National Aeronautics and Space Administration

NASAfacts

Space Shuttle External Tank ET-128, STS-124

ET-128, which will fly on the STS-124 space shuttle mission, is the first tank completed since the first Return to Flight mission, STS-114, July 2006, with redesigned features incorporated during production. It also is the first tank to fly with redesigned liquid hydrogen ice frost ramps and liquid oxygen feedline support brackets.

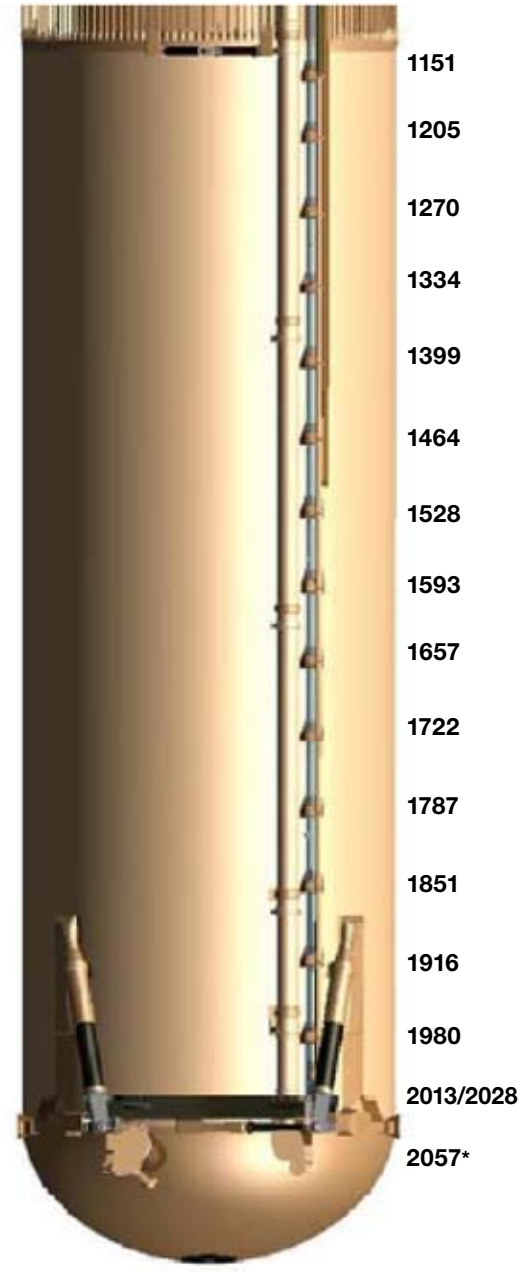
The Space Shuttle Program remains committed to understanding external tank foam in order to more accurately assess potential risks and improve the space shuttle external tank. A number of improvements were made prior to the first Return to Flight mission and additional changes have been made since that time. While external tank foam loss can never be completely eliminated, the program continues to make tank improvements to minimize foam and ice loss by looking at areas where debris may be shed, prioritizing them and methodically eliminating them one at a time.

ET-128 shipped from NASA's Michoud Assembly Facility in New Orleans March 20, 2008, headed to Kennedy Space Center, Fla., (Lockheed Martin/NASA Michoud)

Liquid Hydrogen Tank Ice Frost Ramps

The Space Shuttle Program approved a redesign to the ramps after foam debris loss during previous shuttle flights and after cracks were discovered during post-STS-114 dissections on external tank ET-120.

The external fuel tank main propulsion system pressurization lines and cable trays are attached along the length of the tank at multiple locations by metal support brackets. They are protected from forming ice and frost during tanking operations by foam protuberances called ice frost ramps. There are 36 ice/frost ramps on the tank, 12 on the liquid oxygen tank, seven on the intertank and 17 on the liquid hydrogen tank. The size and design of each ice frost ramp depends on its location. The smaller ramps on the liquid oxygen tank are roughly 1.5 feet long by 1.5 feet wide by 5 inches high and weigh about 12 ounces. The larger ramps on the liquid hydrogen tank are roughly 2 feet long by 2 feet wide by 1 foot high and weigh approximately 1.7 pounds each.



Redesign changes were incorporated at all 17 ice frost ramp locations on the liquid hydrogen tank (stations 1151 through 2057).

***Station 2057 is located under the umbilical feed for the liquid oxygen tank feedline.**

Lockheed Martin technicians at NASA's Michoud Assembly Facility apply ice frost ramps to ET-128.

Redesign changes were incorporated into all 17 ice frost ramps on the liquid hydrogen tank (stations 1151 through 2057) to reduce foam loss. They appear identical to the previous design but several changes have been made:

- BX* manual spray foam has replaced PDL* and NCFI* foam in the ramp's base cutout to reduce debonding and cracking.
- Pressline and cable tray bracket feet corners have been rounded to reduce stresses.
- Shear pin holes have been sealed to reduce leak paths.

***BX is a type of foam used on the tank's "closeout," or final areas, and is applied manually or hand-sprayed. PDL is an acronym for Product Development Laboratory, the first supplier of the foam during the early days of the external tank's development. PDL foam is hand-poured foam used for filling odd-shaped cavities. NCFI foam is used on the aft dome, or bottom, of the liquid hydrogen tank.**

- Isolators were primed to promote adhesion; isolator corners were rounded to help reduce thermal protection system (foam) stresses.

- BX manual spray was applied in bracket pockets to reduce geometric voids.

A similar ice frost ramp configuration was flown on ET-120/ STS120 and performed exceptionally well with no debris events observed.

