from Altus AFB, Okla., to KSC

Sept. 11 Discovery (OV-103) at Orbiter Processing Facility, KSC

Sept. 13 Mated 41-G (STS-17), Challenger (OV-099), transported from Vehicle Assembly Building to Launch Complex 39-A for its sixth flight

Oct. 5 Conduct 41-G (STS-17) Challenger (OV-099), launch KSC, land KSC, Runway 33, Oct. 13, 192 hours (8 days), 5 hours, 23 minutes, 38 seconds

Oct. 18 Discovery (OV-103) from Orbiter Processing Facility to Vehicle Assembly Building, KSC, for mating

Oct. 23 Mated 51-A (STS-19), Discovery (OV-103) transported from Vehicle Assembly Building to Launch Complex 39-A, KSC, for its sixth flight

Oct. 26 Complete subsystems test, Palmdale, Atlantis (OV-104)

Nov. 3 Enterprise (OV-101) from World's Fair at New Orleans, La., via barge to Mobile, Ala.

Nov. 5 Enterprise (OV-101) arrived at Brookley Field, Ala.

Nov. 7 Conduct 51-A, Discovery (OV-103), postponed for 24 hours due to high shear winds at altitude

Nov. 8 Conduct 51-A, Discovery (OV-103), launch KSC, land KSC, Runway 15, Nov. 16, 168 hours (7 days), 23 hours, 44 minutes, 56 seconds

Nov. 9 Installation of right-hand OMS/RCS pod, Challenger (OV-099) (from OV-104)

Nov. 10 Ferry flight, Enterprise (OV-101) from Mobile, Ala., to Kansas City, Mo.

Nov. 13 Ferry flight, Enterprise (OV-101) from Kansas City, Mo., to Edwards Air Force Base, Calif.

Nov. 16 Ferry flight, Enterprise (OV-101) from Edwards Air Force Base to Vandenberg Air Force Base, Calif.

Nov. 16 OV-103 at Orbiter Processing Facility, KSC

Dec. 21 OV-103 transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

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Jan. 5 Mated Discovery (OV-103), transported from Vehicle Assembly Building to Launch Complex 39-A for 51-C

Jan. 24 Conduct 51-C, Discovery (OV-103), launch KSC, land KSC, Runway 15, Jan. 27, 72 hours (3 days), 1 hour, 33 minutes, 27 seconds

Jan. 27 Discovery (OV-103) at Orbiter Processing Facility, KSC

Feb. 10 Challenger (OV-099) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

Feb. 15 Mated Challenger (OV-099), transported from Vehicle Assembly Building to Launch Complex 39-A for 51-E

March 4 Challenger (OV-099) rollback from Launch Complex 39-A to Vehicle Assembly Building for demate due to a timing problem with the TDRS-B satellite. Telesat-I with PAM-D and TDRS-B with IUS removed into payload changeout room at Launch Complex 39-A prior to rollback.

March 7 Challenger (OV-099) transferred from Vehicle Assembly Building to Orbiter Processing Facility at KSC for remanifest of payload bay from 51-E to 51-B mission

March 23 Discovery (OV-103) transferred from Orbiter Processing Facility to Vehicle Assembly Building at KSC for mating with remanifested new mission

March 28 Discovery (OV-103) mated, transported from Vehicle Assembly Building to Launch Complex 39-A for remanifested new 51-B mission

April 6 Atlantis (OV-104) rollout at Rockwell Palmdale assembly facility

April 9 Overland transport of Atlantis (OV-104) from Palmdale to Edwards AFB, Calif.

