

# LANDING THE SPACE SHUTTLE ORBITER AT KSC

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#### **Prime Landing Sites**

NASA's Kennedy Space Center (KSC) in Florida and Edwards Air Force Base (EAFB) in California serve as primary landing sites for the Space Shuttle orbiter. Each site offers unique advantages.

Landing the orbiter at KSC, where it is also processed and launched, saves at least an estimated \$1 million and five to seven days of processing time for its next mission. Also, a KSC landing eliminates the necessity of exposing the orbiter, a national resource, to the uncertainties of a cross-country ferry flight from the California landing site to KSC atop one of NASA's modified 747 Shuttle Carrier Aircraft.

Edwards AFB, with its diverse choice of concrete and spacious dry lakebed runways, is the preferred site when the returning orbiter is carrying a payload and is heavier than usual, is undergoing testing or there is a mission-specific reason for landing there. Located in California's high desert country, Edwards also offers more stable and predictable weather conditions than the Florida landing site. A switch in sites usually can be made up to 90 minutes prior to landing. Almost half the Shuttle orbiter landings in the future are expected to take place at KSC.

As originally envisioned, KSC's Shuttle Landing Facility (SLF) would be the primary landing site for the operational Space Shuttle era. The initial six Shuttle missions ended at EAFB so the crews and support teams could gain experience in landings. STS-7 in June 1983 was the first end-of-mission landing scheduled for KSC. The orbiter Challenger landed instead at EAFB, two orbits later than planned, because of marginal weather conditions at KSC.

The first landing at KSC was Mission 41-B on Feb. 11, 1984. KSC was the landing site for four of the next six missions. Extensive brake damage and a blown tire at the conclusion of the 51-D mission in April 1985 prompted officials to postpone further KSC landings until nose wheel steering and improved brakes were installed in the orbiters. Landings were scheduled to resume at KSC with Mission 61-C in January 1986, but that flight also was diverted to EAFB due to bad weather in Florida. The Space Shuttle Challenger accident less than two weeks later resulted in renewed concerns about safety, weather and runway conditions. KSC landings again were put on hold.

Planned end-of-mission landings at KSC resumed in 1991 after safety modifications and improvements were begun to the orbiters and KSC's landing strip.

The space planes have been outfitted with upgraded main landing gear and carbon brakes, and additional nose wheel steering capability. Another orbiter modification is improved tires. Drag chutes are being installed on the three older orbiters to help reduce rollout speed after touchdown. Endeavour, delivered to KSC in 1991, was the first to have this modification.

The original lateral cross grooves cut on the KSC runway to help prevent hydroplaning were ground down on the first 3,500 feet at both ends of the landing strip to reduce the friction and abrasion levels on the orbiter's tires at the time of touchdown. Smaller corduroy-like ridges run longitudinally in the nominal touchdown area. Other enhancements completed or planned to increase the runway safety margin include resurfacing the 1,000-foot overruns and rebuilding and strengthening the runway shoulders, and replacing runway edge lights.

### **Returning From Space**

A returning orbiter's glide to Kennedy Space Center begins on the opposite side of the planet. The deorbit burn which will bring the space plane back to Earth occurs about an hour before landing.

Approximately 30 minutes before touchdown, the space vehicle begins entering the atmosphere at an altitude of about 400,000 feet. At approximately 45,000 feet, the orbiter starts maneuvers enabling it to intercept the landing approach corridor at the desired altitude and velocity. As the orbiter nears the landing site, the commander takes manual control and the vehicle is steered into the nearest of two heading alignment cones (HACs) to line up the spacecraft with the center line of the runway.

Depending on the mission and its orbital parameters, the path the vehicle takes as it enters the atmosphere and lands can vary greatly.

The ground track is determined by the inclination of launch. Generally, re-entry will follow one of two general patterns, either from a low-inclination or a high-inclination orbit.

Space Shuttles carrying most communication satellites, for example, usually have a launch azimuth of about 90 degrees, which places the vehicle in an orbit that has a 28.5-degree inclination to the equator.

This means that as it circles the Earth, the orbiter's ground track ascends to approximately 28.5 degrees above the equator (28.5 degrees north latitude) and 28.5 degrees below the equator (28.5 degrees south latitude) - a relatively narrow band of the globe.

Typically, re-entry from this orbit begins with a deorbit burn over the Indian Ocean off the western coast of Australia. Usually, the flight path of the orbiter then proceeds across the Pacific Ocean to the Baja Peninsula, across Mexico and southern Texas, out over the Gulf, and on to the west coast of Florida.

Depending on the mission, the space plane passes over Florida's west coast somewhere between Sarasota and Yankeetown and proceeds across the central part of the state, with its tell-tale sonic booms heralding its arrival.

The final approach to the KSC landing strip takes the orbiter over the Titusville-Mims area, and out over the Atlantic Ocean where it circles for a landing approach from either the south (Runway 33) or the north (Runway 15), depending largely on wind direction and speed.

Shuttles launched into high-inclination orbits generally follow the second major re-entry pattern. Usually, these missions fly in an orbit with a 57-degree inclination to the equator.

The ground track on these missions covers a much broader section of the globe, as the orbiter reaches as far north as 57 degrees above the equator and 57 degrees below the equator. This type of orbit is well-suited to Earth observation missions.

The entry ground track of high-inclination orbits will vary. Depending on where re-entry occurs, landing on a descending portion of an orbit could take the orbiter across Canada and the eastern United States; or, from an ascending portion of an orbit, above the Southern Pacific and across South America.

On these re-entries, the space plane may parallel the northeast Florida coast after cutting across Georgia, or will fly over the Florida Everglades and up the southeast coast of the state.

The sonic booms as the orbiter slices through the atmosphere at velocities greater than the speed of sound may be heard across the width of Florida, depending on the flight path.

The sonic boom is really two distinct claps that occur a fraction of a second apart, and are audible to the human ear. It is the noise produced by an aircraft flying at supersonic speeds. The vehicle, in effect, compresses the air in front of the nose and the wing, creating shock waves that spread away from the aircraft.

Although the boom may rattle some windows, it has little or no effect on humans, wildlife or property. At peak intensity, the boom is about as loud as an automobile backfiring on the next block or the clap of thunder from a lightning strike about a half mile away. The pressure wave of the boom at its maximum intensity is equivalent to about half the force exerted on a person's ears when the door of a full-sized car is slammed with the windows shut.

The boom should be barely audible as the orbiter crosses the western part of the state. It will get louder as the space plane drops in altitude, although for much of Central Florida it may be at a level which goes unnoticed by persons indoors. The orbiter goes subsonic as it flies over the Indian River before circling to the north or the south for a final landing approach.

# **Shuttle Landing Facility**

KSC's Shuttle Landing Facility (SLF), first opened for flights in 1976, was specially designed for returning Space Shuttle orbiters. The SLF is located approximately three miles northwest of the huge Vehicle Assembly Building, with the launch pads only an additional three to four miles to the east. The runway is longer and wider than found in most commercial airports, yet comparable in size to runways designed for research and development facilities.

The paved runway is 15,000 feet long and 300 feet wide, with a 1,000-foot overrun on each end. Orbiters can land from either the northwest on Runway 15 or from the southeast on Runway 33.

In comparison, Orlando International Airport's longest runway is 12,004 feet long and 200 feet wide. The John F. Kennedy International Airport in New York has a runway nearly as long, 14,572 feet but much narrower at 150 feet. O'Hare International Airport in Chicago has a runway 13,000 feet long and 200 feet wide; and Miami International Airport's longest runway is 13,002 feet long by 150 feet wide.

In contrast, the other prime end-of-mission landing site, Edwards Air Force Base in California, has several dry lakebed runways and one hard surface runway on which an orbiter can land. The longest strip, part of the 44-square-mile Rogers Dry Lake, is 7.5 statute miles long. Concrete runways are generally preferred for night landings so the dust from the lakebed does not obscure the lighting.

About the size of a DC-9 jetliner, a Space Shuttle orbiter does not require such a large runway for landing. However, EAFB offers an extra safety margin because of its choice and size of landing strips. The orbiter differs in at least one major aspect from conventional aircraft: it is unpowered during re-entry and landing so its high-speed glide must be perfectly executed the first time - there is no go-around capability. The landing speed is up to 226 miles per hour. One concern about landing at KSC has been the canals and marshes surrounding the runway.

Foreign object debris (FOD) is any material which does not belong on or over the surface of the runway environment, where it becomes a potential hazard to the returning orbiter. Workers check the runway for FOD up to about 15 minutes prior to landing.

Birds are a hazard to the orbiter, as well as other aircraft. This "airborne FOD" could damage the orbiter's delicate outer skin of thermal protection materials. Birds are of special concern at KSC because much of the space center is a national wildlife refuge which provides a home to more than 300 species of birds. SLF employees use special pyrotechnic and noise-making devices, as well as selective grass cutting, to discourage birds around the runway.

The KSC concrete runway is 16 inches thick in the center with 15 inches on the sides. The landing strip is not perfectly flat; it has a slope of 24 inches from the center line to the edge to facilitate drainage.

