

National Aeronautics and
Space Administration

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Return to Flight Focus Area

External Tank Liquid Oxygen Feedline Bellows

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.

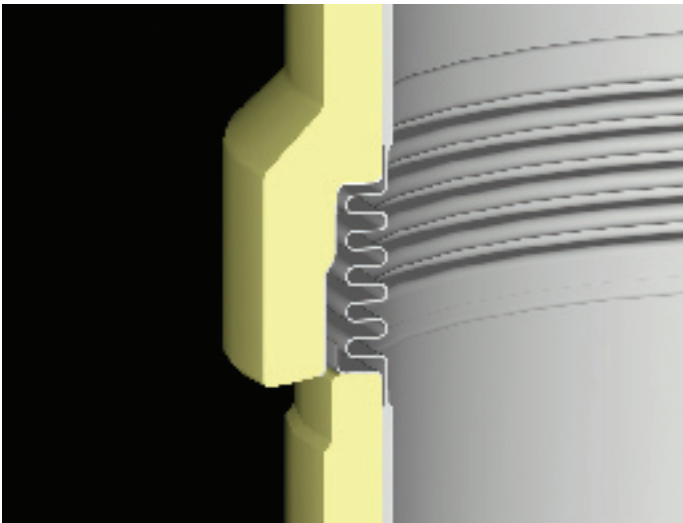
The Space Shuttle External Tank Project is redesigning the bellows on the tank's liquid oxygen (LO2) feedline, topmost fueline, as part of the Shuttle Program's efforts to minimize potential debris sources during launch and ascent. The modification will reduce the potential for ice accumulation on the bellows, improving the overall safety of the tank.

The Space Shuttle Program determined that the original design of the three external bellows could permit ice to form around the outside of the bellows and ultimately that ice could be shaken free during launch and potentially damage the Orbiter. Though this typically happens due to the vibration that occurs during the initial stages of liftoff and the climb to orbit,

the potential still exists for ice and frost to come off later when it would be a more hazardous debris source.

The liquid oxygen feedline carries liquid oxygen from the tank to the main engines. The bellows are the joints that allow the feedline to move, or flex, when the tank is assembled, when it is fueled, and during liftoff and ascent. They are part of the liquid oxygen feedline assembly that extends externally along the right side of the liquid hydrogen tank, up to and within the intertank—the section of the tank that joins the liquid hydrogen and oxygen tanks—and then to the aft dome, or tail, of the liquid oxygen tank.





New 'drip-lip' configuration on bellows

The feedline, which is approximately 70 feet long and about 17 inches in diameter, is insulated with foam. However, because the bellows must allow for movement, they are not insulated with foam.

Two of the liquid oxygen feedline bellows are located inside the intertank and three are on the outside of the tank. Of the outside bellows, two are near the aft end of the tank and one is near the top of the hydrogen tank. Of the five bellows, the two in the intertank and the two located at the aft of the tank are not considered a source for ice or foam debris that can damage the Orbiter. For STS-114, the Return to Flight mission, the focus for the modifications has concentrated on the bellows located near the top of the hydrogen tank, near the liquid oxygen feedline fairing.

The bellows are protected by a rain-shield covered with BX-265 insulating foam. However, because the shield is designed to permit movement, the bellows are exposed to open air. When moisture in the air contacts the extreme-cold surface of the exposed bellows, ice and frost may form, presenting a potential source of debris. The cold bellows surface is caused by the near minus-297 degree liquid oxygen.

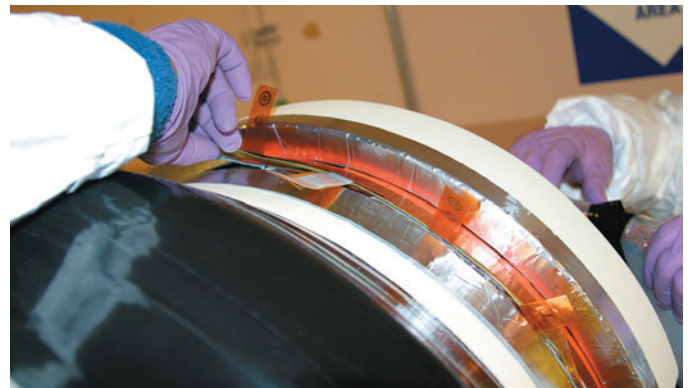
To prevent ice from forming, the insulating foam on the bellow's cover has been reshaped to include a "drip-lip" that allows condensate, or water, to run off. The new "lip" is squared at its bottom end—it has a slight 10 degree angle—so that the condensate drips off the cover. The original design was angled toward the tip of the rain-shield, which allowed water to contact the shield and freeze.

Though the Space Shuttle Program decided the drip-lip configuration would be flown on STS-114, the External Tank Project



The redesigned bellows on tank ET-120.

Office continued to pursue the option of a strip heater on the topmost bellows to further reduce the amount of ice and frost formed. The installation of the heater was planned for the third Return to Flight tank, ET-119. However, new information from debris studies performed by the Space Shuttle Engineering and Integration Office showed that any ice formed on the bellows located near liquid oxygen feedline fairing poses a significant debris concern. Therefore, it was decided a heater should be added to that bellows before the STS-114 mission.



Mock-up of the bellows heater.

The heater is a copper-nickel alloy metal strip heater, similar to heaters used on the Solid Rocket Motor joints, which will keep the bellows area slightly warmer than freezing, about 40 degrees Fahrenheit. The heater strips are about 53 inches long – the circumference of the bellows – and about 0.5 inches wide. The two heater strips are covered and joined by a silicone gasket that allows the heater to be bonded between the bellows rain shield and end shield. Tabs placed at intervals on the heater assist in its placement on the bellows and allow pull tests to verify the strength of the adhesive bond.

The heater, which is connected to the ground support equipment that operates prior to launch, will be turned on shortly after the liquid oxygen tank begins fast fill approximately 5 hours and 10 minutes before launch, and turned off 1 minute and 52 seconds before launch.

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

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