SPACE LAUNCH INITIATIVE

Technology Summary

Propulsion

Since the beginning of time, mankind has considered it an expression of … inadequacy to be bound to the Earth, to be unable to free itself from the shackles of gravity. Not without good reason has the concept of the transcendental always been associated with the idea of weightlessness, the power "to be able freely to rise into the sky."

— Hermann Noordung, The Problem of Space Travel, 1929

Since Icarus, humanity has challenged itself to find ways to rise freely into the sky. Since the dawn of the space program and our first forays into the cold reaches of space, the men and women of NASA have continued to meet that challenge: finding means of propulsion that would enable humanity to escape the shackles of Earth's "gravity well," crossing a vast ocean of air into the next great frontier.

One of the toughest challenges of travel into space is found in the first few hundred miles. That is because fully half the energy needed to go to the farthest planets in our solar system is devoted to escaping Earth's gravitational pull. The power and speed required to reach low-Earth orbit — let alone travel to other worlds — demands a highly sophisticated propulsion system with a much greater level of simplicity, dependability and low cost than today's rockets provide.

Such a propulsion system is among the critical technologies now in development for the 2nd Generation reusable launch vehicle — part of NASA's ambitious Space Launch Initiative. As NASA's designated Center of Excellence for Space Propulsion, the Marshall Space Flight Center in Huntsville, Ala., leads this initiative for the Agency.

The Space Launch Initiative is NASA's effort to reduce risks associated with developing a 2nd Generation vehicle by defining and developing technologies needed to safely and cheaply gain access to space. NASA's goal is to significantly increase safety and reliability and reduce payload launch costs from today's $10,000 per pound to less than $1,000 per pound — thereby enabling a long-life, high thrust-to-weight rocket-based reusable launch vehicle by early in the next decade.

Space propulsion, by definition, encompasses the energy storage, transfer and conversion subsystems and components required to propel a space transportation system or maneuver a vehicle. Specific Earth-to-orbit technologies now under investigation include rocket, augmented rocket and combined-cycle propulsion, which may include air or magnetic launch assistance.

Risk-reduction studies devoted to 2nd Generation propulsion technologies will address three primary system elements and their components:

- **The main engine**: Providing primary propulsion for the Earth-to-orbit stage or stages of a reusable launch vehicle, including cryogenic upper stages designed to propel spacecraft beyond low-Earth orbit
- **The main propulsion system**: All propulsion-related ducts, valves, lines and actuators delivering fuel from the main propellant tanks to the main engine, including propellant pressurization, management and gauging systems
- **Auxiliary propulsion systems**: All other propulsion systems required for the Earth-to-orbit stage, including systems for orbit maneuvering, reaction control, emergency crew escape and atmospheric re-entry and landing

Working with NASA scientists and engineers, selected industry teams will seek to reach a level of risk reduction adequate to support full-scale propulsion system development, integration and testing by the middle of this decade. Technologies they are studying to help meet this goal include lightweight composite thrusters; composite lines, ducts and housings; ceramic turbines; and other components.

NASA's Marshall Center leads the Space Launch Initiative with support from Ames Research Center in Moffett Field, Calif.; Stennis Space Center in Bay St. Louis, Miss.; Kennedy Space Center, Fla.; Dryden Flight Research Center in Edwards, Calif.; Johnson Space Center in Houston, Texas; Langley Research Center in Hampton, Va.; the Jet Propulsion Laboratory in Pasadena, Calif.; Glenn Research Center in Cleveland, Ohio; and the Air Force Research Laboratory, which includes research and development facilities at nine U.S. Air Force bases nationwide.

Pub 8-1320

FS-2001-00-00-MSFC