Phase I and Phase II Safety and Performance Upgrades

ALTERNATE TURBOPUMP PROGRAM (FUEL and OXIDIZER)

DESCRIPTION

- **Increase the margin of safety of the SSME and facilitate its fabrication, assembly, and maintenance and increase the operating life of the turbopumps themselves by providing line replaceable turbopumps that are more robust (new bearings, stiffer rotors, single crystal blades) and satisfy all current SSME interface requirements. Eliminates failure modes, utilizes latest technology (design, material, fabrication), and is completely inspectable. First flight of fuel turbopump in 08/00**

LARGE THROAT MAIN COMBUSTION CHAMBER (LTMCC)

DESCRIPTION

- **The Large Throat Main Combustion Chamber design allows the Space Shuttle Main Engine to operate at a lower chamber pressure while maintaining performance through the efficiencies of the new baffle-less main injector (Phase II+ Powerhead). The lower chamber pressure reduces operating temperatures and pressures throughout the engine system, resulting in improved reliability and safety margins of the engine system. The wider throat accommodates more cooling channels and an accompanying reduction in hot gas wall thickness. Hot gas wall temperatures are significantly reduced, which increases chamber life. The design utilizes modern materials and manufacturing techniques (precision cast manifolds) and is less labor intensive to produce and maintain (fewer welds).**

SSME PHASE II+ POWERHEAD

DESCRIPTION

- The hot gas manifold is changed from a 3-duct to a 2-duct design with elimination of center fuel transfer duct. Other improvements are: Redesigned main injector flow shields, strengthened preburner injector elements, improved hot gas flow path for lower pressure loss and reduced turbine loads, and elimination of main injector baffles. The bifurcated heat exchanger tube is replaced with a single tube with thicker walls and no inter-propellant welds. The result is a less severe engine operating environment and a powerhead with fewer critical failure modes.
- Part of the Block I Engine configuration
- First flight was in 7/95.

SUPER LIGHTWEIGHT TANK (SLWT)

DESCRIPTION

- The Super Lightweight Tank will achieve the desired weight reduction by: selective substitution of high strength, low density aluminum- lithium alloys for the current External Tank (ET) aluminum alloys; optimization of structural design weight through the selective redesign of certain structural components (orthogonal grid versus longitudinal tee) and reduction of the as manufactured thickness of the thermal protection system (TPS).

MULTIFUNCTION ELECTRONIC DISPLAY SYSTEM (MEDS)

DESCRIPTION

•MEDS is a state-of-the-art integrated display system utilizing a four string multiple redundant architecture and full color multifunction liquid crystal displays to retrofit the current Orbiter Multifunction CRT Display Subsystem (MCDS) and dedicated displays. MEDS is required due to the aging and wear out of the current electro-mechanical devices along with the inherent parts and skills obsolescence leading to increased repair times and costs. The main objectives of MEDS are to improve safety and reduce aging and obsolescence currently being experienced. MEDS will also reduce Orbiter weight and power consumption.

ORBITER APU NEW GAS GENERATOR VALVE (NGGVM)

DESCRIPTION

•The current APU GGVM, which controls the flow of fuel into the APU, is limited to a 20 hour operational life limit and a 21 month “wet” (exposed-to-fuel) life limit. The new GGVM design will eliminate the current life limits, eliminate some potential failure modes, and enhance vendor support capability.

SIMPLIFIED AID FOR EVA RESCUE (SAFER)

DESCRIPTION

•Should a spacewalking ISS or Shuttle-Mir astronaut inadvertently become untethered, the Shuttle may be unavailable or unable to perform a rescue. The SAFER backpack will allow the detached astronaut to safely maneuver back to the International Space Station (ISS) or Shuttle-Mir complex. A SAFER development test unit was tested on STS-64.

HARDWARE INTERFACE MODULE CARDS (HIT)

DESCRIPTION

•The launch processing system HIM cards and the Kennedy Space Center became obsolete and caused increased failure rates and repair costs. This upgrade replaced all chassis and cards with state-of-the-art hardware which improved system reliability, maintainability, and fault detection.

LIGHTWEIGHT SOLID ROCKET BOOSTER

DESCRIPTION

•Reduce booster launch weight by 12,000 lbs. Per flight set, resulting in 1200 pounds of additional payload capability. Weight reductions achieved through aft skirt gusset removal and parachute subsystem redesign and material substitution (kevlar)

Proposed High Priority Safety Upgrades

($ in Millions)

	2000	EAC RANGE
Electric APU (Orbiter)	$11.0	190.0 - 240.0
SSME Adv Health Monitoring	$10.0	110.0 - 135.0
Avionics/Cockpit/Safety Studies	$10.0	25.0
Studies/Other Minor: *(propulsion studies, abort improvement, TPS lower surface tile, new MLG tire, crew escape, SCAPE suit)*	$19.0	25.0 - 30.0
Overall Safety Totals	**$50.0***	**370.0 - 430.0**

All upgrades to be completed by 2005

Addendum 3

* *Note: NASA's FY 2000 Appropriation identifies $25M additional funding for Safety Upgrades.*