NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

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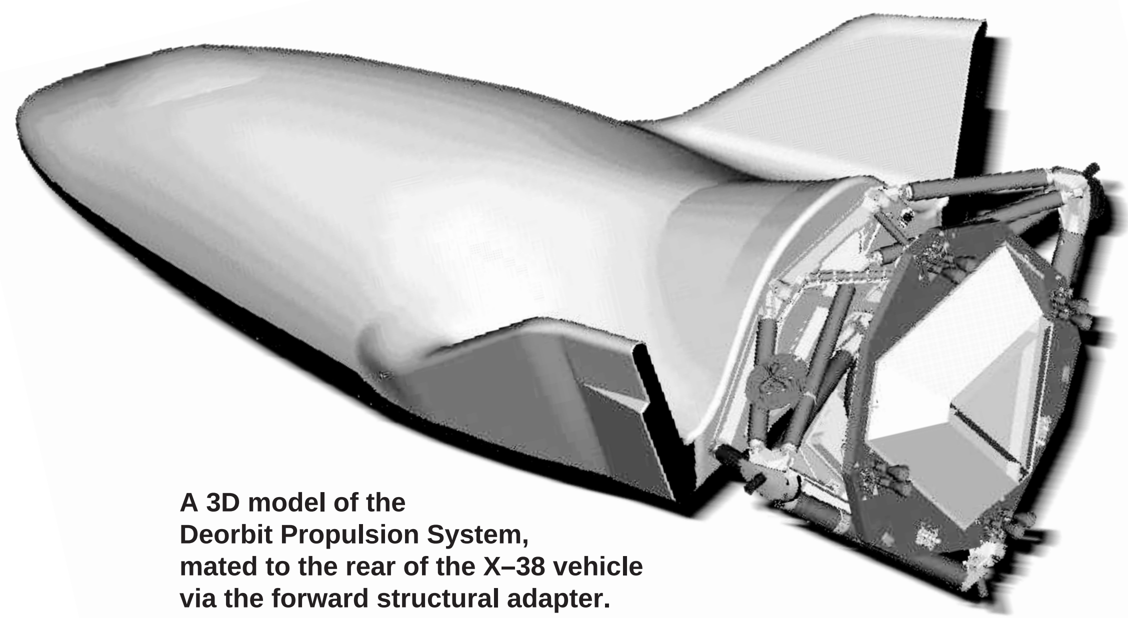
X–38 Deorbit Propulsion System

International Space Station Crew Return Vehicle Uses Marshall Center Propulsion, Off-The-Shelf Technology



A 3D model of the Deorbit Propulsion System, mated to the rear of the X–38 vehicle via the forward structural adapter.

The challenge: Design the propulsion system for a new-generation, emergency return spacecraft, with off-the-shelf or easily available hardware wherever possible, and with minimal manpower and resources.

A team of engineers at NASA's Marshall Space Flight Center in Huntsville, Ala., is meeting the challenge for a vehicle that can return astronauts to Earth quickly and safely from the International Space Station.

They're working on the Deorbit Propulsion Stage of a prototype vehicle called the X–38. Its first space flight test is scheduled for early 2002.

As NASA's Lead Center for Space Transportation Systems Development, the Marshall Center is managing the X–38's propulsion system.

Marshall experts are analyzing composite materials for use in the X–38's propulsion stage. The team is also assisting in the development of additional components, including thrusters, avionics, pyrotechnics, separation mechanisms, structures, propellant tanks and valves.

The X–38 project emphasizes an innovative "off-the-shelf" approach by using existing technologies, the strengths of several NASA Centers and alliances between NASA and other government agencies. The concept allows significant cost and schedule reductions when compared to more traditional approaches to spacecraft development.

Aerojet GenCorp in Sacramento, Calif., is under contract to Marshall to design, develop, manufacture, test and deliver the Deorbit Propulsion Stage.

The Marshall Center has lead responsibility: Marshall personnel are supporting the design, development, testing and verification of the integrated Deorbit Propulsion Stage. The Johnson Space Center in Houston, Texas, has overall responsibility for the X–38.

The Spacecraft

When fully developed, the X–38 will transition to the Crew Return Vehicle and be used when:

- A crewmember is ill or injured, needs immediate medical attention and no other spacecraft are docked at the Space Station.
- Ground problems or other factors delay re-supply of the Space Station for an extended period.
- There is a need to evacuate the Space Station immediately.

The spacecraft will accommodate up to seven crewmembers in a "shirtsleeve" environment. The Space Shuttle will deliver the Crew Return Vehicle to the Space Station where it will be placed into its berthing area by the Station's robotic arm.

