

Glovebox for Suborbital and Parabolic Flight Research

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Introduction

In December of 2008, at the annual meeting of the American Geophysical Union, NASA sponsored a workshop for researchers and flight providers to explore the use of commercial suborbital flight vehicles as research platforms. Many scenarios were considered, including having investigators fly with their experiments as is done during parabolic flight research. This proposed scenario (which may occur in 2020) suggested the need for a glovebox to provide an experiment workstation that provides secondary containment of test materials. In previous iterations, the canopy from a neonatal intensive care incubator was adapted to create a glovebox to provide secondary containment for biomedical experiments during 18 parabolic flight missions. Based on that experience, a new glovebox has been created that is compatible with parabolic flight aircraft and commercial suborbital space craft originally intended for space tourism.

Suborbital Flight Glovebox Features

The custom-designed glovebox, made of aluminum and transparent polycarbonate (Figure, left), is designed to provide secondary containment for experiments using fluids, solids, and large particulate; the current glovebox does not have a pressure seal to contain gases. The glovebox is the equivalent size of two stacked ISS stowage lockers (18.5" x 23" x 21.5") and weighs 35 lbs, leaving up to 65 lbs for experiment weight. Experiments can be attached to interchangeable mounting boards that are 20" x 17" or multiple mounting boards that fit within that footprint. The mounting boards are fastened to the bottom of the glovebox for flight. The inside of the glovebox mounting plate and canopy surfaces can also be used to mount experiment components; camera mounts on the canopy record experiment function with LED light strips to provide illumination. The glovebox features side doors that hinge down for

experiment installation, servicing, and removal (Figure left), as well as three pairs of arm access ports to permit interaction with the experiment by investigators during flight. During suborbital flight, arm access ports are on the end of the glovebox so that the investigator can position themselves in the aisle of the suborbital spacecraft (Figure center-right). For parabolic flight, arm access ports are also available on each side door so a total of three investigators can interact with the experiment in-flight (Figure right). External electrical connectors are located in the front corners of the glovebox to receive spacecraft power (24 V, 2.1 A x 2) that is distributed to the experiments inside of the glovebox via sealed cable feed-through ports. The glovebox has undergone design review and performance testing to assure that it would provide adequate accommodation and secondary containment for the experiments and mate correctly to the payload mounting structure in the cabin of SpaceShipTwo and New Shepard.

Future Plans

The first opportunity to evaluate the glovebox performance in suborbital flight is anticipated in 2020 onboard the Virgin Galactic SpaceShipTwo. The glovebox was used to test the rehydration of dehydrated red blood cells in reduced gravity during parabolic flight in November 2019 with all glovebox features performing well. Input from suborbital and parabolic flight investigators to improve the design and functionality of the glovebox is welcomed.

Acknowledgement

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Figures: Glovebox with sides up and down (left), illuminated (center), and mounted inside the cabin of SpaceShipTwo (center-right) and mounted on a stand for parabolic flight (right)