NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

FS-2001-04-81-MSFC **May 2001**

Four propulsion enhancements planned for Space Shuttle fleet by 2005

Four improvements to the Space Shuttle's propulsion systems are planned for completion by 2005. These include upgrades on the Shuttle's Main Engines, External Tank, and Solid Rocket Boosters—all of which are managed by NASA's Marshall Space Flight Center in Huntsville, Ala.

The following upgrades are planned for the Space Shuttle:
- Advanced Health Management System for the Space Shuttle Main Engines
- Enhanced Nozzle studies
- Friction Stir Welding on the External Tank
- Solid Rocket Booster Advanced Thrust Vector Control

The goal of these upgrades is a 100-percent increase in ascent reliability.

Advanced Health Management System

The Advanced Health Management System is a series of computer systems that will monitor the performance of the Shuttle's Main Engines. The system has two elements—the Advanced Space Shuttle Main Engine Controller and the Health Management Computer. This system–which will monitor operation from Engine start to cutoff—will be able to detect and track an almost microscopic flaw in the engine's performance in a split second. It will analyze propulsion data and—should less-than-optimal performance occur—may select to safely shut down the Shuttle's Main Engines.

One part of the health management system, called the Real Time Vibration Monitoring System, was successfully tested on the STS–96 mission in December 1999. The test showed it was possible, in real time, to accurately gather information and analyze the performance of an engine's high-speed turbopumps during flight. When implemented, the Advanced Health Management System, will significantly improve Space Shuttle flight safety, reliability and operability.

Enhanced Nozzle design studies

As high-pressure pumps inject fuel and oxidizer into the main combustion chamber of a Space Shuttle Main Engine, the expansion of the resulting hot gases—passing through the engine's chamber and nozzle—produces thrust.

Because the hot gases reach temperatures as high as 6,000 degrees Fahrenheit (3,315 degrees Celsius)—hot enough to melt steel—super-cooled liquid hydrogen circulates through miles of tubing on the engine nozzle to keep it cool. The proposed Enhanced Nozzle design will eliminate high stress points on the nozzle, reduce the length of coolant lines, eliminate hundreds of welds—more than 500 feet (152.4 meters) of them—simplify the manufacturing process, and improve engine reliability.

Friction Stir Welding on the External Tank

The External Tank contains the liquid hydrogen and liquid oxidizer for the Shuttle's Main Engines and serves as the structural backbone of the Shuttle vehicle. At almost 154 feet long (47 meters) and 28 feet (8.5 meters) in diameter, it holds more than 1.5 million pounds (675,000 kilograms) of propellants that are burned in less than nine minutes. The aluminum skin of the tank, however, is less than 0.25 inches (0.64 centimeters) thick.

Aluminum panels are curved to form the large "barrel" sections of the tanks. On current tanks, advanced plasma arc or fusion welding joins the panels. When fusion welding, the metal heats to a liquid state. This can change its chemical properties when the metal cools.

Friction Stir Welding uses friction to create heat to bond metal together. This process doesn't reduce the metal to a liquid state—meaning the chemical properties are not changed, and it results in a stronger weld This results in fewer repairs. Also, in testing, there have been zero defects using the Friction Stir Welding technique. The method is faster and less costly than fusion welding.

Solid Rocket Booster Advanced Thrust Vector Control

Each Solid Rocket Booster is equipped with a thrust vector control system—powered by an auxiliary power unit– that allows the booster's engine nozzles to swivel. This swivel action provides steering as the Space Shuttle climbs to orbit after launch. The current energy source is a turbine powered by hydrazine, a highly volatile and toxic rocket fuel that presents a risk of fire if there is any leakage. Present plans are to replace the hydrazine-powered system with a helium-powered system. Because helium is an inert–buoyant and noncombustible–gas that has no harmful effects on the environment, it is a safer, more environmentally friendly option than liquid hydrazine.

The new technology will use gaseous helium to spin a turbine that in turn provides hydraulic power to steer the Shuttle vehicle from liftoff to burnout and separation of the twin Solid Rocket Boosters. The modified unit is similar to the hydrazine-powered unit in that it uses gas to spin a turbine. The present system requires the hydrazine be converted from a liquid to a hot gas, thus necessitating a fuel pump and gas generator. The high temperatures resulting from the decomposed hydrazine place the entire system at risk for combustion due to the numerous ignition sources.

The helium-powered unit does not require a fuel pump or gas generator and, therefore, contains no ignition sources. There are two Auxiliary Power Units in each aft skirt, or bottom part, of the Solid Rocket Booster. Therefore, if one unit fails, the remaining unit will provide steering control.

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Pub 8-1292