The Shuttle Landing Facility includes a 550-by-490-foot parking apron, or ramp, on the southeastern end of the runway. On the northeast corner of the ramp is the Mate/Demate Device (MDD) which attaches the orbiter to or lifts it from the Shuttle Carrier Aircraft during ferry operations. The MDD is 150 feet long, 93 feet wide and 105 feet high.

When an orbiter lands anywhere other than KSC, it must be ferried back to the Florida space center riding piggyback style atop the Shuttle Carrier Aircraft.

Whether an orbiter lands here on its own or atop the Shuttle Carrier Aircraft, it is towed by a diesel-driven tractor to processing facilities via a two-mile towway from the Shuttle Landing Facility.

Adjacent to the MDD is the Landing Aids Control Building, which houses equipment and the personnel who operate the Shuttle Landing Facility on a daily basis. Other aircraft operations at the SLF include the astronauts' T-38 trainers; the Shuttle Training Aircraft, NASA's flying orbiter simulators; military and civilian cargo; and helicopters.

At the midfield point is the convoy staging area for the recovery team, a control tower, a fire station, and a viewing area for press and guests.

### Landing Aids

An array of visual aids as well as sophisticated guidance equipment at the Shuttle Landing Facility help to guide the orbiter to a safe landing.

The Tactical Air Navigation (TACAN) system on the ground provides range and bearing measurements to the orbiter when it is at an altitude of up to 145,000 feet. More precise guidance signals on slant range, azimuth and elevation come from the Microwave Scanning Beam Landing System (MSBLS) when the orbiter gets closer - up to 18,000 to 20,000 feet. Both TACAN and MSBLS are automatic systems that update the orbiter's onboard navigation systems.

The MSBLS also provides an autoland capability that can electronically acquire and guide the space plane to a completely "hands off" landing. So far, Shuttle mission commanders have taken control of the orbiter for all final approach and landing maneuvers during subsonic flight, usually about 22 miles from the touchdown point.

The initial landing approach at a glide slope of 19 degrees is more than six times steeper than the 3-degree slope of a typical commercial jet airliner as it approaches landing.

The Precision Approach Path Indicator (PAPI) lights are an electronic visual system that shows pilots if they are on the correct outer glide slope. PAPI lights are used at airports all over the world, but these have been modified for the unique configuration of the orbiter. A set of PAPI lights are at 7,500 feet and at 6,500 feet to delineate an outer glide slope of between 17 and 19 degrees. White lights are seen by the crew if the vehicle is above the glide slope; red lights show if they are below the glide slope. If they are "on" the correct glide slope, both red and white lights can be seen.

The "Ball-Bar" light system is a visual reference to provide inner glide slope information. The bar lights are 24 red lamps in horizontal sets of four each. They are about 2,200 feet from the runway threshold, and 300 feet from the first nominal touchdown point. Five-hundred feet closer to the runway threshold are three white lights - the ball - at a higher elevation.

If the orbiter is above the glide slope of 1.5 degrees, the white lights will appear to be below the bar of red lights. If the vehicle is below the glide slope, the white lights will appear to be above the red lights. If the red and white lights are superimposed, the orbiter is on the correct glide slope.

Just before touchdown, flare or a pull-up maneuver brings the orbiter into its final landing configuration. Touchdown nominally is 2,500 to 2,700 feet beyond the runway threshold.

Distance markers show the crew the distance remaining to the end of the runway during landing and rollout.

For night landings, the SLF has 16 powerful xenon lights, each of which produces up to one billion candlepower.

Flatbed trailers hold eight lights, in two groups of four, at each end of the runway. To avoid blinding the crew, only the xenon lights at the end of the runway which will be behind the orbiter at landing are turned on.

# Weather Constraints

Weather plays a major role in determining whether an end-of-mission landing is at KSC or Edwards Air Force Base, or is postponed until a later orbit.

The following weather constraints apply to KSC:

At the time of the deorbit burn go/no-go decision, which occurs approximately 90 minutes prior to landing, observed cloud cover below 10,000 feet should not exceed 20 percent.

Also, observed visibility and the forecast for visibility should be five miles or greater. Crosswinds should not be greater than 12 knots; in more restrictive landings - because of weight, for example, - crosswinds should not exceed 10 knots. Thunderstorms within 30 nautical miles and/or rain within 10 nautical miles are also landing constraints.

Wind direction usually will be the key factor in determining the final approach to the runway. Under normal circumstances, the orbiter will land into the wind. If the wind direction is from the south, the final approach will be from the north; if the wind direction is from the north, the orbiter will approach from the south.

Pre-landing weather forecasts will be issued by the Spaceflight Meteorology Group at Johnson Space Center, Houston, Texas. The group is part of the National Weather Service and works closely in coordinating its forecasts with the Cape Canaveral Forecast Facility. Weather instrumentation at KSC and the adjacent Cape Canaveral Air Force Station provides some of the data which the Spaceflight Meteor-ology Group uses in preparing their landing forecast. Weather conditions are also evaluated by NASA astronauts piloting reconnaissance aircraft along the orbiter's landing approach before the space plane is committed to re-entry.

### **Post-Landing Operations**

Although on call during an entire mission in case of an earlier-than-scheduled landing, the Orbiter Recovery Convoy normally begins recovery operations in earnest about two hours before the orbiter is scheduled to land.

The convoy consists of 20 to 30 specially designed vehicles or units and a team of some 150 trained personnel who "safe" the orbiter, prepare it for towing, assist the crew in leaving the orbiter and tow the vehicle to the processing facilities. The team which recovers the orbiter is primarily composed of KSC personnel, whether the landing takes place at KSC, at EAFB in California, or elsewhere.

The first staging position of the convoy after landing is 200 feet upwind of the orbiter. A safety assessment team dressed in protective garb and with breathing apparatus uses a high-range flammability vapor detector to obtain vapor level readings and to test for possible explosive or toxic gases such as hydrogen, monomethyl hydrazine, nitrogen tetroxide and hydrazine and ammonia.

The Vapor Dispersal Unit, a mobile wind machine, blows away the potentially dangerous gases if high levels are detected and winds are calm. The safety assessment team continues to determine whether hazardous gases are present. Purge and Coolant Umbilical Access Vehicles are moved into position behind the orbiter to get access to the liquid hydrogen umbilical. The ground half of the onboard hydrogen detection sample lines are connected to determine the hydrogen concentration.

If the hydrogen concentration is less than 3 percent, convoy operations continue. If it is greater than 3 percent, the crew is evacuated immediately, convoy personnel are cleared from the area and an emergency power-down of the orbiter is conducted. After the carrier plates for the hydrogen and oxygen umbilicals are installed, the flow of coolant and purge air through the umbilical lines begins. Purge air provides cool and humidified air conditioning to the payload bay and other cavities to remove any residual explosive or toxic fumes. The purge of the vehicle normally occurs within about 45 minutes after the orbiter comes to a full stop. Cooling transfer to ground services occurs at

approximately the same time, allowing onboard cooling to be shut down.

When it is determined that the area in and around the orbiter is safe, the Crew Hatch Access Vehicle moves to the hatch side of the orbiter and a "white room" is mated to the orbiter hatch. The hatch is opened and a physician performs a brief preliminary medical examination of all the crew members before the astronauts depart. Crew egress generally occurs within an hour after landing.

Astronauts now can egress from the orbiter quicker and more comfortably by transferring from the white room directly into a new Crew Transport Vehicle (CTV), a modified "people mover" used at airports. The crew passes through a curtained ramp to the CTV so they no longer will be visible to people watching the landing.

It is only after the crew has left the orbiter and the cool-down completed that Johnson Space Center, Houston, Texas, "hands over" responsibility of the vehicle to Kennedy Space Center.

The flight crew is replaced aboard the orbiter by exchange crew members who prepare the orbiter for ground tow operations, install switch guards and remove data packages from any onboard experiments. After a 45-minute tire cool-down period, vehicle ground personnel make numerous preparations for the towing operation, including the installation of landing gear lock pins, disconnection of the nose landing gear drag link, positioning of the towing vehicle in front of the orbiter and connection of the tow bar. Towing normally begins within four hours after landing, and is completed within six hours.

In addition to convoy operations on the runway, a KSC engineering test team monitors data from the orbiter from its station in one of the Launch Control Center's firing rooms. After the orbiter "hand over" to KSC, this team is enabled to issue commands to the orbiter to configure specific orbiter systems for the tow to one of three high bays of the Orbiter Processing Facility at KSC for the beginning of the processing flow which will ready the vehicle for its next flight. If the orbiter lands at Edwards, the vehicle will be towed to the Mate/Demate Device there to be attached to the Shuttle Carrier Aircraft which will bring the space plane back to KSC.

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# LANDING THE SPACE SHUTTLE ORBITER AT KSC

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April 24, 1992 KSC Contact: Bruce Buckingham KSC Release No. 49-92

#### AIRSPACE, BRIDGES AND WATERWAYS RESTRICTIONS WILL BE IN EFFECT FOR LAUNCH OF ENDEAVOUR ON SPACE SHUTTLE MISSION STS-49

During preparations prior to Space Shuttle launches and immediately following liftoff, a number of restrictions are in effect around Kennedy Space Center. The launch of Endeavour on mission STS-49 is targeted for 8:34 p.m. EDT, May 4, 1992.

