NASA Facts

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Marshall Space Flight Center
Huntsville, Alabama 35812

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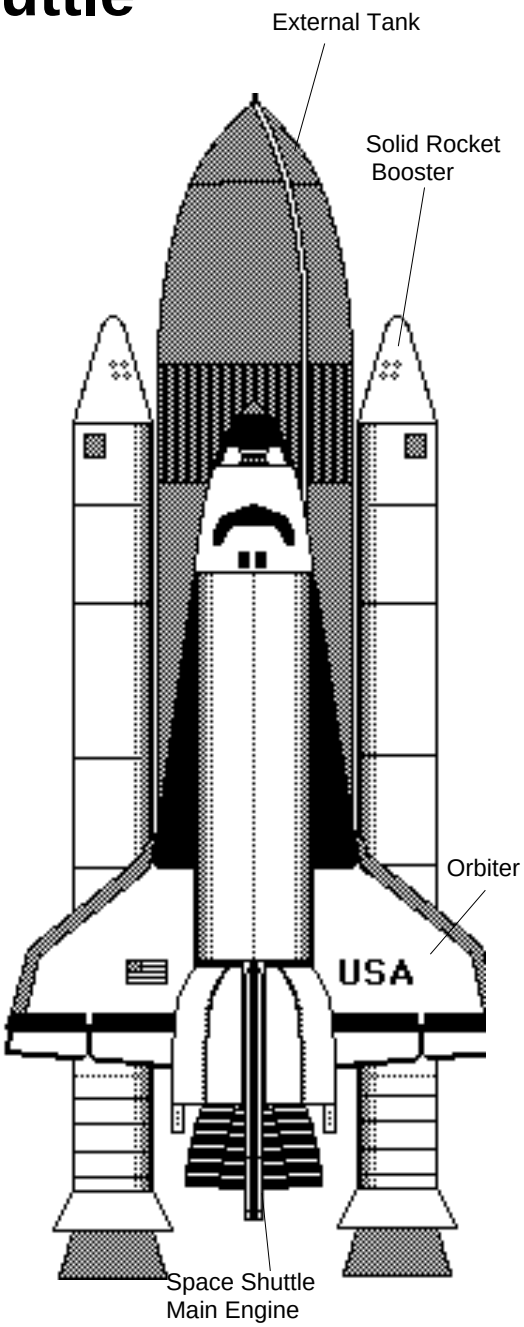
A Walk Around the Space Shuttle



The Space Shuttle's superlative design provides capabilities and a flexibility unmatched by any other launch system. Here is what makes it work. The Shuttle's major components are: the orbiter spacecraft; the three main engines, with a combined thrust of more than 1.2 million pounds(5.4 million newtons); the huge external tank (ET) that feeds the liquid hydrogen fuel and liquid oxygen oxidizer to the three main engines; and the two solid rocket boosters (SRBs), with their combined thrust of some 5.8 million pounds (25.9 million newtons), which provide most of the power for the first two minutes of flight. The SRBs take the Space Shuttle to an altitude of 28 miles (44.8 kilometers) and a speed of 3,094 miles (4950.4 kilometers) per hour before they separate and fall back into the ocean to be retrieved, refurbished, and prepared for another flight. After the solid rocket boosters are jettisoned, the orbiter's three main engines, fed by the external tank, continue to provide thrust for another six minutes beforethey are shut down, at which time the giant tank is jettisoned and falls back to Earth, disintegrating in the atmosphere.

The Space Shuttle Orbiter

The orbiter is both the brains and heart of the Space Transportation System. About the same size and weight as a DC-9 aircraft, the orbiter contains the pressurized crew compartment (which can normally carry up to seven crew members), the huge cargo bay, and the three main engines mounted on its aft end. The thermal tile system which protects the orbiter during its searing reentry through the atmosphere was a breakthrough technology that proved much more