April 10 Challenger (OV-099) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

April 12 Conduct 51-D, fourth flight of Discovery (OV-103), launch KSC, land KSC, Runway 33, April 19, 144 hours (6 days), 23 hours, 55 minutes, 23 seconds

April 12 Ferry flight, Atlantis (OV-104) from Edwards AFB, Calif., to Ellington AFB, Texas

April 13 Ferry flight, Atlantis (OV-104) from Ellington AFB, Texas, to KSC

April 14 Atlantis (OV-104) at Orbiter Processing Facility, KSC

April 15 Challenger (OV-099) mated 51-B, transported from Vehicle Assembly Building to Launch Complex 39-A at KSC for its seventh flight

April 19 Discovery (OV-103) at Orbiter Processing Facility, KSC

April 29 Conduct 51-B, seventh flight of Challenger (OV-099), launch KSC, land Edwards AFB, Calif., Runway 17, May 6, 168 hours (7 days), 8 minutes, 46 seconds

May 10 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Kelly AFB, Texas

May 10 Atlantis (OV-104) transferred from Orbiter Processing Facility to Vehicle Assembly Building at KSC for temporary storage

May 11 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to KSC

May 11 Challenger (OV-099) at Orbiter Processing Facility, KSC

May 24 Ferry flight, Enterprise (OV-101) from Vandenberg AFB, Calif., to DFRF, Calif.

May 28 Discovery (OV-103) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

May 28 Atlantis (OV-104) transferred from Vehicle Assembly Building to Orbiter Processing Facility, KSC

June 4 Discovery (OV-103) mated 51-G, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

June 17 Conduct 51-G, fifth flight of Discovery (OV-103), launch KSC, land Edwards AFB, Calif., lake bed Runway 23, June 24, 168 hours (7 days), 1 hour, 38 minutes, 52 seconds

June 24 Challenger (OV-099) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

June 28 Ferry flight, Discovery (OV-103) from Edwards AFB, Calif., to Bergstrom AFB, Texas, to KSC

June 29 Challenger (OV-099) mated 51-F, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

June 29 Discovery (OV-103) at Orbiter Processing Facility, KSC

July 11 Columbia (OV-102) overland transport from Rockwell Palmdale assembly facility to DFRF

July 12 Conduct 51-F, eighth flight of Challenger (OV-099), launch scrubbed at T-3 seconds and shutdown of SSMEs due to loss of redundancy (channel A) on SSME 2 chamber coolant valve

July 14 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Offutt AFB, Neb.

July 14 Ferry flight, Columbia (OV-102) from Offutt AFB, Neb., to KSC

July 15 Columbia (OV-102) awaiting transfer from KSC demate area to Vehicle Assembly Building transfer aisle, KSC

July 16 Columbia (OV-102) at Vehicle Assembly Building transfer aisle, KSC

July 18 Atlantis (OV-104) transferred from Orbiter Processing Facility to Vehicle Assembly Building High Bay 2, KSC

July 18 Columbia (OV-102) transferred from Vehicle Assembly Building transfer aisle to Orbiter Processing Facility, KSC

July 29 Conduct 51-F, eighth flight of Challenger (OV-099), launch KSC, land Edwards AFB, Calif., lake bed Runway 23, Aug. 6, 168 hours (7 days), 22 hours, 45 minutes, 26 seconds

July 30 Discovery (OV-103) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

July 31 Atlantis (OV-104) transferred from Vehicle Assembly Building High Bay 2 to Orbiter Processing Facility, KSC

Aug. 6 Discovery (OV-103) mated 51-I, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Aug. 10 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Davis-Monthan AFB, Ariz., to Kelly AFB, Texas

Aug. 11 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to Eglin AFB, Fla., to KSC

Aug. 11 Atlantis (OV-104) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

Aug. 12 Challenger (OV-099) at Orbiter Processing Facility, KSC

Aug. 24 Conduct 51-I, sixth flight of Discovery (OV-103), launch scrubbed at T-5 minutes due to weather

Aug. 25 Conduct 51-I, sixth flight of Discovery (OV-103), launch scrubbed at T-9 minutes due to a comparison check between the primary set and backup flight control general- purpose computers

Aug. 27 Conduct 51-I, sixth flight of Discovery (OV-103), launch KSC, land Edwards AFB, Calif., lake bed Runway 23, Sept. 3, 168 hours (7 days), 2 hours, 17 minutes, 42 seconds