Listed and described below are restrictions that apply to pilots, boaters and motor traffic crossing bridges leading to KSC.

### KSC AREA AVIATION RESTRICTIONS

The airspace immediately surrounding Kennedy Space Center will be limited to official aircraft only and will be offlimits to general aviation pilots prior to and during the launch of the Space Shuttle Endeavour on mission STS-49.

NOTAMS must be checked by pilots prior to flights near the KSC area. Pilots are warned that violations of restricted airspace may result in serious penalties, including suspension or revocation of pilot privileges.

Official aircraft supporting the launch will be in the air. Pilots must be aware that wandering into a restricted area is not only forbidden, but will also create a safety hazard to support aircraft and the errant pilot.

Anyone wishing to view the launch from the air should stay well west of the Indian River. Pilots should be advised that the airspace in that area is expected to be extremely congested with both controlled and uncontrolled aircraft.

Pilots should also be aware of the solid rocket booster (SRB) exhaust cloud that occurs after launch. They should stay at least five miles away from that cloud, even if it drifts out of the restricted area. Research aircraft will be flying into and out of the cloud, and visibility will be limited.

In general, the airspace restrictions cover a variety of air ranges from now through launch. In addition to the normal restrictions over Kennedy Space Center and Cape Canaveral Air Force Station, the launch will require that all private aircraft stay out of an area roughly bounded by the west side of the Indian River on the west, the Trident Basin (State Road 528 area) on the south, slightly north of Haulover Canal, and three miles out into the Atlantic on the east. The restrictions are "surface-to- unlimited." These launch-specific restrictions begin three hours before launch.

Pilots should consult the most recent edition of the Jacksonville Sectional Aeronautical Chart. In addition, they should contact the St. Petersburg Flight Service Station at 1-800- 99-27433 (1-800-WX-BRIEF). Advisories will be available from the Patrick Approach Control (VHF 134.95 megahertz), Space Center Executive Airport Tower (TIX) (VHF 118.9 megahertz), or the NASA Tower (128.55 megahertz).

Pilots should also refer to the current Patrick Air Force Base release on restricted airspace.

#### **BRIDGES CONTROLLED FOR LAUNCH**

The opening and closing of bridges over waterways surrounding the Kennedy Space Center will be strictly controlled during the hours immediately before and after the launch period of the Space Shuttle Endeavour on mission STS-49.

Bridges affected by the launch requirements include:

- Canaveral Harbor Barge Canal (State Road 401, south of Cape Canaveral Air Force Station Gate 1);
- Indian River Causeway west, a.k.a. NASA Causeway (Intracoastal Waterway at Addison Point);
- Merritt Island Barge Canal (Merritt Island State Road 3);
- Haulover Canal Bridge (State Road 3, north of KSC).

Restraints on bridge openings for boat traffic begin three hours before launch. The bridges may be opened for 5 minutes at the following points in the launch countdown: T-180 minutes, T-150 minutes, T-120 minutes, T-90 minutes, and T-65 minutes.

Bridges will remain closed to boat traffic until 90 minutes after liftoff (T+90). They may then open for 5 minutes at T+90 minutes, T+120 minutes, and T+150 minutes. Bridge operations will return to normal at three hours (T+180 minutes) after launch.

Should the Shuttle orbiter be required to perform a Return- to-Launch-Site (RTLS) landing at KSC, all bridges would remain closed to boat traffic from 45 minutes before landing to one hour after landing.

# KSC AREA BOATING RESTRICTIONS

Waterways and boating near the Kennedy Space Center will be strictly controlled prior to and during the launch of the Space Shuttle Endeavour.

Safety and security requirements, including U.S. Air Force Range Safety impact limit lines, will go into effect as early as three days before launch. Other requirements will be phased into effect through sundown the night before launch. A general description of the restricted areas follows.

Banana River: Security limits begin at the Banana River Barge Canal south of KSC at the State Road 528 crossing and extend north. This restriction goes into effect at sundown the night before launch.

Atlantic Ocean: Beginning at sundown the night before launch, a general exclusion zone will be in effect three miles offshore from the Haulover Canal, near the north end of KSC, to the entrance of Port Canaveral on the south end of KSC. Four hours prior to launch, all ocean-going traffic will be restricted from entering an area measured from five miles north and south of the pad, and extending 30 miles east into the ocean. Pad 39-B is located at latitude 28 degrees, 37 minutes, 37.26 seconds north; longitude 80 degrees, 37 minutes, 15.09 seconds west. An additional three mile wide exclusion zone will be extended eastward through the projected flight path of the shuttle.

Mosquito Lagoon: This area south of the Haulover Canal is off limits to all boats beginning at dusk the night before launch.

Indian River: Restrictions apply from the NASA Causeway north to the Haulover Canal and east of the Indian River's main channel. Restrictions begin at sundown the night before launch.

All boating restrictions will be lifted approximately one hour after launch.

The U.S. Coast Guard, the U.S. Fish and Wildlife Service, and KSC security forces share responsibility for enforcing the boating guidelines.

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June 18, 1992 KSC Contact: Bruce Buckingham KSC Release No. 77-92

# TECHNOLOGY TRANSFER PARTNERSHIP FORMED

NASA's Technology Transfer Program (TTP) at Kennedy Space Center and the State of Florida's Technology Research and Development Authority (TRDA) have joined forces under a partnership of arrangement to transfer and exchange space-related technology. This partnership, designed to benefit the general public and commercial companies, will permit NASA and the state to share the costs of jointly sponsoring technology transfer projects of common interest.

The first transfer project under this arrangement is currently underway. It involves the verification and demonstration of a space-age, infrared video survey system for detecting and locating leaks in gas and electrical power transmission lines. The project will be accomplished under a team effort consisting of federal and state agencies, gas and electric power companies, a major research university and an aerial survey equipment company.

Frank Kinney of TRDA will serve as the overall project manager with Carlos H. Blazquez of the University of Florida being the principle investigator. E.L. Myrick of Space Island Products and Services, Inc., Merritt Island, Fl., will provide the infrared video equipment and conduct the aerial surveillance using a small, twin engine aircraft.

The utilization of this new infrared survey system will allow gas pipeline and electric power companies to increase safety and efficiency of operations and maintenance, while at the same time realizing a significant savings in energy.

"We are pleased to have TRDA join us as a partner by co- funding technology transfer projects which will result in space spinoff benefits to people and organizations outside the space program," said James Aliberti, KSC's Technology Transfer Officer. "Since NASA's TTP and the state's TRDA have similar goals concerning the transfer and commercialization of new technology," Aliberti added, "this partnership will prove to be an economical and effective way of benefiting the economy, both locally and nationally."

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June 19, 1992 KSC Contact: Bruce Buckingham KSC Release No. 79-92

### STS-50 COUNTDOWN SCHEDULED TO BEGIN JUNE 22

The countdown to launch for the Space Shuttle Columbia on mission STS-50 is scheduled to begin at 8:00 a.m. EDT on Monday, June 22, at the T-43 hour mark. This launch will be the 12th for the orbiter Columbia and the 48th overall in the Space Shuttle program. The countdown includes 33 hours and 7 minutes of built- in hold time leading up to the opening of the launch window at 12:07 p.m. (EDT) on Thursday, June 25. The launch window extends until 2:37 p.m.

Columbia will carry into orbit the United States Microgravity Laboratory-1 on a 13-day mission.

At the start of the countdown, the launch team in Firing Room 3 in the Launch Control Center will verify that the Shuttle vehicle is powered up and that the data processing system and backup flight control system are operating without problem. Verifications will also be conducted to ensure that a review of the flight software stored in the orbiter's twin memory banks is being conducted, computer controlled display systems are being activated, and the backup flight system general purpose computer is being loaded.

This weekend, final ordnance operations will be conducted at the pad and the aft orbiter compartment will be closed for flight. Following countdown commencement on Monday, operations will begin to prepare the main propulsion system and orbiter's main engines for cryogenic loading, orbiter navigation aids will be turned on and tested and the inertial measurement units will be activated.

Also performed on Monday will be final storage of mid-deck and flight deck supplies and payloads, microbial sampling of drinking water and water level adjustment of the crew waste management system.

At T-27 hours, the countdown will enter its first built-in hold. This is a four-hour hold lasting from 12:00 midnight to 4:00 a.m. Tuesday. When the countdown resumes, the launch pad will be cleared of all personnel in preparation for cryogenic fuel loading of the Power Reactant and Storage Distribution system tanks and the Extended Duration Orbiter (EDO) tanks in the payload bay. These tanks hold the super-cold liquid hydrogen and liquid oxygen reactants used by the fuel cells to provide electricity to the orbiter and drinking water for the crew.

Cryogenic flow is scheduled to start at the T-25 hour mark. Servicing activities will take approximately 11 hours.