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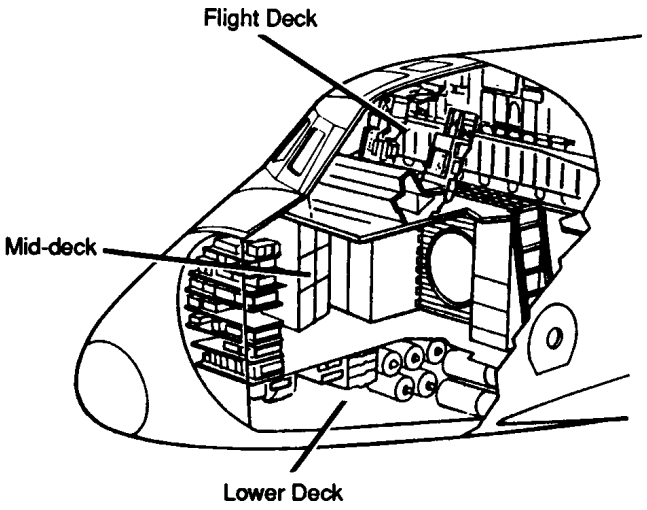
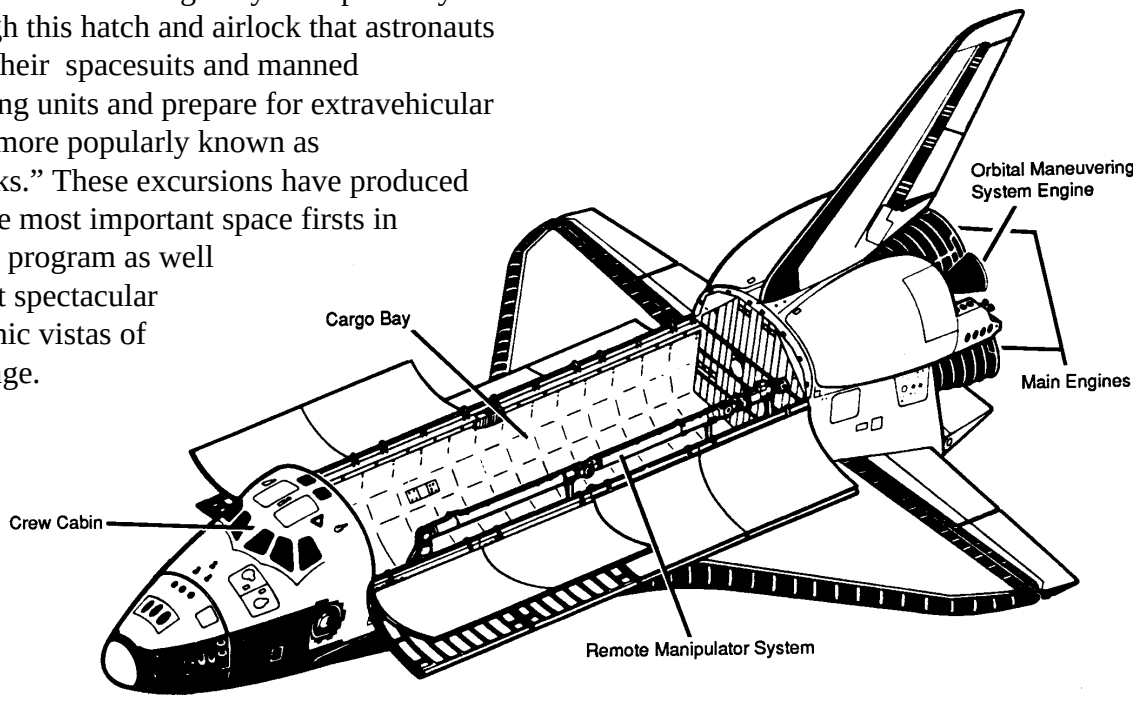
challenging than expected. There are three levels to the crew cabin. Uppermost is the flight deck where the commander and the pilot control the mission, surrounded by an array of switches and controls. During the launch of a seven-member crew, two other astronauts are positioned on the flight deck behind the commander and pilot. The



three other crew members are in launch positions in the mid-deck, which is below the flight deck. There are three levels to the crew cabin. The mid-deck is where the galley, toilet, sleep stations, and storage and experiment lockers are found for the basic needs of weightless, daily living. Also located in the mid-deck are the side hatch for passage to and from the vehicle before and after landing, and the airlock hatch into the cargo bay and space beyond. It is through this hatch and airlock that astronauts go to don their spacesuits and manned maneuvering units and prepare for extravehicular activities, more popularly known as "spacewalks." These excursions have produced some of the most important space firsts in the Shuttle program as well as the most spectacular photographic vistas of the space age.

Below the mid-deck's floor is a utility area for the air and water tanks and their ducts.

