National Aeronautics and Space Administration

NASA**facts**

Space Shuttle Main Engine

Advanced Health Management System

When a NASA space shuttle lifts off the launch pad it does so with the help of three reusable, high performance rocket engines. Each space shuttle main engine is fourteen feet long, seven and one-half feet in diameter at the nozzle exit, weighs approximately 7,750 pounds and generates more than twelve million horsepower. The output of the shuttle's three main engines is equivalent to 13 Hoover Dams. The engines operate for about eight-and-one-half minutes during a shuttle liftoff and ascent—long enough to burn more than 500,000 gallons of super-cold liquid hydrogen and liquid oxygen propellants stored in the huge external tank attached to the underside of the orbiter. Liquid oxygen is stored at -298 degrees Fahrenheit and liquid hydrogen at -423 degrees Fahrenheit. The engines shut down just before the orbiter, traveling at about 17,000 mph, reaches orbit.

NASA is confident that an upgrade to these engines, called the Advanced Health Management System (AHMS), will significantly improve space shuttle flight safety and reliability. The upgrade, developed by NASA's Marshall Space Flight Center in Huntsville, Ala., is a modification of the existing main engine controller, which is the on-engine computer that monitors and controls all main engine operations. The modifications include the addition of advanced digital signal processors,

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radiation-hardened memory and new software. These changes to the main engine controller provide the capability for completely new monitoring and insight into the health of the two most complex components of the space shuttle main engine — the high pressure fuel turbopump and the high pressure oxidizer turbopump.

The high pressure fuel and high pressure oxidizer turbopumps rotate at approximately 34,000 revolutions per minute and 23,000 revolutions per minute, respectively. To operate at such extreme speeds, the high pressure turbopumps utilize highly specialized bearings and precisely balanced components. The AHMS upgrade utilizes data from three existing sensors (accelerometers) mounted on each of the high pressure turbopumps to measure how much each pump is vibrating. The output data from the accelerometers is routed to the new AHMS digital signal processors installed in the main engine controller. These processors analyze the sensor readings 20 times per second looking for vibration anomalies that are indicative of impending failure of rotating turbopump components such as blades, impellers, inducers and bearings. If the magnitude of any vibration anomaly exceeds safe limits, the upgraded main engine controller immediately would shut down the unhealthy engine.

The Advanced Health Management System made its first flight in monitor-only mode on one engine during STS-116 in December 2006 and operated in active mode — the ability to shut down an engine if anomalies are detected — on one engine during STS-117 in June 2007. Data collected and examined following the missions indicated AHMS operated as intended. AHMS will operate in active mode on all three engines during the STS-118 mission in August 2007.

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