As servicing of the cryogenic tanks continues, the clock will enter another built-in hold at the T-19 hour mark. This hold will last for 12 hours. Normally, this is a four-hour hold. However, an additional eight hours was added into the schedule to allow extra time to complete the loading of the EDO tanks in the payload bay. This hold is scheduled to last from 12:00 noon to 12:00 midnight Tuesday.

Following cryogenic loading operations, the pad will be reopened for normal work and the orbiter mid-body umbilical unit used to load the super-cold reactants into the orbiter's fuel cell tanks will be demated.

When the countdown resumes, technicians will complete final vehicle and facility closeouts and begin activating the orbiter's communications systems and configuring Columbia's cockpit for flight. The orbiter's flight control system and

navigation aids will be activated. The stowable mission specialist and payload specialist seats will be installed in the flight and mid-decks. Also, a trace contaminant purge on the United States Microgravity Laboratory will be concluded.

The countdown will enter a standard built-in hold at the T- 11 hour mark at 8:00 a.m. Wednesday. The 13-hour, 47minute hold will extend to 9:47 p.m. Wednesday. During this hold, time critical equipment will be installed in the orbiter's cockpit and the inertial measurement units will be activated and warmed up. At about 11:00 a.m. Wednesday, the Rotating Service Structure is scheduled to be moved away from the vehicle to the launch position.

At T-9 hours (11:47 p.m. Wednesday), the onboard fuel cells will be activated. At T-8 hours, the launch team will begin evacuating the blast danger area. At T-7 hours, 30 minutes, conditioned air that is flowing through the orbiter's payload bay and other areas will be switched to gaseous nitrogen in preparation for loading the external tank with super-cold liquid propellants. The inertial measurement units will transition from the warm up stage to the operate/attitude determination mode at T-6 hours and 45 minutes.

The countdown will enter another planned built-in hold at the T-6 hour mark at approximately 2:47 a.m. Thursday. During this one-hour hold, final preparations for loading the external tank will be completed and a pre-tanking weather briefing will be conducted.

Childown of the lines that carry the cryogenic propellants to the external tank begins approximately when the clock starts counting again at 3:47 a.m. Thursday. Filling and topping of the external tank should be complete at the beginning of the next planned hold at T-3 hours or 6:47 a.m.

During the two-hour planned hold, an ice inspection team will perform a survey of the tank's outer insulation, and the closeout crew will begin configuring the crew module and white room for the flight crew's arrival. Liquid oxygen and liquid hydrogen will be in a stable replenish mode during this time to replace any propellant that "boils" off.

During the hold at T-3 hours, the seven-member STS-50 crew will be awakened at about 6:30 a.m.

Following breakfast, the crew will receive a briefing on weather conditions both here at KSC and around the world via satellite from Mission Control-Houston.

The flight crew will suit up in their partial-pressure suits, then leave the Operations and Checkout Building at about 8:52 a.m., at T-2 hours and 55 minutes. They will arrive at the pad white room at about 9:22 a.m. where they will be assisted by white room personnel in getting into the crew cabin.

Just prior to the T-1 hour mark, the test team and the flight crew will get another weather update, including observations from an astronaut flying in a Shuttle Training Aircraft in the KSC area.

The last two built-in holds will be 10 minutes in duration and will occur at the T-20 minute mark or at 11:27 a.m. and at the T-9 minute mark or at 11:48 a.m. During the final hold, the flight crew and ground team receive the NASA Launch Director's and the Mission Management Team's final "go" for launch.

Milestones after the T-9 minute mark include start of the ground launch sequencer; retraction of the orbiter access arm at T-7 minutes, 30 seconds; start of the orbiter's auxiliary power units at T-5 minutes; pressurization of the liquid oxygen tank inside the external tank at T-2 minutes, 55 seconds; pressurization of the liquid hydrogen tank at T-1 minute, 57 seconds; and the electronic "go" to Atlantis' onboard computers to start their own terminal countdown sequence at T-31 seconds. The orbiter's three main engines will start at T-6.6 seconds.

#### COUNTDOWN MILESTONES Launch - 3 Days (Monday, June 22)

Prepare for the start of the STS-50 launch countdown and perform the call-to-stations at the T-43 hour mark. Countdown will begin at 8:00 a.m. All members of the launch team will report to their respective consoles in Firing Room 3 of the Launch Control Center for the start of the countdown.

# Launch - 2 Days (Tuesday, June 23)

Enter first planned built-in hold at T-27 hours for a duration of four hours.

Check out backup flight system and review flight software stored in mass memory units and display systems. Load backup flight system software into Columbia's general purpose computers.

Begin stowage of flight crew equipment. Inspect the orbiter's mid and flight decks and remove crew module platforms. Start external tank loading preparations and prepare Shuttle main engines for main propellant tanking and flight. Complete Spacelab trace contaminant purge.

Resume countdown. Start preparations for servicing fuel cell storage tanks and begin final vehicle and facility closeouts for launch.

Clear launch pad of all personnel and begin loading liquid oxygen and liquid hydrogen reactants into Columbia's fuel cell storage tanks and the EDO pallet tanks in the payload bay.

After the loading operation, the pad will be reopened for normal work and orbiter and ground support equipment closeouts will resume.

Enter planned built-in hold at T-19 hours for a duration of 12 hours.

Demate orbiter mid-body umbilical unit used during fuel cell loading.

### Launch - 1 Day (Wednesday, June 24)

Resume countdown. Activate orbiter communications systems, flight control and navigation systems. Install mission and payload specialist seats in crew cabin. The tail service masts on the mobile launcher platform will be closed out for launch.

Enter planned hold at T-11 hours for a duration of 13 hours and 47 minutes.

Perform orbiter ascent switch list in crew cabin. During this hold, the orbiter's inertial measurement units will be activated and kept in the "warm up" mode and film will be installed in the numerous cameras on the launch pad. In addition, safety personnel will conduct a debris walkdown and the pad sound suppression system water tank will be filled.

The Rotating Service Structure will be moved to the park position during this hold at about 11:00 a.m.

Resume Countdown. Install time critical flight crew equipment and perform the pre-ingress switch list. Start fuel cell flow-through purge.

### Launch Day (Thursday, June 25)

Activate orbiter fuel cells. Configure communications at Mission Control Houston for launch. Clear the blast danger area of all non-essential personnel and switch Atlantis' purge air to gaseous nitrogen.

Enter one-hour planned built-in hold at T-6 hours.

Resume countdown. Launch team verifies there are no violations of launch commit criteria prior to cryogenic servicing of the external tank. Clear pad of all personnel. Start loading the external tank with cryogenic propellants. Loading is scheduled to begin at 3:47 a.m.

Complete filling the external tank with its flight load of liquid hydrogen and liquid oxygen propellants. Perform open loop test with Eastern Space and Missile Center and conduct gimbal profile checks of orbital maneuvering system

engines.

Perform inertial measurement unit preflight calibration and align Merritt Island Launch Area tracking antennas.

Enter two hour hold at T-3 hours. Wake flight crew. Closeout crew and ice inspection team proceeds to Launch Pad 39-A.

Resume countdown at T-3 hours. Complete closeout preparations in the white room and cockpit switch configurations. Crew departs Operations and Checkout Building for the pad.

Flight crew enters orbiter. Astronauts perform air-to-ground voice checks with Mission Control Houston. Close Columbia's crew hatch. Begin Eastern Space and Missile Center final network open loop command check, perform hatch seal and cabin leak checks, and begin the inertial measurement unit preflight alignment and range safety closed loop test. The white room is closed out and the closeout crew moves to fallback area. Primary ascent guidance data is transferred to the backup flight system.

Enter planned 10-minute hold at T-20 minutes. NASA Test Director conducts final briefing

Resume countdown. Transition orbiter onboard computers to launch configuration and start fuel cell thermal conditioning. Close orbiter cabin vent valves. Backup flight system transitions to launch configuration.

Enter planned 10 minute hold at T-9 minutes. Launch Director and Mission Management Team complete final polls for launch.

Resume countdown.