The Space Shuttle's cargo bay is adaptable to hundreds of tasks. Large enough to accommodate a tour bus (60 x 15 feet or 18.2 x 4.6 meters), the cargo bay instead carries satellites, spacecraft , and Spacelab scientific laboratories to and from Earth orbit. It is also a work station for astronauts to repair satellites, a foundation from which to erect space structures, and a hold for retrieved satellites to be returned to Earth. Mounted on the port side of the cargo bay behind the crew quarters is the remote manipulator system (RMS). The RMS is a robot arm and hand with three joints analogous to those of the human shoulder, elbow and wrist. It is operated from the aft station of the orbiter's flight deck. The RMS, some 50 feet long, can move anything from satellites to astronauts to and from the cargo bay or to different points in nearby space.Thermal tile insulation and blankets (also known as the thermal protection system or TPS) cover the underbelly, bottom of the wings, and other heat-bearing surfaces of the orbiter and protect it during its fiery reentry into the Earth's atmosphere. Designed to be used for 100 missions before replacement is necessary, the Shuttle's 24,000 individual tiles are made primarily of pure-sand silicate fibers, mixed with



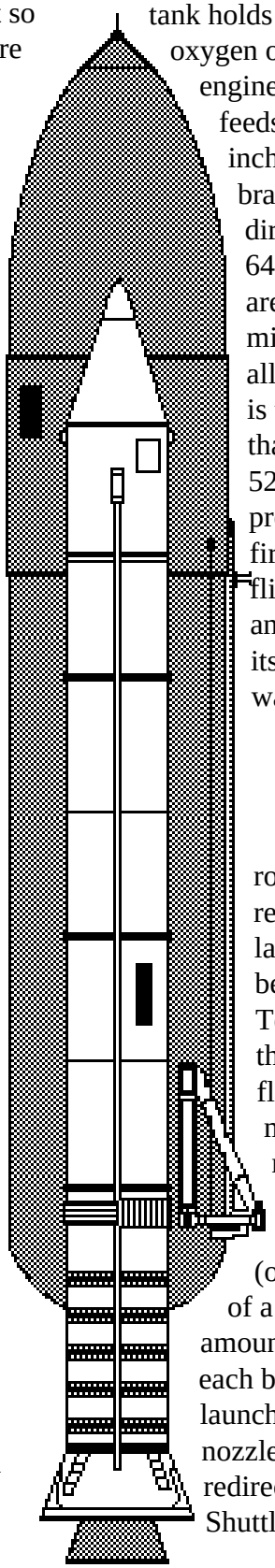
a ceramic binder. Incredibly lightweight, about the density of balsa wood, they dissipate the heat so quickly that a white-hot tile with a temperature of 2,300 degrees Fahrenheit (1,260 degrees Celsius) can be taken from an oven and held in bare hands without injury.

The Main Engines and Orbital Propulsion Systems

The three main engines are clustered at the aft end of the orbiter and have combined thrust of more than 1.2 million pounds (5.4 million newtons) at sea level. They are high performance, liquid propellant rocket engines whose thrust can be varied over a range of 65 to 109 percent of their rated power level. They are the world's first reusable rocket engines, designed to operate for 55 flights, and are 14 feet long (4.3 meters) and seven and one-half feet (2.3 meters) in diameter at the nozzle exit. Two orbital maneuvering system (OMS) engines, mounted on either side of the upper aft fuselage, provide thrust for major orbital changes. For more exacting motions in orbit, forty-four small rocket engines, clustered on the Shuttle's nose and on either side of the tail, are used. Together they are known as the reaction control system and are used to aid in retrieving, launching, and repairing satellites in orbit.

The External Tank

The giant cylinder, higher than a 15-story building, with a length of 154 feet (47 meters) and as wide as a silo with a diameter of 27.5 feet (8.4 meters) , is the largest single piece of the Space Shuttle. During launch the external tank also acts as a backbone for the orbiter and solid rocket boosters to which it is attached. In separate pressurized tank sections inside, the external tank holds the liquid hydrogen fuel and liquid oxygen oxidizer for the Shuttle's three main engines. During launch the external tank feeds the fuel under pressure through 17-inch (43.2 centimeter) ducts which branch off into smaller lines that feed directly into the main engines. Some 64,000 gallons (234,696 liters) of fuel are consumed by the main engines each minute. Machined from aluminum alloys, the Space Shuttle's external tank is the only part of the launch vehicle that currently is not reused. After its 526,000 gallons (1,998,800 liters) of propellants are consumed during the first eight and one-half minutes of flight, it is jettisoned from the orbiter and breaks up in the upper atmosphere, its pieces falling into remote ocean waters.



The Solid Rocket Boosters

The Space Shuttle's two solid-rocket boosters, the first designed for refurbishment and reuse, are also the largest solids ever built and the first to be flown on a manned spacecraft. Together they provide the majority of the thrust for the first two minutes of flight—some 5.8 million pounds (25.9 million newtons). The solid propellant mix is composed of 16 percent aluminum powder (fuel) and almost 70 percent ammonium perchlorate (oxidizer), with the remainder made up of a binder, a curing agent and a small amount of catalyst. A small rocket motor in each booster ignites the propellant at launch. During flight, the solid booster nozzles swivel up to a six degrees, redirecting the thrust and steering the Space Shuttle toward orbit.