NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

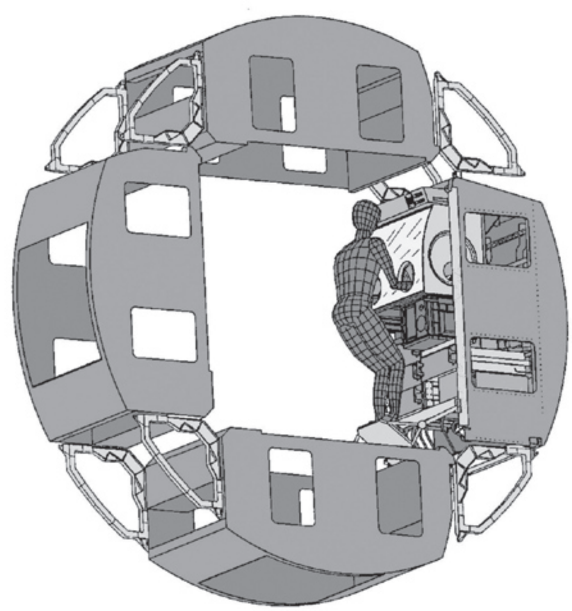
Microgravity Science Glovebox (MSG)

Payload Name: Microgravity Science Glovebox (MSG)
Mission: Expedition Five, ISS Flight UF2, STS-111 Space Shuttle Flight; remains in orbit for up to 10 years to support numerous investigations in multiple disciplines
Payload Location: Currently, U.S. Destiny Laboratory Module
Element Lead: Todd Mullins NASA Marshall Space Flight Center, Huntsville, Ala.
Project Manager: Linda Jeter, NASA Marshall Space Flight Center
Payload Developer: European Space Agency

Overview

These days everyone is talking about thinking "outside the box," but sometimes science is better done inside a box — a glovebox that is. The Microgravity Science Glovebox — a sealed container with built-in gloves — provides an enclosed work space for investigations conducted in the unique, low-gravity, or microgravity, environment created as the International Space Station orbits Earth. NASA fuels discoveries that make the world smarter, healthier and safer.

There are good reasons for using a glovebox to contain experiments with fluids, flames, particles and fumes. In an Earth-based laboratory, liquids stay in beakers or test tubes. In the near-weightlessness of the Station, they float away. They might get into the cabin air and irritate a crew member's skin or eyes or even make them sick. They could damage the Station's sensitive computer and electrical systems or contaminate other experiments. To make laboratory-type investigations inside the Station possible, engineers and scientists at NASA's Marshall Space Flight Center in Huntsville, Ala., worked with the European Space Agency to build the Microgravity Science Glovebox — a facility that will support Station investigations for the next 10 years. In exchange for developing the Microgravity Science Glovebox, the European Space Agency will have use of other facilities inside the Destiny laboratory until its Space Station laboratory — the Columbus Orbital Facility — is attached to the Station.

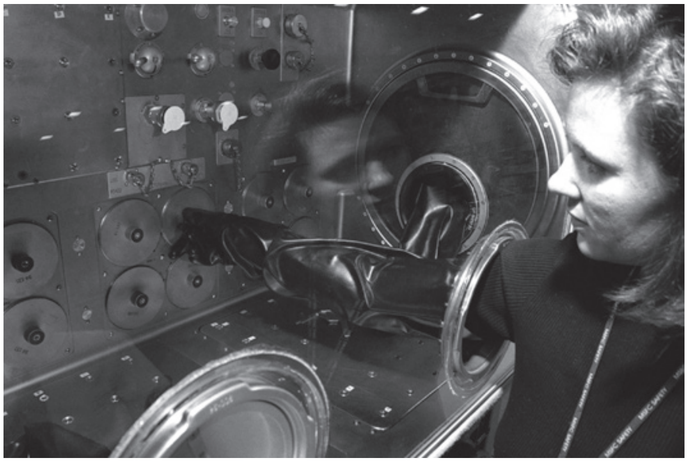


This cut-away of the cylindrical, Destiny laboratory module on the Space Station shows how the Microgravity Science Glovebox fits inside. Racks for science experiments are positioned around the outside of the cylindrical module.

Facility Operations

The Microgravity Science Glovebox was launched on the Space Shuttle Endeavor, STS-111, ISS Flight UF2, in June 2002.

The Expedition Five crew moved the glovebox facility from the Shuttle to the Station's Destiny Laboratory, where they performed the initial setup and checkout of the facility.

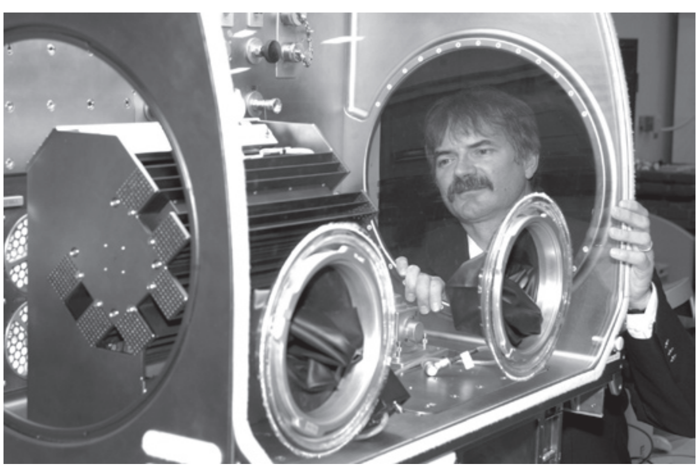


Mary Etta Wright, one of the lead glovebox engineers at NASA's Marshall Space Flight Center in Huntsville, Ala., inserts her hands in the gloves on the outside of the glovebox doors.