Start automatic ground launch sequencer (T-9 minutes) Retract orbiter crew access arm (T-7:30) Start mission recorders (T-5:30) Start APU's. Arm SRB and ET range safety safe and arm devices (T-5) Start liquid oxygen drainback (T-4:55) Start orbiter aerosurface profile test (T-3:55) Orbiter transfers to internal power (T-3:30) Start MPS gimbal profile test (T-3:30) Pressurize liquid oxygen tank/retract gaseous oxygen vent arm (T-2:55) Fuel cells to internal reactants (T-2:35) Pressurize liquid hydrogen (LH2) tank (T-1:57) Deactivate SRB joint heaters (T-1:00) LPS go for start of orbiter automatic sequence (T-0:31 seconds) Ignition of Shuttle's three main engines (T-6.6 seconds) SRB ignition and liftoff (T-0)

#### SUMMARY OF HOLDS AND HOLD TIMES FOR STS-50

т-27	hours	4	hour hold	Tuesday, 12 midnight - 4:00 am
T-19	hours	12	hour hold	Tuesday, 12 noon - 12 midnight
T-11	hours	13	hour, 47 min. hold	Wednesday, 8:00 am - 9:47 pm
T-6	hours	1	hour hold	Thursday, 2:47 am - 3:47 am
т-З	hours	2	hour hold	Thursday, 6:47 am - 8:47 am
T-20	minutes	10	minute hold	Thursday, 11:27 am - 11:37 am
т-9	minutes	10	minute hold	Thursday, 11:48 am - 11:58 am

#### SUMMARY OF STS-50 LAUNCH DAY CREW ACTIVITIES

Thursday June 25:

6:30	am	Wake Up				
7:30	am	Breakfa	st/Dinner			
8:12	am	Weather	Briefing	(CDR,	PLT,	MS2)

8:12	am	Don F	'light	Equipment	(MS1,	MS2,	PS1,	PS2)
8:22	am	Don F	'light	Equipment	(CDR,	PLT,	MS2)	
8:52	am	Depar	t for	Pad 39-A				
9:22	am	Arriv	e at 🛛	White Room				
12:07	pm	Launc	h					

The seven crew members who will be launched aboard Columbia on Space Shuttle mission STS-50 are:

- Commander Richard Richards
- Pilot Kenneth Bowersox
- Mission Specialists: Bonnie Dunbar, Ellen Baker, Carl Meade
- Payload Specialists: Lawrence DeLucas, Eugene Trinh

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# KSC AND SPACE-RELATED AREA ATTRACTIONS

KSC Release No. 131-92 February 1993

The following is a listing of visitor facilities on Kennedy Space Center or nearby that are related to space exploration.

Spaceport USA, Kennedy Space Center, FL 32899 (407) 452-2121 Exploration Station: (407) 867-2959 Educators Resources Laboratory: (407) 867-4090

Spaceport USA is the KSC visitors center, operated for NASA by concessioner TW Recreational Services. It is located on NASA property, on the NASA Parkway West between the KSC Industrial Area and U.S. 1 on the mainland. The origins of a visitors center for KSC date back to the 1960s when public curiosity about the space program mushroomed. At first, only drive-through tours were permitted, but as interest continued to mount, the need for a permanent visitors center became clear. A site was selected in the mid-1960s, and in August 1967 the first official visitors center was opened. Since then it has undergone a number of expansions and upgrades.

Spaceport USA features a wide variety of exhibits and activities related to the space program, including guided bus tours of KSC and Cape Canaveral Air Force Station. Two IMAX movies, shown on a 50-by-70-foot screen in the IMAX theater, incorporate footage shot by Shuttle astronauts. "The Dream is Alive" allows the viewer to experience the sights and sounds of a Shuttle liftoff, while "The Blue Planet" takes a look at Planet Earth.

Other films are shown regularly at Spaceport USA's Galaxy Theater, including "The Boy from Mars." A Space Station Freedom exhibit is located nearby with a full-scale model depicting living and laboratory quarters aboard Freedom, complete with experiment setups and a crew shower. "Satellites and You" is a 45-minute exhibit that incorporates animatronics and audiovisual effects to show how satellites affect daily life. The Rocket Garden and outdoor exhibits contain authentic rockets and spacecraft. The Ambassador is a full-scale model of a Space Shuttle orbiter that features a walk-through exhibit of the crew compartment and cargo bay with the familiar robot arm and a space experiment package on display. A moon rock and other historical exhibits on human space flight are on display in the Gallery of Space Flight exhibit hall.

On the educational side, the Educators Resources Laboratory at Spaceport USA was established for professional teachers. It has extensive facilities to aid educators in the preparation of aerospace-related teaching materials. For students, there is the Exploration Station, featuring hands- on science demonstrations.

Admission to Spaceport USA is free. There is a nominal charge for the bus tours and the IMAX films. Reservations are required for large groups wishing to take the bus tour, for student visits to the Exploration Station, and for large groups of teachers planning to use the Educators Resources Laboratory.

Spaceport USA is open every day of the year except Christmas. It opens at 9 a.m.; closing time will vary depending the time of year, typically it is later in the summer. Launch day opening and closing times vary depending on the mission; visitors should call ahead for information.

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#### Astronauts Memorial (Space Mirror), Spaceport USA, Kennedy Space Center Built and operated by: Astronauts Memorial Foundation Inc. Mail Code: AMF Kennedy Space Center, FL 32899 (407) 268-0272

Also located at Spaceport USA is the Astronauts Memorial, or Space Mirror. The 42.5-foot-high by 50-foot-wide monument was constructed by a non-profit foundation, the Astronauts Memorial Foundation, on six acres of land provided by NASA at Spaceport USA. Engraved on the mirror-finished black granite surface of the memorial are the names of those American astronauts who have given their lives to the quest to explore space. A moving base supporting the mirror rotates on track with the sun, allowing sunlight to reflect through the astronauts' names and appearing to emblazon them against the sky. The Astronauts Memorial Foundation built the memorial primarily with funds raised from the sale of Challenger license plates in Florida. The foundation also plans to build a Center for Space Education adjacent to the visitors center. This is envisioned as a "living memorial" that will expand existing educational programs at KSC into a world-class center for space education.

Hours for the Space Mirror are the same as for Spaceport USA.

\*\*\* Astronaut Hall of Fame (407) 269-6100 U.S. SPACE CAMP Florida (407) 267-3184 Both are located at: 6225 Vectorspace Blvd. Titusville, FL 32780-8040

Space education programs varying from a few hours' visit, an overnight stay, a weekend trip to a five-day training session are offered in a joint venture of the U.S. Astronaut Hall of Fame and U.S. SPACE CAMP Florida.

The programs are headquartered in the combined facilities at 6225 Vectorspace Blvd., Titusville, off the NASA Causeway (State Road 405), just west of the entrance to Kennedy Space Center.

One of the most well-known SPACE CAMP programs introduces students to space sciences and exploration in a fiveday session of mostly hands-on activities, including propulsion exercises and astronaut training on simulators in the Training Center, as well as classroom instruction. The program culminates in a simulated Space Shuttle mission. A tour of NASA's rocket garden in nearby Spaceport USA is part of a segment on assembling and launching model rockets. The Florida program is designed for students in grades 4-7.

SPACE CAMP participants as well as day visitors to the facilities are invited to enter the U.S. Astronaut Hall of Fame which follows the lives of America's first astronauts, the Mercury 7, from their days as astronaut candidates through their historic missions in space. Videotapes of flights and interviews are shown at individual displays which also feature personal memorabilia.

The "Shuttle To Tomorrow" exhibit outside the main building is a full-scale replica of a Space Shuttle orbiter in which visitors experience a multi-screen video show with a 3-D sound system. The astronaut "adventure" includes the rumble of liftoff and a simulated space walk.

The first U.S. SPACE CAMP was established in 1982 in Huntsville, AL. The Florida camp opened in 1988 under the sponsorship of the U.S. Space Camp Foundation and the Mercury Seven Foundation, two non-profit educational organizations which encourage young people to pursue science, math and high technology studies.

Six of the original Mercury astronauts, and Betty Grissom, widow of the seventh, Virgil "Gus" Grissom, oversee the Mercury Seven Foundation which, in partnership with the Space Camp Foundation, operate the Astronaut Hall of Fame. The Mercury Seven Foundation also provides college scholarships in all areas of science and technology.

Besides the five-day camp for youths, there is a Friday- Sunday camp in Florida for parents and their children ages 7-11. Also, professional educators can attend a five-day space academy specially designed to assist teachers in motivating students toward greater achievements in math and science through the excitement of space exploration. Lodging and meals are provided on site for the camp or field trip programs.

Special field trip programs available to students in grades 3-12 are:

\* SPACE CAMP Action Tour is an approximately three-hour session designed to introduce students to space science.

\* The Space Exploration Merit Badge Weekend for Scout troops completes the requirements for the Space Exploration Merit Badge during the two-night stay.

\* Blue Sky Below My Feet Weekend participants receive a 4-H Club "Blue Sky" certificate after completion of the weekend program.

\* Outerspace Tour is designed to introduce students to space exploration through an overnight stay.

\* Final Frontier program, billed as "a complete Space Coast adventure," requires a two-night stay.

The facilities are open to visitors seven days a week from 9 to 5, closing only on Christmas Day. The hours may vary according to the season. The nominal admission charge covers a visit to the U.S. Astronaut Hall of Fame and the show in the Shuttle orbiter replica. The cost varies for the camp programs and field trips.

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### Merritt Island National Wildlife Refuge & Canaveral National Seashore, Kennedy Space Center Refuge information: Refuge Manager Merritt Island National Wildlife Refuge P.O. Box 6504 Titusville, FL 32782 Refuge: (407) 861-0667 Seashore information: Canaveral National Seashore Headquarters 308 Julia St. Titusville, FL 32796-3521 Seashore Headquarters (Titusville): (407) 267-1110 Seashore Visitor Information Center (New Smyrna): (904) 428- 3384

Much of the 140,000 acres comprising KSC is a wildlife refuge. Launch pads, as well as facilities where hazardous rocket propellants are processed, must be located well away from inhabited areas. When KSC was first established, NASA bought all of northern Merritt Island to provide the needed isolation, leaving huge tracts of undeveloped land in their natural condition. In 1963, in cooperation with NASA, the U.S. Fish and Wildlife Service established the Merritt Island National Wildlife Refuge. Canaveral National Seashore was created in 1975 and is managed by the National Park Service. The refuge is one of the finest in the United States, while the seashore boasts the last extended stretch of undeveloped beach on Florida's east coast.

