NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

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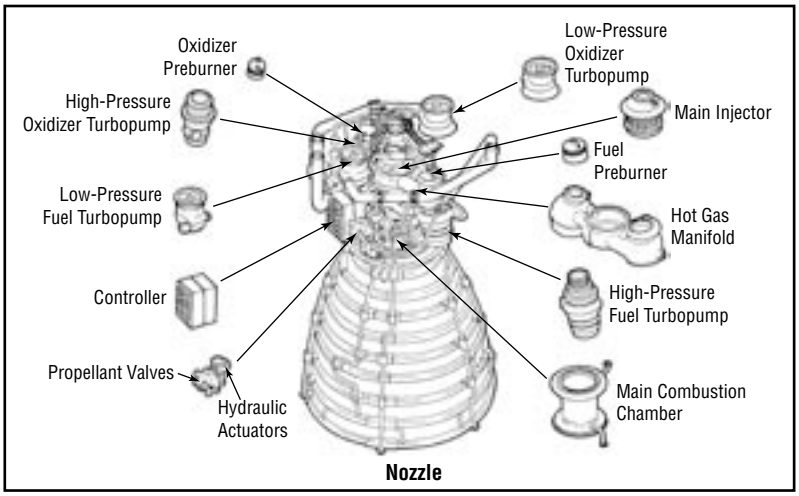
Space Shuttle Propulsion Systems managed by the Marshall Space Flight Center

The Space Shuttle is NASA's reusable space vehicle designed for transport of people, spacecraft and equipment to and from Earth orbit. The propulsion elements of the Space Shuttle, including the Main Engine, External Tank and Solid Rocket Boosters that propel the Space Shuttle into orbit are managed at the Marshall Space Flight Center in Huntsville, Alabama.

The Space Shuttle Main Engines

The three Space Shuttle Main Engines are clustered at the aft end of the orbiter and have a 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 and are 14 feet long (4.3 meters) and 7.5 feet (2.3 meters) in diameter at the nozzle exit. The main engine weighs approximately 7,000 pounds (3,150 kilograms). Propelled by liquid hydrogen (fuel) and liquid oxygen (oxidizer), the main engines operate during the entire eight-and-one-half-minute ride to orbit. Following each mission the Space Shuttle Main Engines are taken to the Space Shuttle Main Engine Processing Facility at the Kennedy Space Center, Fla., for post-flight inspections and maintenance in preparation for the next Shuttle mission.

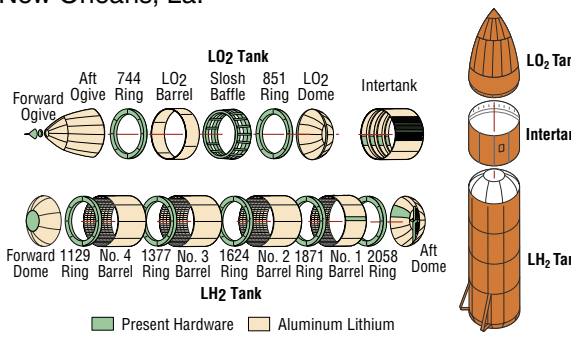


In April 2002, a redesigned Shuttle Main Engine – the updated Block II Engine – began flying on Space Shuttle missions. The Block II Engine includes a new high-pressure fuel turbopump, modified to eliminate welds using a casting process for the housing and an integral shaft/disk with thin wall blades and ceramic bearings. This modification makes the pump stronger and should increase the number of flights between required overhauls. The Space Shuttle Main Engines are built by Rocketdyne Propulsion and Power Division of the Boeing Company in Canoga Park, Calif. The engine turbopump is built by Pratt and Whitney of West Palm Beach, Fla. The turbopumps are made by Pratt and Whitney of West Palm Beach, Fla.

The External Tank

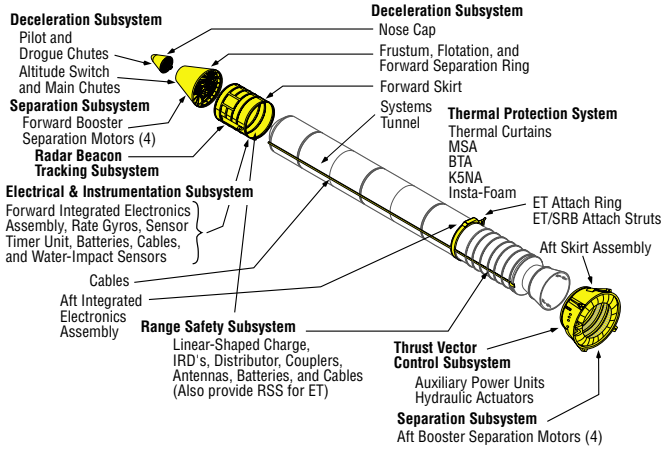
The External Tank is a giant cylinder container with a rounded, or ogive, top -- higher than a 15-story building, with a length of 154 feet (47 meters) and a diameter of 27.5 feet (8.4 meters). Weighing in at approximately 59,400 pounds (27,000 kilograms) while empty and 1,658,900 pounds (752,000 kilograms) full of fuel and oxidizer, the external tank 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, absorbing the thrust loads. 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 in to smaller lines that feed directly into the main engines. Some 62,300 gallons (235,831 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 External Tank is manufactured by Lockheed Martin Space Systems Company at the Michoud Assembly Facility in New Orleans, La.



The Solid Rocket Boosters

The Space Shuttle's two solid-rocket boosters provide 80 percent of the thrust for the first two minutes of flight -- some 5.3 million pounds (23.6 million newtons). Each booster is 149.2 feet (45.5 meters) and weighs approximately 186,800 pounds (84,700 kilograms) inert and 1,298,500 pounds (589,000 kilograms) full of fuel before launch. Each booster consists of a nose cone, three main parachutes, forward skirt segment, aft skirt segment, solid rocket motor, motor igniter and nozzle. The booster is developed by United Space Alliance at the Kennedy Space Center in Florida. The solid rocket motors are manufactured by ATK Thiokol Propulsion



in Brigham City, Utah. The solid rocket motor segments are formed from D6AC high strength steel. Each motor is filled with approximately 1.1 million pounds of solid propellant that consists of 16 percent aluminum powder (fuel), almost 70 percent ammonium perchlorate (oxidizer), with the remainder of the propellant being made up of a binder, a curing agent and a small amount of catalyst. The solid rocket boosters (SRB) are the largest man rated motors ever built. The SRB's are refurbished and reused after each flight.

The small solid propellant igniter in each booster ignites the propellant at launch. During flight, the solid rocket motor nozzles swivel up to 3.5 degrees, redirecting the thrust and steering the Space Shuttle toward orbit. After their approximate two-minute flight, the boosters are jettisoned from the external tank and fall back into the Atlantic Ocean under parachute. Both boosters are retrieved by two large recovery ships and returned to the Solid Rocket Booster Disassembly Facility located at Hangar AF at Cape Canaveral Air Force Station, Fla. The nose cone and parachutes are disassembled for processing by United Space Alliance at the Parachute Refurbishment Facility located at the Kennedy Space Center. The solid rocket motor casings are disassembled and inspected by NASA and contractor personnel before being shipped by rail to ATK Thiokol in Utah for final refurbishing and loading with propellant for reuse on subsequent flights.