To checkout the glovebox's systems, they performed some on-orbit commissioning operations. These initial glovebox activities were supported by scientists and engineers working in a tele-science center at the Microgravity Development Laboratory — a unique Marshall Center facility that helps scientists and engineers prepare investigations from conception to implementation in space. This laboratory has an identical engineering model of the glovebox for investigation testing and flight preparation.

The Space Station glovebox occupies a floor-to-ceiling rack inside Destiny. It is more than twice as large as gloveboxes flown on the Space Shuttle and can hold larger investigations that are about the size of an airline carry-on bag.

The part of the unit that holds experiment equipment is called the Work Volume, and has a usable volume of about 67 gallons (255 liters). This work space is approximately waist-high and can slide out to extended or protracted positions, making it easier for crew members to use. An airlock under the work volume can be accessed to bring objects safely into the work volume, while other activities are going on inside the glovebox.



Dr. Richard Grugel, a materials scientist at NASA's Marshall Space Flight in Huntsville, Ala., examines the furnace used to conduct his Pore Formation and Mobility Investigation — one of the first two materials science experiments conducted on the International Space Station.

The glovebox has side ports, 16 inches (40 centimeters) in diameter, for setting up and manipulating equipment inside the box. The ports are equipped with rugged gloves that are sealed tightly to prevent leaks. The gloves can be removed to provide uninhibited access to the inside of the glovebox when contaminants are not present.

The Station glovebox allows investigators to control their investigations inside the box from the ground. It has an upgraded video system and a coldplate that can provide cooling for experiment hardware. It provides vacuum, venting and gaseous nitrogen, power and data interfaces to investigations.

All of these improvements allow the Microgravity Science Glovebox to accommodate a broad range of investigations. It is set up like a traditional lab bench on Earth to minimize the gap between what can be accomplished in a ground-based lab and what can be achieved in the Space Station lab.

The Microgravity Science Glovebox is designed to support Station investigations for 10 years, with occasional replacement of limited life parts in orbit and upgrades in technology to video and data systems.

Investigation Operations

The Microgravity Science Glovebox accommodates small and medium-sized investigations from many disciplines including biotechnology, combustion science, fluid physics, fundamental physics and materials science. Many of these experiments use chemicals or burning or molten samples that must be contained.

The crewmembers insert their hands in gloves attached directly to the facility doors. Using gloves, they can safely manipulate samples inside the sealed working area.

As investigations are conducted in space, the crew can see inside the glovebox. A video display shows glovebox investigations, and the crew can scrutinize samples with a microscope attached to the inside of the work volume. Video is sent from the Space Station to scientists on Earth so they can observe their investigations as they take place in orbit.

As part of the initial glovebox science activities, two investigations were conducted during Expedition Five:

- Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environ ment Investigation (PFMI), *developed at the Marshall Center by principal investigator Dr. Richard Grugel.*
- Solidification Using a Baffle in Sealed Ampoules (SUBSA) *was developed by principal investigator Dr. Aleksander Ostrogorsky of the Rensselaer Polytechnic Institute in Troy, New York.*

Astronaut Mike Foale, Expedition 8 commander and science officer, installs equipment in the Microgravity Science Glovebox for the Pore Formation and Mobility Investigation experiment in November 2003 on the International Space Station. This experiment studies how bubbles form in metal and crystal samples, deteriorating the samples' strength and usefulness in experiments.

The pore formation and the solidification experiments (PFMI and SUBSA) were the first materials science investigations conducted on the Station. The pore formation investigation melted a material and then solidified it. As the materials solidify, tiny holes or pores form. These pores can affect how strong a material is and how well it performs. This experiment examined ways to control pore formation and improve materials processing for many applications including turbine blades used in aircraft engines.

The SUBSA investigation melted materials used for semiconductor crystals, a key component in computers and other electronic devices. On Earth, convection — the gravity-dependent phenomenon, which causes hot air to rise — can cause defects in semiconductors and other materials. As the material melts, convection causes mixing and fluid motion. Investigators used a moving baffle to see if it reduced convection in the melt and improved crystal formation.

Since June 2002 there have been a total of 12 investigations operated in the MSG for a total of over 2,600 hours. There are approximately 18 additional glovebox investigations being planned for future Space Station missions in the near term.

Flight History/Background

The development of the Microgravity Science Glovebox builds on a series of successes with the Middeck Glovebox and Spacelab Glovebox, both used on several prior Space Shuttle missions and on the Russian space station Mir. These gloveboxes also were built by Bradford Engineering B.V., an engineering company in The Netherlands, in collaboration with the Marshall Center.

The Station glovebox supports larger, more sophisticated investigations, expanding the capabilities of its predecessors.

Benefits

The Microgravity Science Glovebox makes it possible to do investigations in space similarly to those done in ground-based laboratories. It provides a safe environment for research with liquids, flames and particles used as a part of everyday research on Earth.

Without the glovebox, many types of hands-on investigations would be impossible or severely restricted on the Station. The Microgravity Science Glovebox is a valuable research tool that lets space crews handle materials safely.

The glovebox allows scientists to test small parts of larger investigations in a microgravity environment, try out equipment in microgravity, and even do complete laboratory-like investigations. It also enables researchers to fly simple investigations more quickly.

The glovebox can support all key areas of microgravity research as well as other scientific fields that may want to use it. This makes it a useful laboratory resource for scientists in many different fields conducting a wide array of investigations.

For more information on the Microgravity Science Glovebox and other Space Station investigations, please visit:

http://www.nasa.gov

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