**Refuge:** Refuge headquarters and a visitor information center are located on KSC, on SR 402 four miles east of Titusville. Talks, exhibits and walks are offered on a seasonal basis. There are several self-guided walking trails and one driving trail on the refuge. Each Christmas the Audubon Society conducts a count of the abundant bird population, many of which have migrated from points north. Fishing and duck hunting are permitted in season in certain areas; restrictions apply.

There is no charge for visiting either the refuge or visitor information center. Hours vary depending on the time of year:

\* **Refuge visitors center**: November through April, 8 a.m.- 4:30 p.m., Monday through Friday, and 9 a.m.-5 p.m, Saturday and Sunday. May through October, hours are same as above, except closed Sundays;

\* **Refuge**: Open during daylight hours.

**Seashore:** Co-located with the refuge on KSC is Canaveral National Seashore, a pristine stretch of undeveloped beach extending from just north of Pad 39B to a little south of New Smyrna Beach. Swimming, surfing and surf-fishing are permitted. There are no lifeguards. Elsewhere, crabbing, clamming and shrimping are popular activities; fishing may require a state license. Boat-launching sites provide access to Mosquito Lagoon and the Indian River. There are two backcountry campsites along a self-guided canoe trail about two miles long which circles through the seashore area south of Turtle Mound. Other backcountry sites are located on islands in Mosquito Lagoon and on the beach (winter only).

The beach is open free of charge. Beach hours match up with daylight saving time:

\* 8 a.m.-6 p.m., from the last Sunday in October until the first Sunday in April; 6 a.m.-8 p.m. from the first Sunday in April until the last Sunday in October.

Headquarters for the seashore are located at 308 Julia Street in downtown Titusville. Hours are 8 a.m. to 4:30 p.m. Monday through Friday.

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#### Air Force Space Museum, Cape Canaveral Air Force Station For information: Museum Curator 45 SPW/PAC Patrick Air Force Base, FL 32925 Call (407) 494-NEWS (494-6397, recording)

The Air Force Space Museum on Cape Canaveral Air Force Station encompasses both Air Force and NASA facilities. It is located off Lighthouse Road, about 1 mile east of Samuel Phillips Parkway (formerly Cape Road). The museum is staffed by volunteers and operated by the 45th Space Wing and the USAF Museum Program. Two historic launch complexes, Complex 26 and Complex 5/6, are located here. Complex 26 was the site of the first successful American satellite launch (Explorer I) in 1958. The blockhouse and exhibit hall next door are open to visitors. An extensive display of rockets is located behind the blockhouse. South of Complex 26 is Complex 5/6, site of Mercury astronaut Alan Shepard's historic suborbital flight in 1961. NASA oversees this complex.

Admission to the museum is free; donations are welcome to support upkeep on the historic rockets and launch facilities. Employees and the general public may visit the museum on Saturday and Sunday from 10 a.m. to 4 p.m. Visitors must enter Gate 1 on Cape Canaveral Air Force Station north of the Beeline Expressway (528) and Highway A1A. They will be given a visitors pass at the gate. Visitors are advised to call first for an update on museum hours, as it may be closed in the event of launch operations on the Cape.

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Astronaut Memorial Space Science Center Brevard Community College 1519 Clearlake Road Cocoa, FL 32922 (407) 631 7889 or (407) 632 1111 oxt 3500

# (407) 631-7889 or (407) 632-1111, ext. 3500

The Astronaut Memorial Space Science Center on the Cocoa campus of Brevard Community College (BCC) on weekends offers planetarium and laser light shows as well as an observatory with Florida's largest viewing telescope

open to the public.

The observatory features a 24-inch viewing telescope, as well as seven other telescopes. Brevard Community College staff members are on hand to guide telescope users.

The observatory is open on Friday and Saturday nights from dusk to 10 p.m., weather permitting. A planetarium show in the building's theater is presented on those nights at 8 p.m. A laser light show with music is held at 9 and 10 p.m., both nights. The lobby is open daily. The lobby displays photographs of the early U.S. astronauts as well as original photographs of astronomy-related subjects.

There is no admission fee to the observatory; there is a nominal charge for the planetarium and laser light shows.

# GO TO THE <u>KSC FACT SHEETS</u> HOME PAGE



August 7, 1992 KSC Contact: Bruce Buckingham KSC Release No. 107-92

### ATLANTIS SCHEDULED TO LAND AT KSC

The orbiter Atlantis is scheduled to land at Kennedy Space Center on Saturday, Aug. 8, after spending eight days in space on Shuttle mission STS-46. The landing will mark the conclusion of the orbiter's 12th mission which began at KSC on July 31. Landing had previously been slated for Friday, but was delayed a day due to mission related concerns.

Landing of Atlantis at KSC's Shuttle Landing Facility (SLF) is currently slated for 7:39 a.m. eastern time on orbit 126. Landing will occur at mission elapsed time of 7 days, 21 hours and 42 minutes. Deorbit burn will occur on orbit 125 at about 6:45 a.m. at 7 days, 20 hours and 48 minutes.

There is a second landing opportunity at KSC Saturday at 9:12 a.m. on orbit 127. Two landing opportunities are also available at KSC on Sunday, Aug. 9, at 7:21 a.m. and 8:55 a.m.

If weather prohibits a landing at Kennedy, landing opportunities are also available at Edwards Air Force Base, Ca., on Saturday and Sunday. Times for a possible touchdown in California are: Saturday, 9:04 a.m. and 10:38 a.m. EDT; Sunday, 10:20 a.m. EDT.

During descent, Atlantis will enter Florida airspace north of the gulf coast city of Crystal River and travel east across the state. Atlantis will continue across Florida, passing over Orlando and Titusville before landing at KSC's Shuttle Landing Facility.

The orbiter will pass over Crystal River about 9 minutes before touchdown at an altitude of about 119,000 feet and traveling at a speed of Mach 5.

### **Shuttle Landing Facility**

The SLF was built in 1975. It is 300 feet wide and 15,000 feet long with 1,000 foot overruns at each end. The strip runs northwest to southeast. It is located about 3 miles northwest of the Vehicle Assembly Building.

The up-coming landing of Atlantis, if weather permits, will be the eleventh landing at KSC in the 11-year history of Space Shuttle flight.

#### Previous landings at KSC

- 41-B Challenger, Feb. 11, 1984
- 41-G Challenger, Oct. 13, 1984
- 51-A Discovery, Nov. 16, 1984
- 51-C Discovery, Jan. 27, 1985
- 51-D Discovery, April 19, 1985
- STS-38 Atlantis, Nov. 20, 1990

- STS-39 Discovery, May 6, 1991
- STS-43 Atlantis, Aug. 11, 1991
- STS-45 Atlantis, April 2, 1992
- STS-50 Columbia, July 9, 1992

# Landing Weather Constraints

General weather restrictions for a KSC landing are specified in part as:

\* Surface winds must be less than 20 knots in any direction, and less than 12 knots for crosswinds;

\* The ceiling must be greater than 10,000 feet. For scattered clouds below 10,000 feet, cloud cover must be observed to be less than 20 percent at the deorbit burn go/no go decision time;

- \* Visibility must be seven miles or greater;
- \* There can be no precipitation at the surface or aloft in the proximity of the orbiter;

\* Thunderstorms, rain or the potential for lightning cannot exist within 30 nautical miles of the landing site;

\* Vertical cloud clearance at the 30 nautical mile range must be greater than 2 nautical miles.

# **KSC Ground Operations**

Once the orbiter is on the ground, safing operations will commence and the flight crew will prepare the vehicle for post- landing operations. For this mission and all following missions, a new transport vehicle will be used to assist the crew, allowing them to egress the vehicle and doff their launch and re-entry suits easier and quicker. This vehicle, called the Crew Transport Vehicle, or CTV, was purchased from Continental Airlines at Denver for use at KSC. A similar CTV is used to assist crew egress at the conclusion of missions landing at Edwards Air Force Base, Ca.

The CTV and other KSC landing convoy operations have been in an "on-call" status since the launch of Atlantis on July 31. The primary functions of the Space Shuttle recovery convoy are to provide immediate service to the orbiter after landing, prepare the orbiter for towing to the Orbiter Processing Facility and assist crew egress.

Convoy vehicles are stationed at the SLF's mid-point. About two hours prior to landing, convoy personnel don SCAPE suits, or Self Contained Atmospheric Protective Ensemble, and communications checks are made.

A warming up of coolant and purge equipment is conducted and nearly two dozen convoy vehicles are positioned to move onto the runway as quickly and as safely as possible once the orbiter coasts to a stop. When the vehicle is deemed safe of all potential explosive hazards and toxic gases, the purge and coolant Umbilical Access Vehicles move into position at the rear of the orbiter.