Aug. 29 Atlantis (OV-104) mated 51-J, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Sept. 7 Ferry flight, Discovery (OV-103) from Edwards AFB, Calif., to Kelly AFB, Texas

Sept. 8 Columbia (OV-102) transferred from Orbiter Processing Facility to Vehicle Assembly Building, KSC, for temporary storage

Sept. 8 Ferry flight, Discovery (OV-103) from Kelly AFB, Texas, to KSC

Sept. 8 Discovery (OV-103) at Orbiter Processing Facility, KSC

Sept. 12 Flight readiness firing of Atlantis (OV-104) for 20 seconds at Launch Complex 39-A, KSC

Sept. 20 Ferry flight, Enterprise (OV-101) from Edwards AFB, Calif., to Kelly AFB, Texas, to KSC

Sept. 26 Discovery (OV-103) transferred from Orbiter Processing Facility to Vehicle Assembly Building, KSC

Sept. 26 Columbia (OV-102) transferred from Vehicle Assembly Building to Orbiter Processing Facility, KSC

Oct. 3 Conduct 51-J, first flight of Atlantis (OV-104), launch KSC, land Edwards AFB, Calif., lake bed Runway 23, Oct. 7, 96 hours (4 days), 1 hour, 44 minutes, 38 seconds

Oct. 11 Ferry flight, Atlantis (OV-104) from Edwards AFB, Calif., to Kelly AFB, Texas, to KSC

Oct. 12 Challenger (OV-099) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

Oct. 12 Atlantis (OV-104) at Orbiter Processing Facility, KSC

Oct. 16 Challenger (OV-099) mated 61-A, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Oct. 30 Conduct 61-A, ninth flight of Challenger (OV-099), launch KSC, land Edwards AFB, Calif., lake bed Runway 17, Nov. 6, 168 hours (7 days), 44 minutes, 51 seconds

Nov. 8 Atlantis (OV-104) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

Nov. 10 Ferry flight, Challenger (OV-099) from Edwards AFB, Calif., to Davis-Monthan AFB, Ariz., to Kelly AFB, Texas

Nov. 11 Ferry flight, Challenger (OV-099) from Kelly AFB, Texas, to Eglin AFB, Fla., to KSC

Nov. 11 Challenger (OV-099) in Orbiter Processing Facility, KSC

Nov. 12 Atlantis (OV-104) mated 61-B, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Nov. 18 Enterprise (OV-101) ferry flight from KSC to Dulles Airport, Washington, D.C., becomes property of Smithsonian

Nov. 22 Columbia (OV-102) transferred from Orbiter Processing Facility to Vehicle Assembly Building for mating, KSC

Nov. 22 Discovery (OV-103) transferred from Vehicle Assembly Building to Orbiter Processing Facility, KSC

Nov. 26 Conduct 61-B, second flight of Atlantis (OV-104), launch KSC, land Edwards AFB, Calif., concrete Runway 22, Dec. 3, 144 hours (6 days), 21 hours, 4 minutes, 49 seconds

Dec. Structural spare mid fuselage on dock Palmdale for storage

Dec. 1 Columbia (OV-102) mated 61-C, transported from Vehicle Assembly Building to Launch Complex 39-A, KSC

Dec. 7 Ferry flight, Atlantis (OV-104) from Edwards AFB, Calif., to Kelly AFB, Texas, to KSC

Dec. 8 Discovery (OV-103) transferred from Orbiter Processing Facility to Vehicle Assembly Building, KSC, for modification period

Dec. 8 Atlantis (OV-104) in Orbiter Processing Facility, KSC

Dec. 16 Challenger (OV-099), rollover from Orbiter Processing Facility to Vehicle Assembly Building, KSC

Dec. 19 Conduct 61-C, seventh flight of Columbia (OV-102), launch scrubbed at T-13 seconds due to right-hand SRB auxiliary power unit turbine system B overspeed

Dec. 22 Challenger (OV-099), mated 51-L, transported from Vehicle Assembly Building to Launch Complex 39-B, KSC

