NASA Facts

National Aeronautics and
Space Administration

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Huntsville, Alabama 35812

Return to Flight Focus Area

External Tank
Liquid Hydrogen Tank/Intertank Flange

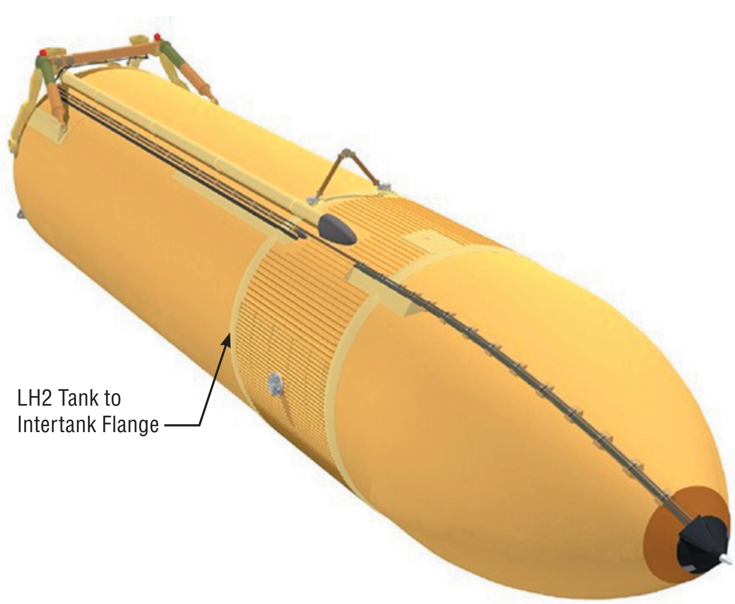
As part of NASA's work to return the Space Shuttle to flight, the Space Shuttle Program has examined all areas where the External Tank's foam insulation, a component of the tank's Thermal Protection System, could potentially be lost during launch and ascent.

Returning the Space Shuttle to flight is the first step in realizing the Vision for Space Exploration, which calls for a stepping stone strategy of human and robotic missions to achieve new exploration goals. NASA fuels discoveries that make the world smarter, healthier and safer. The Shuttle will be used to complete assembly of the International Space Station, a vital research platform for human endurance in space and a test bed for technologies and techniques that will enable longer journeys to the Moon, Mars and beyond.

To further minimize the potential for debris loss, a top-to-bottom assessment of the tank's Thermal Protection System has been completed. As part of this process, the External Tank Project Office re-evaluated the area where the liquid hydrogen tank is attached to the intertank flange and has made several improvements.

The External Tank's intertank is the cylinder structure that joins the liquid hydrogen tank and the liquid oxygen tank. Flanges—a rib or bracket that permits one object to attach to another—are affixed at the top and bottom of the intertank so the hydrogen and oxygen tanks can be joined. The liquid hydrogen tank flange is at the bottom of the intertank. After the two tanks are joined to the intertank, the flanges at both ends are insulated with foam.

During the tank assessment, testing and analysis revealed gaseous nitrogen used to purge the intertank area could potentially turn to liquid when exposed to the extreme cold of the liquid hydrogen: The temperature of the liquid hydrogen tank is near minus 423 degrees. Once liquid nitrogen forms inside the intertank area it can potentially migrate to any voids—or spaces—in the foam or voids that are contained in the foam adjacent to the flange located near the liquid hydrogen tank.



During ascent, the heat generated by the decreasing liquid hydrogen level in the tank causes the liquid nitrogen to rapidly return to gaseous form, building pressure that can cause foam loss. This phenomenon is known as cryo-ingestion—cryo-pumping is the same as cryo-ingestion except it addresses surface air that is pulled into voids in the foam when the tank is filled and reaches cryogenic temperatures.

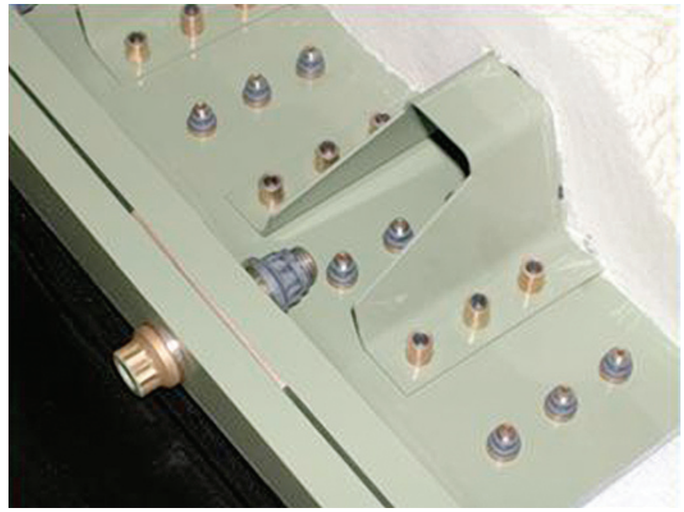
Foam loss has not been seen in the liquid oxygen tank flange area because the near minus 297 degree temperature of the liquid oxygen is not cold enough to turn the gaseous nitrogen to liquid.

Improvements

To reduce the number of voids, an enhanced close-out—or finishing—procedure that includes improved foam application to the stringer area, or intertank ribbing, and to the upper and lower area of the flange has been implemented. The hand-sprayed foam is also being applied with an enhanced finishing procedure that requires four technicians, a new mold-injection procedure to the intertank's ribbing and real-time videotaped surveillance of the process.

The enhanced process requires that during the manual spray, one technician sprays and another observes to detect possible imperfections so they can be immediately repaired. Additionally, there is an observer in the spray cell who can determine the quality of the spray and a camera person who videos the spray. Outside of the spray cell, there are other observers—including additional sprayers and quality engineers—who watch the live video feed and who are in radio contact with the spray booth should any imperfections be detected.

Additionally, the flange bolts that connect the liquid hydrogen tank and intertank have been reversed. By reversing the bolts, the nut ends are enclosed by the intertank's stringers. The stringers are then filled with foam, incorporating a new process that requires injecting foam into a mold. The changes provide the technician with a less complex structure to spray and reduce chances for defects.



This image shows the bolt reversal on the lower flange.

The spraying process on the intertank's thrust panel has also been changed. The new three-step procedure requires two days to complete and includes dividing the panel into sections, an additional sprayer and lead-in and lead-out panels to assure a smooth spray.

In addition to the changes, numerous controls and process verifications have been incorporated to assure compliance to engineering requirements. These controls include engineering evaluation of processing constraints; real-time and video observation of the process; and dissection of sample panels.

Steps are also being taken to prevent the cryo-ingestion that takes place when the intertank is purged with nitrogen. One such step is the addition of a sealant to the threads on the flange bolts. This preventative action reduces the risk for foam debris from the flange region.

For more information, visit **http://www.nasa.gov**.

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