Following purge and coolant operations, flight crew egress preparations will begin and the CTV will be moved into position at the crew access hatch located on the orbiter's port side.

Once access to the vehicle is gained, a physician will board the Shuttle and conduct a brief preliminary examination of the astronauts. The crew will then make preparations to leave the vehicle.

About 3 hours after landing, the orbiter will be towed to Orbiter Processing Facility bay 2 for post-flight deservicing. Preparations will also begin to ready Atlantis for its ferry flight later this year to Palmdale, Ca., where it will be taken out of service for about one year while it undergoes scheduled modifications and refurbishments.

Following departure from the SLF, the seven astronauts will be taken to their quarters in the O&C Building, meet with their families, undergo additional physical examinations and depart for the skid strip at Cape Canaveral Air Force Station for their flight back to JSC.

The crew plans to depart for JSC roughly 5 to 6 hours after landing. The exact time of departure will be determined following touchdown.

In the event a landing at KSC is not feasible and Atlantis lands at Edwards, an augmented KSC convoy team will be at the California site to safe the vehicle, disembark the crew and move the orbiter to the Mate/Demate Device. The turnaround team will be deployed to Edwards by charter aircraft on landing day.



August 27, 1992 KSC Contact: Bruce Buckingham KSC Release No. 115-92

# NASA TECHNOLOGY ASSISTANCE PAYS OFF FOR SOUTHWEST FLORIDA COUNTY

A decade ago Charlotte County, Fla., was appraising its thousands of acres of citrus groves much like they and other Florida counties had been doing for years -- physically counting each and every individual tree. But over the past 10 years, this sleepy gulf coast community has come to recognize the benefits of space technology by implementing an infrared appraisal process that is now saving the taxpayers of Charlotte Country \$100,000 a year.

Instead of sending men into the groves with counters, high flying aircraft fitted with infrared scanners are doing all the leg work. Assessments that used to take seven months to complete are now being done in less than seven weeks, and the savings are being transferred directly to the taxpayers.

"It was increasingly difficult to complete the appraisals of our then 8,000 acres and still submit a timely appraisal to the State of Florida," said Oliver Lowe, Charlotte County Property Appraiser. "I knew there had to be a better, more economical way."

The idea of using the NASA-derived technology to count and assess the health of citrus trees appealed to Lowe and his staff after they saw some examples of infrared photography. They knew it would assist them in appraising the taxable value of citrus groves.

"We decided to get aerial photos of our orange groves using color infrared photography," Lowe said at a demonstration of the technology last week in Port Charlotte, Fla. The interest from citrus growers and Country managers that came on the heels of the concept was incredible.

In 1982, Dr. Carlos Blazquez of the University of Florida Citrus Research and Education Center heard of Charlotte County's endeavors and offered his assistance. A world renowned expert in infrared photography, his expertise proved an invaluable asset.

The first flights over the Charlotte County groves using infrared photography occurred in 1983. Not only did the data reveal how many trees existed in the groves, but it told which ones were not healthy and should not even be tallied in the assessment process.

"We were amazed at what we were able to see," Lowe said. "And we quickly found out that we were able to greatly speed up our annual appraisal process."

With the preliminary infrared photography system well in use, Dr. Blazquez began to speak with his many contacts in the infrared photography and computer fields. His search led him to NASA at Kennedy Space Center.

Now, 10 years later, the County, with NASA's assistance, is moving away from the simple light table operation where the individual trees are counted by hand from the infrared photographs, to a highly specialized computer counting and analysis system. This system will do all the counting and determine the health of the trees automatically.

Dave Roberts, NASA's chief engineer on this project, said this computerized system is more accurate than having a person actually go out into the groves and count the trees or having someone sit and count trees at a light table. "Computers are so stupid they don't get bored," Roberts said. "They are relentless in their counting."

This system is especially helpful now that Charlotte County's citrus production area has tripled from 8,000 acres to almost 25,000 acres.

Surrounding counties are also interested in what Charlotte County is doing, especially those with 100,000-plus acres of groves to assess each year.

In 1990, five Florida counties -- Highlands, St. Lucie, Indian River, Manatee and Palm Beach -- banded with Charlotte County to help fund a computerized, automatic tree counting system.

A subsequent contract was worked out with KSC's Office of Technology Utilization and the six-county group and NASA agreed to lay out a total of \$50,000 to set up the initial computer counting system.

The NASA-developed technology will not only count citrus trees but will detect the presence of disease and the deterioration of crops.

"If there is a question about a specific tree, the computer can single it out and reveal any problems," said Blazquez.

This same computer technology has been used to count and analyze timber for many years in mid-western states. Eventually, the six Florida counties plan to use satellite remote sensing to obtain the infrared data rather than depend on the aerial photography. This will save even more money over time.

But the greater advantage, according to NASA and Lowe, is being able to look at the productive canopy of the groves and make the proper assessments based on that information. More productive areas would no longer be given the same status as the less productive areas. The infrared photography is also able to identify poor soil and stressed regions that may never produce an abundant crop. The bottom line: a more economical use of tax dollars, with each grower treated equally.

"We owe a lot to everyone who has helped us along the way, and NASA has been one of the great partners in this case. They are to be commended for the time and energy they have put into this project," Lowe said. "We have only touched the tip of the iceberg of what infrared photography and NASA technology can do for us."

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August 28, 1992 KSC Contact: Bruce Buckingham KSC Release No. 117-92

# KSC JOINS IN RELIEF EFFORT FOR HURRICANE ANDREW VICTIMS

A convoy of 12 trucks and cars packed with durable goods left Kennedy Space Center this morning en route to South Florida to assist residents hit hardest by Hurricane Andrew.

Hurricane Andrew swept through areas south of Miami earlier this week with relentless devastation, leaving more than 250,000 people homeless.

Because of the great outcry for assistance, NASA and its KSC contractors began mobilizing to do whatever possible to assist those left hungry, hurting and homeless.

Three 5,000-gallon water tankers led the convoy on the five- hour drive followed by two 40-foot tractor trailers loaded with an assortment of relief items for the people of South Florida. Included on the trucks are: meal packets, sleeping cots, blankets, mattreses, tents, tables, shelves, chairs, generators, plywood, rope, wire fencing, tool boxes, a three-ton hoist and a variety of clothes and shoes.

"It's all excess material over and above what we are required to keep here at the center for our own hurricane plan," said NASA's Mike Stevens of the Fire and Rescue Office.

The convoy will establish the initial drop center for future relief efforts.

Cal Staubus, NASA's Fire and Rescue Office chief, said, "at this time we are piggybacking our operation with that of the Titusville Chapter of the Salvation Army. They already have a network established to dispatch the supplies."

The group, made up of about 16 NASA and contractor employees, will dispatch the wares from a designated staging area to locations the Salvation Army says is in most need. Everything will be given away.

Staubus said two of the water tankers have already been allocated to area hospitals.

"The tanker drivers accept the possibility that their stay may be longer than expected," Staubus said. "They may be asked to continue to refill them for quite a while. We're not sure when the tankers themselves will be returned."

Forklift operator, Ralph Brown, EG&G, said he was given an armful of toys from friends when they learned he was driving one of the convoy trucks. "It's a chance to help somebody," he said. "I even went down to Winn Dixie last night myself and bought a bunch of baby food so I could hand it out. It feels good to be able to help."

Scores of other KSC employees also assisted in the effort to ready the water tankers and trucks. Included are those who loaded the supplies on the trucks and those who tested the water in the tankers to ensure its purity.

Already, KSC has been organizing drop points at all major KSC facilities for the collection of additional supplies to be taken to Hurricane Andrew victims.



September 1, 1992 KSC Contact: Bruce Buckingham KSC Release No. 119-92

# KSC CONTINUES RELIEF EFFORT FOR HURRICANE ANDREW VICTIMS

Employees at Kennedy Space Center are uniting in their efforts to assist Hurricane Andrew victims in South Florida by donating food, supplies and cash.

KSC is encouraging its 20,000-plus employees to bring in additional supplies to various drop points around the center so they can be properly packaged for delivery to those areas hit hardest by the storm.

Items employees are being asked to bring include all types of baby products and food, meal-type canned foods, an assortment of camping gear, large family-size tents, flashlights, batteries, can openers, trash bags and personal hygiene items.

Lou Phillips, a packaging specialist for NASA, is assisting in the effort to properly package the items being brought in for South Florida residents. "We will be spending the next day making food packs for small, medium and large families so they can be handed out easily," Phillips said. "We will also be sending a lot of excess building materials that we have on hand here at KSC."

Materials from KSC employees will be gathered through tomorrow in time for a convoy of at least three 40-foot long flat-bed trucks to leave KSC Thursday morning. Contributions coming in after Wednesday will be transported to South Florida later.

Cash donations are also being accepted through a special KSC fund established with the Salvation Army in Titusville.

The effort to collect needed items will continue throughout the next several weeks.

Last week a convoy of nearly a dozen trucks and cars packed with durable goods left Kennedy Space Center en route to South Florida to assist residents hit hardest by Hurricane Andrew.

NASA and its KSC contractors began mobilizing soon after the storm passed to do whatever possible to assist the nearly 250,000 people left homeless and hungry in Andrew's wake.

