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Main Engine Candidates for a Second Generation Reusable Launch Vehicle

NASA's Space Launch Initiative marks the beginning of a new era of human space flight for the United States with development of technologies to improve safety and reliability while lowering the cost of space travel. The Space Launch Initiative Propulsion Office -- managed by NASA's Marshall Space Flight Center in Huntsville, Ala., -- is advancing technologies and exploring new avenues of space propulsion to develop safer, more reliable and affordable propulsion solutions. Four main engine candidates for a second generation reusable launch vehicle have emerged, including two hydrogen-fueled and two kerosene-fueled staged combustion engines.

COBRA Prototype Engine

COBRA, short for Co-optimized Booster for Reusable Applications, is a reusable, hydrogen-fueled, liquid booster and second stage engine with a thrust level of 600,000 pounds of force. The engine is being developed by Pratt & Whitney-Aerojet Propulsion Associates -- a joint venture of Aerojet of Sacramento, Calif., and Pratt & Whitney Space Propulsion of West Palm Beach, Fla. COBRA is a single fuel-rich preburner, staged combustion engine using liquid oxygen and liquid hydrogen as propellants. Preburners are used to heat and ready propellants for the turbopumps before being injected into the main combustion chamber. Engineers are designing the engine to have a 100-mission lifespan, requiring a maintenance check-up only after every 50 missions. COBRA uses several Space Shuttle Main Engine technologies, including the advanced turbopump design for both of the high-pressure turbopumps and key sensors for advanced health management to monitor the health of the engine. In addition, the COBRA team is developing the channel wall nozzle to help meet second generation goals of increased safety, reliability and lower cost. Other technology features on the COBRA engine include a single preburner with parallel turbines, platelet main combustion chamber, low torque valves and an advanced powerduct.



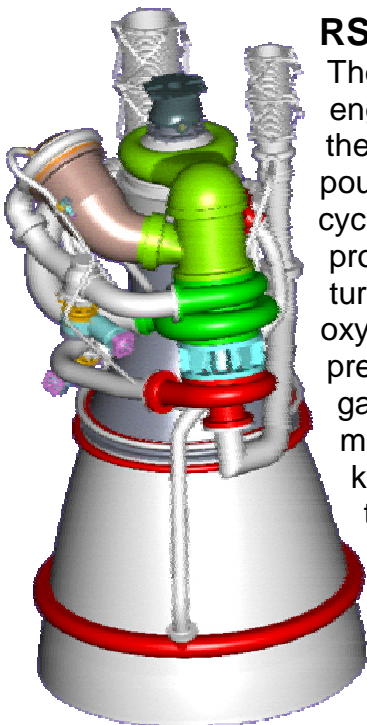
RS-83 Prototype Engine

RS-83, developed by the Rocketdyne Propulsion and Power division of the Boeing Company of Canoga Park, Calif., is a reusable, staged combustion engine in the 650,000-pound thrust class. The engine, fueled by liquid hydrogen and liquid oxygen, uses a single preburner with series turbines to increase reliability, safety and offer higher efficiency turbine flow than current engines. Design features include lower turbine temperatures with more uniformity and lower temperature spikes to increase safety and robustness. Long-life hydrostatic bearings along with an advanced engine health management system and advanced sensors are used. Unique advanced alloys and processes, such as hot-isostatic process (HIP) powder metallurgy (PM), used throughout the engine reduce weight, increase reliability, and eliminate the need for coatings on engine components. Advanced pre-burner injector technology employs all liquid propellants, instead of the traditional combination of liquid and gas propellants. A regeneratively cooled main combustion chamber and channel-wall nozzle offer increased efficiency, lower heat loads, and longer life. The RS-83 uses low-torque, innovative cartridge-style valves to increase operability, reduce weight, and minimize leak points. The engine will offer a minimum lifespan of 100 missions and a maintenance check-up every 50 missions.



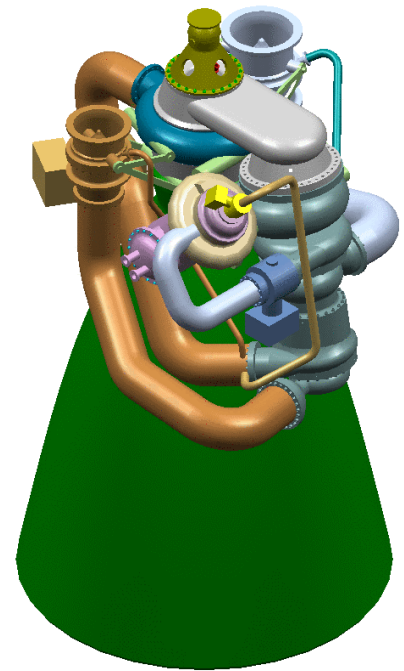
RS-84 Prototype Engine

The RS-84 engine is a reusable, kerosene-fueled, staged combustion engine developed by the Rocketdyne Propulsion and Power division of the Boeing Company of Canoga Park, Calif. Generating 1.1 million pounds of force, the engine increases safety by using a reliable engine cycle with lower turbine temperatures. The engine is being designed to provide a 100-mission life span, lower maintenance costs and quicker turn-around time between missions. The RS-84 engine uses liquid oxygen and kerosene as propellants and features an oxygen-rich preburner – offering a potential first-ever combination of oxygen-rich gases and kerosene fuel in a reusable, U.S. engine. An arrangement of manifolds has been added to the engine design to weave the flow of kerosene fuel in and out of the main combustion chamber coolant tubes, limiting the time the kerosene is exposed to hot temperatures while the fuel cools the chamber and nozzle to optimize cooling. Advanced technologies on the RS-84 engine include an advanced engine health monitoring system and nickel-based alloys in the preburner and turbine that are oxygen-compatible to eliminate the need for special coatings.



TR107 Prototype Engine

The kerosene-fueled TR107 is a reusable, staged combustion engine in the 1 million-pound thrust class developed by TRW Space and Electronics of Redondo Beach, Calif. The engine features a single oxygen-rich preburner and uses liquid oxygen and kerosene as propellants – creating a potential first-ever reusable kerosene engine for the U.S. space program. The engine highlights a duct-cooled main combustion chamber to eliminate conventional cooling channels and features kerosene-compatible materials to prevent coking — a gummy residue from heated kerosene. The main chamber/nozzle assembly of the TR107 engine is made up of only two parts that offer fewer failure modes and are easy to manufacture and inspect. These features significantly reduce system complexity and enhance reliability, operability and cost. The turbomachinery team of Allison Advanced Development Company of Indianapolis, Ind., Barber Nichols of Arvada, Colo., and Concepts NREC of White River Junction, Vt., has designed a single shaft main turbopump. This turbopump includes long-life hydrostatic bearings and a pressurized interpropellant seal cavity, offering a higher safety margin by helping to keep the propellants separated. Other attributes of the TR107 engine are advances with the oxygen-rich preburner, including a single pintle injector and oxygen-compatible materials that eliminate the need for coatings on engine components.



Other Propulsion Projects

In addition to the main engine candidates, the Space Launch Initiative Propulsion Office at the Marshall Center is involved in advancing other propulsion systems for a second generation reusable launch vehicle, including all propulsion-related crossfeeds, ducts, valves, lines and actuators; on-orbit propulsion systems, which include orbit maneuvering systems, reaction control systems, atmospheric re-entry and landing; booster jet flyback propulsion and crew escape propulsion.

For more information on the Space Launch Initiative, visit the Space Launch Initiative on the Web at <http://www.slinews.com/>