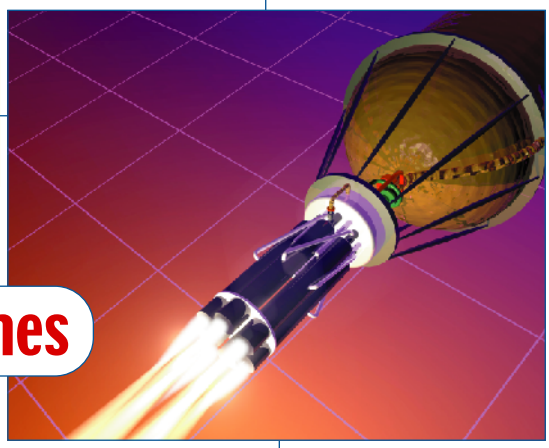
Advanced Space Transportation Technology Summary



Pulse Detonation Rocket Engines

Rocket engines that work much like an automobile engine are being developed at NASA's Marshall Space Flight Center in Huntsville, Ala. Pulse detonation rocket engines offer a lightweight, low-cost alternative for space transportation.

Pulse detonation rocket engine technology is being developed for upper stages that boost satellites to higher orbits. The advanced propulsion technology could also be used for lunar and planetary landers and excursion vehicles that require throttle control for gentle landings. The engine operates on pulses, so controllers could dial in the frequency of the detonation in the "digital" engine to determine thrust.

Pulse detonation rocket engines operate by injecting propellants into long cylinders that are open on one end and closed on the other. When gas fills a cylinder, an igniter—such as a spark plug—is activated. Fuel begins to burn and rapidly transitions to a detonation, or powered shock. The shock wave travels through the cylinder at 10 times the speed of sound, so combustion is completed before the gas has time to expand. The explosive pressure of the detonation pushes the exhaust out the open end of the cylinder, providing thrust to the vehicle.

A major advantage is that pulse detonation rocket engines boost the fuel and oxidizer to extremely high pressure without a turbopump—an expensive part of conventional rocket engines. In a typical rocket engine, complex turbopumps must push fuel and oxidizer into the engine chamber at an extremely high pressure of about 2,000 pounds per square inch or the fuel is blown back out. The pulse mode of pulse detonation rocket engines allows the fuel to be injected at a low pressure of about 200 pounds per square inch.

Marshall engineers and industry partners United Technology Research Corp. of Tullahoma, Tenn., and Adroit Systems Inc. of Seattle have built small-scale pulse detonation rocket engines for ground testing. During about two years of laboratory testing, researchers have demonstrated that hydrogen and oxygen can be injected into a chamber and detonated more than 100 times per second. NASA and its industry partners have also proven that a pulse detonation rocket engine can provide thrust in the vacuum of space.

Technology development now focuses on determining how to ignite the engine in space, proving that sufficient amounts of fuel can flow through the cylinder to provide superior engine performance, and developing computer code and standards to reliably design and predict performance of the new breed of engines.

A developmental, flight-like engine could be ready for demonstration by 2005 and a full-scale, operational engine could be finished about four years later. Manufacturing pulse detonation rocket engines is simple and inexpensive. Engine valves, for instance, would likely be a sophisticated version of automobile fuel injectors.

Pulse detonation rocket engine technology is one of many propulsion alternatives being developed by the Marshall Center's Advanced Space Transportation Program to dramatically reduce the cost of space transportation.