Friday morning, Aug. 28, three 5,000-gallon water tankers led the convoy on the five-hour drive, followed by two 40foot tractor trailers loaded with an assortment of relief items for the people of South Florida. Included on the trucks were: meal packets, sleeping cots, blankets, mattresses, tents, tables, shelves, chairs, generators, plywood, rope, wire fencing, tool boxes and a three-ton hoist.

The water tankers will remain in the Homestead, Fla. area for an indefinite period of time.

Everything sent down last week was excess material over and above what is required to be kept at KSC for the center's own hurricane plan.

"The group, made up of about 16 NASA and contractor employees, dispatched the wares from a darkened Homestead Pizza Hut parking lot late Friday night," said Cal Staubus, NASA's Fire and Rescue Office chief and convoy commander. "Everything was given away."

On Aug. 26, six EG&G Florida Fire Services personnel headed down to Miami to assist local emergency personnel with rescue efforts. They took with them a rescue/extraction vehicle from KSC. While there, the crews assisted with search and rescue, emergency response, and hospital field work efforts.

This team was among the first outside fire/rescue personnel to respond to the need. They are providing around-theclock assistance on a continual basis.

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October 19, 1992 KSC Contact: Bruce Buckingham KSC Release No. 143-92

#### Notice to Editors/News Directors NASA/KSC NEWS RELEASES TO INCLUDE METRIC REFERENCES

As a part of the agency's continued effort to transition to the Metric system, all units of measurement mentioned in press releases and status reports originating from NASA Headquarters and NASA field centers will include metric values.

According to Public Law 100-418 and Executive Order 12770, NASA and other government agencies are directed to implement and use the metric system of measurement by 1995. In addition, all NASA programs approved after October 1990 will be referenced in metric, according to the Executive Order.

To minimize news media/public confusion during the changeover, agency publications will use the traditional English inch-pound measurement first. This will be followed parenthetically by the corresponding metric measurement.

As news media/public acceptance of the metric system progresses, the policy will be changed to use the metric value first with the corresponding English inch-pound following in parentheses. Eventually, the traditional measurements will be eliminated completely.



October 19, 1992 KSC Contact: Bruce Buckingham KSC Release No. 146-92

### TDRS-F/IUS-13 COMPLETES KEY TESTS

The Tracking and Data Relay Satellite (TDRS-F), scheduled to be launched on Shuttle mission STS-54, completed two significant tests last week while in the Vertical Processing Facility at Kennedy Space Center.

On Oct. 14-15, the spacecraft, the sixth of its kind to be launched aboard the Shuttle, successfully completed an Interface Verification Test (IVT) between the satellite and the Inertial Upper Stage (IUS) booster. The IVT, a 30-hour-long systems test, revealed no problems with the electrical or mechanical connections between the TDRS and the IUS. The test also confirmed the ability of the two components to communicate with each other and with the Space Shuttle vehicle. The TDRS was mated to the IUS on Oct. 5.

Following the IVT, Roelof Schuiling, the TDRS Payload Manager, said, "we are continuing on schedule and found nothing that will cause us to deviate from our current timeline."

Also last week, the spacecraft successfully passed the all encompassing "End-to-End" test, a network communications test designed to reveal any specific areas of concern with the satellite and its ground controlling stations. The test involved the spacecraft and the IUS booster; the IUS control facility at the Air Force Consolidated Space Test Center in Sunnyvale, Ca.; the TRW plant in Redondo Beach, Ca., where TDRS was manufactured; the TDRS ground station at White Sands, N.M.; Goddard Space Flight Center, Greenbelt, Md., the primary network operations center for TDRS; Space Shuttle mission control at Johnson Space Center, Tx.; the MILA tracking station at KSC; and the TDRS checkout station at Hanger AO and the IUS checkout station, both on Cape Canaveral Air Force Station.

The test checked the configuration of the satellite and its controlling NASA centers, allowing for simulated control of the spacecraft in the orbiter's payload bay and in its eventual orbit in space.

The end-to-end test was completed Oct. 17 without any surprises, prompting Schuiling to reiterate that the spacecraft is in good health and work is on schedule.

This week, TDRS and IUS will be powered up for additional power-on tests as preparations continue to ready the spacecraft and booster for delivery to pad 39-B in mid-November.

TDRS-F is scheduled to be launched aboard the Shuttle Endeavour in January 1993.



November 10, 1992 KSC Contact: Bruce Buckingham KSC Release No. 153-92

#### **KSC FEATURE STORY IDEAS -- NOVEMBER 1992**

#### **Processing Continues on Next Year's Shuttle Payloads**

Even though there is one more Shuttle launch this year, next year's buffet of American and international payloads to be launched aboard the Space Shuttle are in various stages of preparation at KSC. Some are first-time flyers and others will be continuing a healthy program of flights aboard the Shuttle as NASA's international partners in space. These include the second German Spacelab module to fly on the Shuttle; the ATLAS-2, a pallet and igloo of experiments; and the second Space Life Sciences spacelab module. In addition, the first Spacehab payload to be flown on the Shuttle will arrive at KSC in January.

(Public Affairs Contact: Lisa Malone)

#### KSC Open House Set for Nov. 21

In celebration of the International Space Year, KSC is hosting an open house for all of its employees and their families on Nov. 21. The feature attraction is expected to be the Space Shuttle Endeavour, which is scheduled to be rolled from the Orbiter Processing Facility to the Vehicle Assembly Building transfer aisle where it will be on display. Thousands of KSC employees and family members are expected to visit KSC and view Endeavour. They will also be permitted to drive around Shuttle launch pad 39-B, visit the Launch Control Center, the Shuttle Landing Facility, the Thermal Protection System Facility, the Solid Rocket Booster Assembly and Refurbishment Facility and the NASA News Center. Also open to visitors will be a solid rocket booster recovery ship to be located at the turn basin adjacent to the News Center.

(Public Affairs Contact: Bruce Buckingham)

### KSC Business Opportunities Expo '92

The KSC Business Opportunities Expo '92 is scheduled to be held on November 10 from 9:00 a.m. until 3:00 p.m. at Cruise Terminal No. 5, Port Canaveral, Fla. This is a premier matchmaker expo co-sponsored by the KSC Small Business Council and the Canaveral Port Authority. Coordinators hope to bring together prime contractors, large corporations and government agencies and acquaint buyers and technical representatives with alternative sources of supplies and services. Over 200 exhibitors are expected to be on hand.

(Public Affairs Contact: Lisa Malone)

### KSC to Collect Christmastide Donations for Charity

Center Director Bob Crippen has invited all Government and contractor employees at KSC to participate in the Christmastide Program -- an effort to assist needy individuals and families in Brevard. This year no clothing, toys or food are being collected. Instead, only monetary donations will be presented to the Salvation Army for distribution

throughout the County. This is but one of many ways KSC employees contribute to those less fortunate.

(Public Affairs Contact: Bruce Buckingham)

# KSC Leads in the Development of New Protective Coatings

KSC is spearheading the industry in developing a revolutionary protective coating to safeguard metals such as steel and aluminum and which could have unlimited possibilities in the private sector. These coatings will be used on the Shuttle launching pads and various support equipment to guard against the corrosive effects of launch and the seaside environment. This primer coating could have applications for off-shore oil rigs, automobile parts, underground tanks, bridges and aerospace structures. Several leading coating industries have recently bid on a contract to develop the highly sought-after commercial product.

(Public Affairs Contact: Lisa Malone)

# **New Freon Recovery System**

KSC is working with a new recovery system used to capture unused freon from Space Shuttles following their mission and return to KSC. Freon is used for the cooling of orbiter electronic avionics, payloads and the crew module. Due to information that indicates freon is harmful to the environment, proper disposal is practiced at KSC.

(Public Affairs Contact: Bruce Buckingham)

# **CELSS Continues Crop Studies**

A NASA team has recently harvested nearly 500 pounds of potatoes from KSC's Controlled Ecological Life Support Systems (CELSS) laboratories. The hydroponically grown potatoes are part of a study being conducted by NASA and The Bionetics Corp. to study the most effective ways to grow food plants in space.

(Public Affairs Contact: Mitch Varnes)

### **KSC FY 92 Socioeconomic Goals**

Final results have been received from NASA Headquarters relative to the FY92 socioeconomic goals established by NASA for Small and Small Disadvantaged Business opportunities and Kennedy Space Center has gone above and beyond what was expected of the center. KSC exceeded all goals as indicated: Small Business -- 117 percent; Small Disadvantaged Business -- 117 percent; and Women-Owned Business -- 133 percent.

(Public Affairs Contact: Lisa Malone)

# Kennedy Innovations to be Displayed at "Technology 2002"

Four KSC research topics will be presented at the third annual technology transfer conference scheduled to be held in Baltimore on Dec. 1-3. "Technology 2002" is a NASA-sponsored event that will include exhibits and the presentation of papers. KSC's areas include "Information and Communications," "Energy and Environment," "Artificial Intelligence," and "Sensors and Signal Processing."

(Public Affairs Contact: Lisa Malone)