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Jan. Structural spare body flap on dock Palmdale for storage

Jan. 5 Discovery (OV-103) transported from Vehicle Assembly Building to Orbiter Processing Facility, KSC

Jan. 6 Conduct 61-C, seventh flight of Columbia (OV-102), launch scrubbed at T-31 seconds due to a launch facility liquid oxygen replenish valve problem

Jan. 7 Conduct 61-C, seventh flight of Columbia (OV-102), launch scrubbed at T-9 minute hold due to adverse weather conditions at both transatlantic abort sites

Jan. 10. Conduct 61-C, seventh flight of Columbia (OV-102), launch scrubbed at T-9 minute hold due to adverse weather conditions at KSC

Jan. 12 Conduct 61-C, seventh flight of Columbia (OV-102), launch KSC, land concrete Runway 22, Edwards AFB, Calif., Jan. 18, night landing, 144 hours (6 days), 2 hours, 3 minutes, 51 seconds

Jan. 16 Discovery (OV-103) transported from Orbiter Processing Facility to Vehicle Assembly Building, KSC

Jan. 19 Discovery (OV-103) transported from Vehicle Assembly Building to Orbiter Processing Facility, KSC

Jan. 22 Ferry flight, Columbia (OV-102) from Edwards AFB, Calif., to Davis-Monthan AFB, Ariz., to Kelly AFB, Texas

Jan. 23 Ferry flight, Columbia (OV-102) from Kelly AFB, Texas, to Eglin AFB, Fla., to KSC

Jan. 23 Discovery (OV-103) transported from Orbiter Processing Facility to Vehicle Assembly Building, KSC

Jan. 23 Columbia (OV-102) at Orbiter Processing Facility, KSC

Jan. 27 Conduct 51-L, tenth flight of Challenger (OV-099) launch KSC, first launch of space shuttle from Launch Complex 39-B, launch scrubbed at T-9 minute hold due to unacceptable crosswind conditions at KSC runway in the event of a return-to-launch-site abort

Jan. 28 Conduct 51-L, tenth flight of Challenger (OV-099), launch KSC, first launch of space shuttle from Launch Complex 39-B, loss of vehicle and flight crew

