

Advanced Space Transportation Technology Summary

Air-breathing Rocket Propulsion



Rocket engines that breathe oxygen from the air could dramatically reduce the cost of getting to space. Engineers at NASA's Marshall Space Flight Center in Huntsville, Ala., are developing air-breathing rocket propulsion technologies for 21st century space transportation.

Air-breathing rockets could make future space travel like today's air travel. Spacecraft would be completely reusable, take off and land at airport runways, and be ready to fly again within days.

An air-breathing rocket engine inhales oxygen from the air for about half the flight, so it doesn't have to store the oxygen gas on board. At take-off, an air-breathing rocket vehicle weighs much less than a conventional rocket vehicle, which carries all of its fuel and oxygen onboard. Getting off the ground is the most expensive part of any mission to low-Earth orbit, so reducing a vehicle's weight decreases cost significantly.

An air-breathing—or rocket-based, combined cycle—engine gets its initial take-off power from specially designed rockets strategically placed in a duct that captures air. This rocket-in-a-duct arrangement boosts performance about 15 percent over conventional rockets. When the vehicle's velocity reaches twice the speed of sound, the rockets are turned off and the engine relies totally on oxygen in the atmosphere to burn the hydrogen fuel. Once the vehicle's speed increases to about 10 times the speed of sound, the engine converts to a conventional rocket-powered system to propel the vehicle into orbit.

In 1996, the Marshall Center resurrected rocket-based, combined cycle work from the 1960s and '70s. In 1997, Marshall started testing air-breathing rocket engines. Tests at Marshall and the General Applied Sciences Laboratory (GASL) on Long Island, N.Y., validated performance of the air-breathing rocket engines.

The Marshall Center and NASA's Glenn Research Center in Cleveland, Ohio, intend to design a flight-weight air-breathing rocket engine in-house for flight demonstration in 2005. The project will help determine if an air-breathing rocket engine can be built lightweight enough for a launch vehicle.

NASA's industry partners in developing air-breathing rocket technologies are: Aerojet Corp. of Sacramento, Calif.; Rocketdyne of Canoga Park, Calif.; Astrox Corp. of Rockville, Md.; Pennsylvania State University of University Park; and the University of Alabama in Huntsville.

This unconventional approach to getting to space is one of the technologies NASA's Advanced Space Transportation Program at the Marshall Center is developing to make space transportation affordable for everyone—from business travelers to tourists. NASA's goal is to reduce launch costs from today's price tag of \$10,000 per pound to only hundreds of dollars per pound within 25 years.