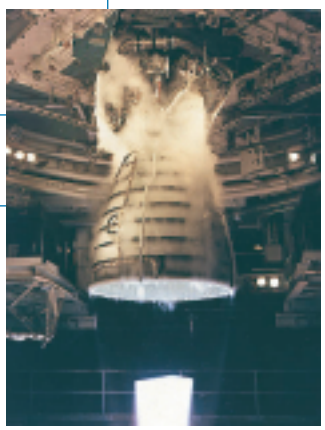
Space Shuttle
Technology Summary



Main Engine Alternate Turbopump Development

Developed in the 1970s by Marshall Space Flight Center in Huntsville, Ala., the Space Shuttle Main Engine is the world's most sophisticated reusable rocket engine. In 1983, NASA began undertaking major improvements to the Main Engine with the Phase II engine development program. The primary enhancement in Phase II was a new more powerful engine control computer, which increased the engine's reliability, durability and safety.

The first modification was the Block I engine, flown in 1995. The main upgrade was a robust low maintenance high-pressure oxygen turbopump – made by Pratt & Whitney of West Palm Beach, Fla. – that supplies up to 970 pounds (440 kilograms) of liquid oxygen per second.

The Block I engine also incorporated a two-duct powerhead, which improved the distribution of the fuel flow and reduced the pressure and temperature in the engine, and a single-coil heat exchanger, which eliminated welds and increased reliability. In addition, the engine included new bearings made of silicon nitride, a ceramic material that is 30 percent harder and 40 percent lighter than steel and whose ultra-smooth finish produces less friction during pump operation.

The Block IIA engine – first flown in 1998 – added a large throat main combustion chamber to the existing Block I engines. The throat of the new chamber is about 10 percent larger – improving the engine's reliability by reducing pressure and temperature in the chamber and throughout the engine. The enlargement allows the high-pressure pumps to operate at lower turbine temperatures and pressures.

The latest modification, the Block II engine, incorporates the changes made in the Block I and Block IIA and adds a new high-pressure hydrogen turbopump. The first Block II engine flew on STS-104, July 2001. The first flight incorporating all three Block II engines is STS-110 in April 2002.

The current hydrogen turbopump design – with 20-year-old technology – requires pump removal and maintenance between flights, and calls for special coatings for thermal protection to the turbine blade airfoils. It also features welded construction, which requires meticulous inspections.

The new design uses a unique casting process to eliminate welds, increasing the number of missions between major overhauls, and eliminates the need for some special coatings.