Acronyms

A/A	Air-to-air
A/G	Air-to-ground
A/L	Approach and landing
AA	Accelerometer assembly
ACCU	Audio central control unit
ACE	Automatic checkout equipment
ACIP	Aerodynamic coefficient identification package
ADI	Attitude director indicator
ADS	Air data system
ADTA	Air data transducer assembly
AFB	Air Force Base
AFD	Aft flight deck
AFRSI	Advanced flexible reusable surface insulation
AFSCF	Air Force Satellite Control Facility
AFTA	Aft frame tilt actuator
AGL	Above ground level
AGS	Anti-gravity suit
ALC	Aft load controller
ALCA	Aft load controller assembly
ALT	Approach and landing test
AOA	Abort once around
APC	Aft power controller
APCA	Aft power controller assembly
APU	Auxiliary power unit
ARF	Assembly and refurbishment facility
ARIA	Advanced range instrumentation aircraft
ARPCS	Atmosphere revitalization pressure control system
ARS	Air revitalization system
ASCS	Atmosphere storage and control subsystem
ASE	Airborne support equipment
ASI	Augmented spark igniter
ATCS	Active thermal control system
ATO	Abort to orbit
ATVC	Ascent thrust vector control
AUX	Auxiliary
BFC	Backup flight control
BFS	Backup flight system
BITE	Built-in test equipment
BSM	Booster separation motor
C&T	Communications and tracking
C/W	Caution and warning
CAPS	Crew altitude protection system
CCAFS	Cape Canaveral Air Force Station
CCMS	Checkout, control and monitor system
CCU	Crew communications unit
CCU	Communications carrier umbilical
CCV	Chamber coolant valve
CDF	Confined detonating fuse
CDI	Course deviation indicator
CDMS	Command and data management system
CDS	Central data subsystem
CEIT	Crew equipment interface test
CITE	Cargo integration test equipment
CIU	Communication interface unit
COAS	Crewman optical alignment sight
CPU	Central processor unit
CRT	Cathode ray tube
CSS	Control stick steering
D&C	Displays and controls
DA	Deployed assembly
DAP	Digital autopilot
DBC	Data bus coupler
DBIA	Data bus isolation amplifier
DBN	Data bus network
DCC	Data computation complex (JSC)
DCM	Display and control module
DDU	Display driver unit
DEU	Display electronics unit
DFI	Development flight instrumentation
DFRF	Dryden Flight Research Facility
DHE	Data-handling equipment
DK	Display keyboard
DME	Distance-measuring equipment
DOD	Department of Defense
DPA	Data processing assembly
DPS	Data processing system
DSC	Dedicated signal conditioner
DSN	Deep-Space Network
DU	Display unit
EAFB	Edwards Air Force Base
EAS	Equivalent airspeed
ECG	Electrocardiograph
ECLSS	Environmental control and life support system
ECU	Electrical control unit
EED	Electroexplosive device
EES	Escape ejection suit
EI	Entry interface
EIU	Engine interface unit
EMK	Emergency medical kit
EMU	Extravehicular mobility unit
EPDS	Electrical power distribution subsystem
EPDU	Electrical power distribution unit
EPS	Electrical power system
ESA	European Space Agency
ESA	Explosive safe area (KSC)
ESRO	European Space Research Organization
ESS	Equipment support section
ESVS	Escape suit ventilation system
ET	External tank
ETR	Eastern test range
EVA	Extravehicular activity
FA	Flight aft
FAA	Federal Aviation Agency
FC	Flight critical
FC	Fuel cell
FCA	Forward controller assembly
FCL	Freon coolant loop
FCOS	Flight computer operating system
FCP	Fuel cell power plant
FCR	Flight Control Room
FDF	Flight data file
FDM	Frequency division multiplexer
FES	Flash evaporator system
FF	Flight forward
FL	Forward link
FLCA	Forward load controller assembly
FM	Frequency modulation, frequency modulated
FMSP	FM signal processor
FPCA	Forward power controller assembly
FRCS	Forward reaction control system
FRSI	Flexible reusable surface insulation
FSS	Fixed service structure
G&N	Guidance and navigation
G/S	Guided steering
GCIL	Ground command interface logic
GH 2	Gaseous hydrogen
GN 2	Gaseous nitrogen
GN&C	Guidance, navigation and control
GMT	Greenwich Mean Time
GO 2	Gaseous oxygen
GPC	General-purpose computer
GS	Glide slope
GSE	Ground support equipment
GSFC	Goddard Space Flight Center
GSTDN	Ground space flight tracking and data network