Liquid Oxygen Feedline Brackets

Because the feedline bracket configuration has the potential for foam and ice debris loss, the Space Shuttle Program approved a redesign that minimizes ice formation in under-insulated areas and minimizes foam damage or loss due to ice and foam interferences during normal feedline relative motion.

The liquid oxygen tank feedline, approximately 70 feet long and about 17 inches in diameter, carries liquid oxygen from the liquid oxygen tank to the orbiter where it is distributed internally to the main engines. The feedline is attached to the tank with five brackets that resemble an L-shaped boomerang. The brackets allow movement or "articulation" of the feedline to compensate for propellant flow during fueling on the launch pad, during detanking and take into consideration during launch external tank thermal expansion and contraction. Liquid oxygen feedline bracket changes include:

- Titanium brackets replace aluminum brackets at four locations (XT 1129, XT 1377, Xt 1624 and Xt 1871) to minimize ice formation in under-insulated areas. The amount of foam required to cover the brackets and the propensity for ice development was reduced. Titanium is much less thermally conductive than aluminum.

- Zero-gap/slip plane (Teflon) material was applied to the upper outboard monoball attachment to eliminate ice adhension.

- Additional foam was added to the feedline to minimize cold spots and reduce ice.

Other space shuttle external fuel tank changes since Return to Flight:

The following major changes were made to space shuttle external tanks that have flown since Return to Flight. Until ET-128, modifications were made on all tanks that have flown after the tanks were manufactured.

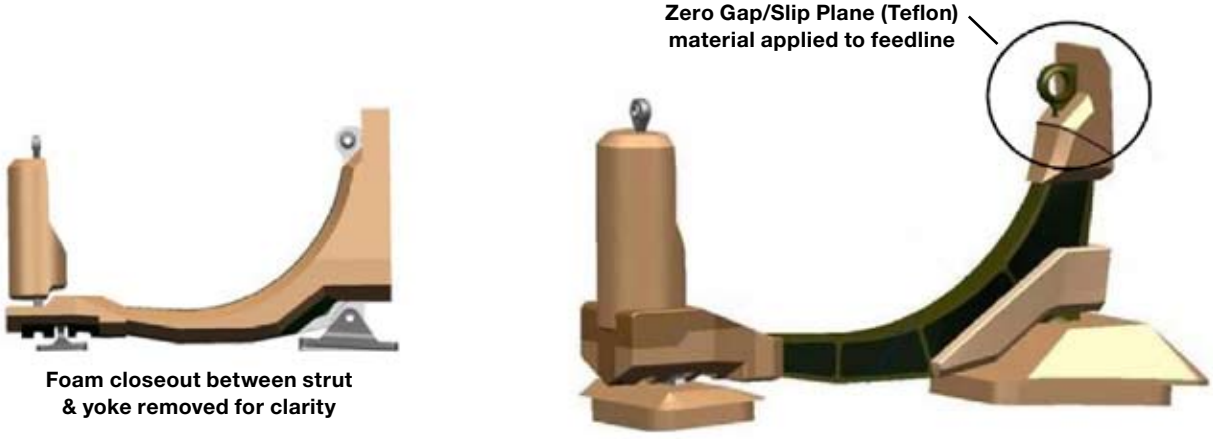
First Return to Flight mission, STS-114 (ET-121), July 2005

- The external tank forward shuttle attach fitting, called the bipod, was redesigned to eliminate the large insulating foam ramps as a debris source; replaced with electric heaters.

- Four rod headers were placed below each forward bipod fitting to reduce heat loss.

- An enhanced closeout, or finishing, procedure was implemented to improve foam application to the stringer, or intertank ribbing, and to the upper and lower area of the liquid hydrogen intertank flange.

- The liquid oxygen feedline bellows were reshaped to include a "drip lip" that allows moisture to run off and prevent freezing. A strip heater was added on the bellow to further reduce the amount of ice/frost formed. Joints on the liquid oxygen feedline assembly allow the the feedline to move during installation and assembly during liquid hydrogen tank fill. Because it must flex, it was not insulated.



Liquid oxygen feedline brackets were redesigned to minimize ice formation in under-insulated areas

Second Return to Flight mission STS-121 (ET-119), July 2006

- The protuberance airload, or PAL, ramp was removed.
- Ice frost ramp extensions were added at locations where the PAL ramp had been removed to make the geometry of the ramps consistent with other locations on the tank. A total of nine extensions were added, six on the liquid hydrogen tank and three on the liquid oxygen tank.

STS-120 (ET-120), Oct.-Nov 2007

- Fourteen liquid hydrogen ice frost ramps and four feedline brackets were modified with a different foam configuration and flown as an interim measure before the redesign flying on ET-128.

STS-122 (ET-125), Feb. 7, 2008

- The engine cutoff sensor feed-through connector on the liquid hydrogen tank was modified on the launch pad after eco sensor system false readings prevented a December 2007 launch. A modified connector was designed with pins and sockets soldered together. The same configuration has flown on subsequent flights. A team continues to study a possible long-term fix to the eco sensor system.

Remaining space shuttle external tanks assigned to space shuttle missions:

ET-127 – STS-125
ET-129 – STS-126
ET-130 – STS-119
ET-131 – STS-127
ET-132 – STS-128
ET-133 – STS-129
ET-134 – STS-130
ET-135 – STS-131
ET-136 – STS-132
ET-137 – STS-133
ET-138 – tank for a launch on need, or rescue, mission for STS-133.

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