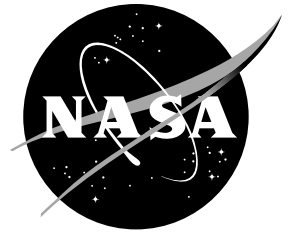


NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812



Space Shuttle Main Engine Turbopump

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. NASA fuels discoveries that make the world smarter, healthier, and safer.

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 second major modification was the Block I engine, first flown in 1995. The main upgrade was a robust, low maintenance high-pressure oxygen turbopump—made by Pratt & Whitney of West Palm Beach, Fla.—which supplies up to 970 pounds 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 new oxygen turbopump included new



bearing elements made of silicon nitride, a ceramic material that is 30 percent harder and 40 percent lighter than steel. Incorporation of this new material greatly improved the wear performance and fatigue life of the turbopump bearings.

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, adds a new high-pressure hydrogen turbopump and incorporates the changes made in the Block I and Block IIA engines. These new hydrogen turbopumps, also developed by Pratt & Whitney, incorporate several significant upgrades in pump technology, resulting in increased operational reliability.

The previous hydrogen turbopump design required pump removal and maintenance between flights, and called for special coatings for thermal protection to the turbine blade airfoils. It also featured welded construction, which required meticulous process control, inspections, and frequent repair.

The new design uses a unique casting process to eliminate welds and eliminates the need for special airfoil coatings. The new design also incorporates silicon nitride bearing elements similar to the upgraded oxygen turbopump.

The first Block II engine flew on STS-104 in July 2001, while the first flight incorporating three Block II engines was STS-110 in April 2002.

For more information, visit <http://www.nasa.gov>.

Explore. Discover. Understand.