H_2	Hydrogen
HAC	Heading alignment cylinder
HAINS	High-accuracy inertial navigation system
HAL/S	High-order assembly language/ shuttle
HDR	High data rate
HDRR	High-data-rate recorder
HIP	Hardware interface program
HiRAP	High-resolution accelerometer package
HIU	Headset interface unit
HMCF	Hypergolic Maintenance and Checkout Facility
HPFT	High-pressure fuel turbopump
HPOT	High-pressure oxidizer turbopump
HPU	Hydraulic power unit
HRM	High-rate multiplexer
HRSI	High-temperature reusable surface insulation
HSI	Horizontal situation indicator
HUD	Head-up display
ICAO	International Civil Aviation Organization
IEA	Integrated electronic assembly
IMU	Inertial measurement unit
IOP	Input/output processor
IPL	Initial program load
ITA	Integrated test article
IU	Interface unit
IUS	Inertial upper stage
IVA	Intravehicular activity
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KBU	Keyboard unit
KSA	Ku-band single access
KSC	Kennedy Space Center
LCA	Load controller assembly
LCC	Launch Control Center (KSC)
LCG	Liquid-cooled garment
LCVG	Liquid cooling and ventilation garment
LDR	Low data rate
LED	Light-emitting diode
LESS	Leading edge structure subsystem
LETF	Launch Equipment Test Facility (KSC)
LH_2	Liquid hydrogen
LiOH	Lithium hydroxide
LO_2	Liquid oxygen
LPFT	Low-pressure fuel turbopump
LPOT	Low-pressure oxidizer turbopump
LPS	Launch processing system
LRSI	Low-temperature reusable surface insulation
LRU	Line-replaceable unit
LVLH	Local vertical/local horizontal
LWHS	Lightweight headset
MA	Multiple-access
MAC	Mean aerodynamic chord
MADS	Modular auxiliary data system
MBK	Medications and bandage kit
Mbps	Megabits per second
MCC	Main combustion chamber
MCC-H	Mission Control Center-Houston
MCDS	Multifunction CRT display system
MCIU	Manipulator controller interface unit
MCM	MADS control module
MCP	Monitoring and control panel
MDA	Motor drive amplifier
MDD	Mate/demate device
MDF	Mild detonating fuse
MDM	Multiplexer/demultiplexer
MEC	Master events controller
MECO	Main engine cutoff
MEP	Minimum entry point
MET	Mission elapsed time
MFV	Main fuel valve
MHA	Multiple headset adapter
MIA	Multiplexer interface adapter
MLG	Main landing gear
MLP	Mobile launcher platform
MLS	Microwave landing system
MM	Major mode or mass memory
MMC	Mid motor controller
MMCA	Mid motor controller assembly
MMH	Monomethyl hydrazine
MMS	Multimission modular spacecraft
MMSE	Multiuse mission support equipment
MMU	Manned maneuvering unit
MMU	Mass memory unit
MOV	Main oxidizer valve
MPC	Mid power controller
MPCA	Mid power controller assembly
MPL	Minimum power level
MRL	Manipulator retention latch
MPM	Manipulator positioning mechanism
MPS	Main propulsion system
MPSR	Multipurpose Support Room
MPST	Multipurpose support team
MPTA	Main propulsion test article
MRL	Manipulator retention latch
MSBLS	Microwave scan beam landing system
MSFC	Marshall Space Flight Center
MTU	Master timing unit
MTVC	Manual thrust vector control
NASA	National Aeronautics and Space Administration
Nascom	NASA communications network
NC	Normally closed
NCC	Network Control Center (GSFC)
NEP	Nominal entry point
NGT	NASA Ground Terminal
NLG	Nose landing gear
NO	Normally open
NOCC	Network Operations Control Center (GSFC)
NSD	NASA standard detonator
NSGT	NASA Ground Terminal
NSP	Network signal processor
NSTL	National Space Technology Laboratories
NWS	Nose wheel steering
O&C	Operations and checkout
O_2	Oxygen
OAA	Orbiter access arm
OBS	Operational bioinstrumentation system
OEX	Orbiter experiments
OFI	Operational flight instrumentation
OI	Operational instrumentation
OMRF	Orbiter Modification and Refurbishment Facility
OMS	Orbital maneuvering system
OPF	Orbiter Processing Facility
OPOV	Oxidizer preburner oxidizer valve
OPS	Operational sequence
OTV	Orbital transfer vehicle
OV	Orbiter vehicle
Pc	Chamber pressure
PAF	Payload attach fitting
PAM	Payload assist module
PASS	Primary avionics software system
PB	Playback
PBI	Push button indicator
PBS	Protective breathing system