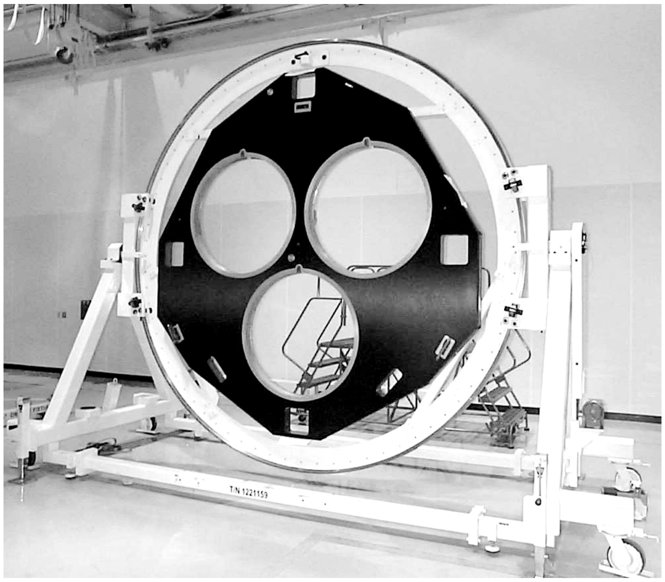
The Crew Return Vehicle will be totally self-operating when it is released from the Space Station. The Crew Return Vehicle onboard computers will control the firing of the propulsion system, as well as other actions, setting it up for a safe return to Earth. Crewmembers traveling in the spacecraft would have override capabilities, however—including selection of the landing site.

The Propulsion System Role

The spacecraft is designed to be occupied and jettisoned away from the Space Station within three minutes if necessary. Upon normal deployment from the Space Station, the Crew Return Vehicle would have 30 minutes to depart from the Space Station and then orbit Earth for a brief period while it collects updated landing site data. Then the propulsion system would ignite to start the spacecraft on its journey for reentry to Earth.

The Deorbit Propulsion System is attached to the rear of the Crew Return Vehicle at six separate points. It is 15-1/2 feet (4.72 meters) wide and 6 feet (1.83 meters) long. The structure is primarily made of composite materials and weighs approximately 6,000 pounds (2721.5 kg) with all components and fuel.

The Forward Structural Adapter is designed to mate the Deorbit Propulsion System to the body of the X–38, locking the Crew Return Vehicle's propulsion system into place.



The Deorbit Propulsion System assembly during testing.

The Deorbit Propulsion System includes four 28-volt non-rechargeable lithium batteries and 1,950 pounds (884.5 kg) of pressurized mono-propellant Hydrazine fuel. It is commonly called a “blow down system,” meaning that the fuel is pressurized (with nitrogen, in this case) prior to launch. As the system continues to be used, the pressure decreases.

Eight axial thrusters, with 100 pounds (45.35 kg) of thrust each, will burn continuously for approximately 10 minutes to take the craft out of orbit. Eight reaction control thrusters, with 25 pounds (11.33 kg) of thrust each, will control attitude during this phase.

Once the propulsion burn is accomplished, the Deorbit Propulsion System will be jettisoned to burn up most of its mass as it enters Earth’s atmosphere. The spacecraft will glide into the atmosphere and return to Earth using a drogue and parafoil parachute system.

How the X–38 Works

When tested in 2002, the X–38 vehicle will leave the Space Shuttle at an altitude of approximately 120 to 150 nautical miles (193 to 241 km). It will go through its propulsion firing sequences and the propulsion system will be jettisoned at about 400,000 feet (122 km) above Earth. The spacecraft will reenter Earth’s atmosphere and glide down.

At approximately 23,000 feet (7 km) a large drogue parachute will deploy and stabilize the spacecraft. The drogue chute is cut away at about 17,000 feet (5.18 km) and then a controllable, 7,500-square-foot (2.3 km) parafoil chute is deployed in incremental stages. Cables attached to electro-magnetic actuators steer the spacecraft and control its rate of descent to a final velocity of 10 to 15 feet (3.1 to 4.5 meters) per second. It lands much like a paratrooper using a personal-sized parafoil for precision landings.

Proven parafoil technology, initially developed by the U.S. Army under the leadership of the Marshall Center, simplifies the internal control systems and eliminates the need for a pilot. The Crew Return Vehicle is designed to land within 5 nautical miles (8.1 km) of its designated landing site.

The X–38 test vehicle successfully glides back to Earth in July 1999, following release from a B–52 during the program’s fourth successful free flight. (Photo: Dryden Flight Research Center)

More About the Marshall Center

NASA's Marshall Space Flight Center in Huntsville, Ala., is NASA's premier organization for development of space transportation and propulsion systems, NASA's leader in microgravity research—unique scientific studies conducted in the near-weightlessness of space—and NASA's leader for advanced large optics manufacturing technology.

The Space Transportation Directorate at Marshall is developing revolutionary technologies that promise to strengthen the U.S. launch industry and increase competition. These innovative technologies will dramatically increase safety and reliability and reduce the cost of space transportation.

In the past, Marshall played key roles in the development and operation of the Saturn V rocket, Skylab, the Lunar Roving Vehicle, Spacelab and the Hubble Space Telescope. Today, the Center's primary management responsibilities include Space Shuttle propulsion systems; the Chandra X-ray Observatory; future large-scale space optics systems; the X–33 and X–34 rocket planes and X–37 space plane; and science operations aboard the International Space Station.

Marshall also is responsible for developing advanced space transportation systems designed to further humankind's exploration of space while slashing the cost of getting there from today's $10,000 per pound to only hundreds of dollars per pound, or even less. The Center is working to bring a future among the stars closer to reality for the people of Earth.

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