PCA	Pneumatic control assembly
PCA	Power controller assembly
PCM	Pulse code modulation
PCR	Payload changeout room
PCTR	Pad connection terminal room
PDRS	Payload deployment and retrieval system
PDU	Power drive unit
PEAP	Personal egress air pack
PEG	Powered explicit guidance
PGHM	Payload ground handling mechanism
PHF	Payload handling fixture
PHSF	Payload Hazardous Servicing Facility
PI	Payload interrogator
PIC	Pyro initiator controller
PL	Payload
PLB	Payload bay
PLSP	Payload signal processor
PLSS	Portable life support system
PM	Phase modulation, phase modulated
POCC	Payload Operations Control Center
POR	Point of resolution
POS	Portable oxygen system
PPO 2	Oxygen partial pressure
PPP	Payload patch panel
PRL	Priority rate limiting
PROM	Progammable read-only memory
PRSD	Power reactant storage and distribution
PSP	Payload signal processor
PTC	Passive thermal control
PTT	Push to talk
QD	Quick disconnect
RA	Radar altimeter
RAAB	Remote amplifier acquisition and advisory box
RAM	Random-access memory
RAU	Remote acquisition unit
RCC	Reinforced carbon-carbon
RCS	Reaction control system
RF	Radio frequency
RGA	Rate gyro assembly
RHC	Rotational hand controller
RJD	Reaction jet driver
RL	Return link
RM	Redundancy management
RMS	Remote manipulator system
RPC	Remote power controller
RPL	Rated power level
RPSF	Rotation, Processing and Surge Facility
RPTA	Rudder pedal transducer assembly
RS	Redundant set (computers)
RSF	Refurbishment and Subassembly Facility (KSC)
RSS	Range safety system
RSS	Rotating service structure
RTC	Real-time command
RTG	Radioisotope thermoelectric generator
RTLS	Return to launch site
RTV	Room-temperature vulcanizing
S/M	Systems management
SAEF	Spacecraft Assembly and Encapsulation Facility (KSC)
SAIL	Shuttle Avionics Integration Laboratory (JSC)
SBTC	Speed brake/thrust controller
SCA	Sequence control assembly
SCA	Shuttle carrier aircraft
SCAPE	Self-contained atmosphere protective ensemble
SCF	Satellite Control Facility
SCM	System control module
SCSG	Strain gauge signal conditioner
SCU	Signal conditioner unit
SDPC	Shuttle Data Processing Complex
SEADS	Shuttle entry air data system
SEC	Secondary
SGLS	Space-ground link system
SILTS	Shuttle infrared leeside temperature sensing
SIP	Strain isolation pad
SIU	Signal interface unit
SLF	Shuttle landing facility (KSC)
SLS	Spacelab simulator
SMAB	Solid Motor Assembly Building
SMS	Shuttle mission simulator
SMU	Speaker/microphone unit
SOMS	Shuttle orbiter medical system
SOP	Subsystem operating program
SPA	Signal processor assembly
SPA	Steering position amplifier
SPC	Shuttle processing contractor
SPI	Surface position indicator
SPIF	Shuttle Payload Integration Facility
SPT	Steering position transducer
SOMS	Shuttle orbiter medical system
SRB	Solid rocket booster
SRM	Solid rocket motor
SSME	Space shuttle main engine
ST	Star tracker
STA	Structural test article
STDN	Space flight tracking and data network
STS	Space transportation system
SUMS	Shuttle upper atmosphere mass spectrometer
T/W	Thrust-to-weight
TACAN	Tactical air navigation
TAEM	Terminal area energy management
TDRS	Tracking and Data Relay Satellite
THC	Translational hand controller
TIO	Target insertion orbit
TLM	Telemetry
TPS	Thermal protection system
TSM	Tail service mast
TT&C	Tracking, telemetry and command
TVC	Thrust vector control
UHF	Ultrahigh frequency
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VCU	Video control unit
VFM	View finder monitor
VHF	Very high frequency
VIB	Vertical Integration Building
VIU	Video interface unit
VPF	Vertical Processing Facility
VTR	Video tape recorder
WBSC	Wide-band signal conditioner
WCCU	Wireless crew communication unit
WCLS	Water coolant loop system
WCS	Waste collection system
WMC	Waste management compartment
WONG	Weight on nose gear
WOW	Weight on wheels
WP	Way point
WSB	Water spray boiler
WSGT	White Sands Ground Terminal
WSTF	White Sands Test Facility
WTR	Western test range

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