National Aeronautics and Space Administration

NASA

NASAfacts

Preparing the External Tank, ET-118

About six hours before Space Shuttle Discovery's launch, the bright orange 15-story-tall fuel tank is loaded with 535,000 gallons of liquid hydrogen and oxygen. Just before liftoff, these super cold liquids are mixed and burned by the shuttle's three main engines, which gulp it at a rate equal to emptying the average size backyard swimming pool in 20 seconds.

The external tank's aluminum skin is a tenth-of-an-inch thick in most places and is covered with polyurethane-like foam averaging an inch thick, which insulates the propellants, prevents ice formation on its exterior, and protects its skin from aerodynamic heat during flight. About 90 percent of the foam is applied by automated systems, while the remainder is applied manually.

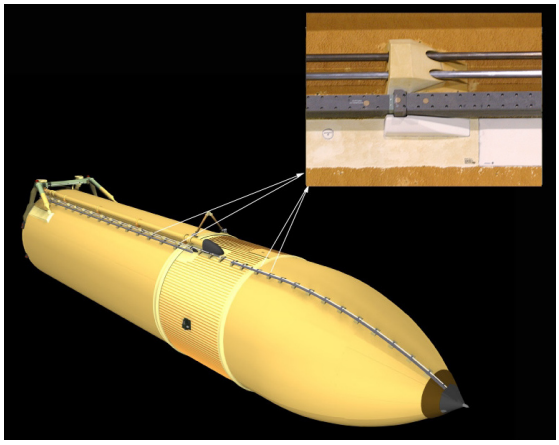
The Space Shuttle Program continues to evaluate the performance of the external tank and remains committed to rigorously pursuing improvements until the shuttle is retired from service in 2010. Work is under way to reduce, and eventually eliminate, the foam Ice/Frost ramps that cover metal brackets on the side of the tank.

Ice/Frost Ramps

The main propulsion system pressurization lines and cable trays are attached along the length of the tank at multiple locations by metal support brackets. These metal brackets are protected from forming ice and frost during tanking operations by foam that is poured and formed into specific shapes, called Ice/Frost Ramps. There are 34 Ice/Frost Ramps on the tank, 12 on the liquid oxygen tank, six on the intertank, and 16 on the liquid hydrogen tank. The size of the Ice/Frost Ramps is dependent upon location. The smaller ramps on the liquid oxygen tank are roughly 1.5 feet long by 1.5 feet wide by 5 inches high. Each weighs about 12 ounces. The larger ramps on the liquid hydrogen tank are roughly 2 feet long by 2 feet wide by 1 foot high. They weigh approximately1.7 pounds each.

Some foam loss from the external tank is expected during ascent. Historically, the estimated mass of foam loss on ice/frost ramps has been minimal and within the current debris requirement of 0.084 pounds for the area. The acerage foam on the hydrogen tank adjacent to the Ice/Frost ramps has a debris maximum requirement of 0.25 pounds.

Camera data from STS-121 indicates that acerage foam adjacent to an Ice/Frost ramp was liberated during ascent, but it was less than the 0.25 pound allowable from that area. Additionally, this foam broke into smaller pieces as it liberated and did so well after 135 seconds into the flight of STS-121. The data gathered during the STS-121 flight will help in NASA's continued efforts to understand foam and more accurately assess potential risks.



Ice/Frost Ramps are foam segments that protect against ice and frost formation. There are 34 Ice/Frost Ramps on the tank.

Nondestructive evaluation techniques and dissection activity on one tank in the inventory (ET-120) which had undergone two pre-flight sequences of cryogenic chill-down and pressurization to flight-like levels revealed cracks in the Ice/Frost Ramps. During dissection of one crack, a portion of the base foam was found to have vertical and horizontal cracks which separated into layers near the substrate, or base aluminum skin of the tank.

Options to resolve the Ice/Frost Ramp cracks continue to be studied, including the possibility of reshaping the ramps to reduce thermal stresses in the foam and to reduce the amount of foam used on each ramp. Wind tunnel tests will continue to be conducted to verify the possibilities for redesign options.

Ice/Frost Ramps are foam segments that protect against ice and frost formation. There are 34 Ice/Frost Ramps on the tank.

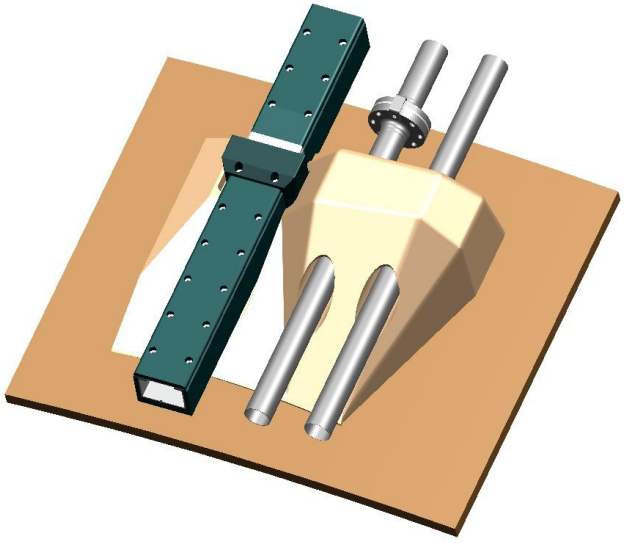
Two redesign options are being considered as an intermediate fix for the Ice/Frost Ramp. Wind tunnel and icing tests will continue and assessments will be made to verify the selected reshaped configuration can safely perform within the aerodynamic and thermal environments. The Space Shuttle Program will downselect the redesign model that performs best to reduce foam loss on the external tank. The reshaped configuration will not be flown until calendar year 2007. The current Ice/Frost Ramp design will fly on the STS-115 and STS-116 missions, and tanks will be modified beginning with the STS-117 mission.

The Space Shuttle Program management made a decision in April 2006 to fly the Ice/Frost Ramps in their current configuration. The rationale for doing so was based on several factors including the performance of the Ice/Frost Ramps on previous flights. Any design changes would need to thoroughly tested and certified before modifying the tank. To do otherwise could result in more uncertainty instead of reducing risk of the tank.

Small foam ramps, called Ice/Frost Ramp extensions, have been added to the ice/frost ramp locations where the PAL ramps were removed. The new extensions were added to make the geometry of those Ice/Frost Ramps consistent with other locations on the tank. A total of nine extensions were added, six on LH2 and three on LO2. Each weighs .10 pounds. ET-119, flown on the STS-121 mission, was the first tank to fly without PAL ramps and with Ice/Frost Ramp extensions.

Current Ice/Frost Ramp

Testing and analysis continues for future modifications to the Ice/Frost Ramp. New cameras will allow better insight into the current ramp performance, which will help in the redesign effort. Flying the current Ice/Frost Ramps limits the design changes on the tank, which has already undergone a significant redesign with the removal of the protuberance air load (PAL) ramp.



Current Ice/Frost Ramp Design.

NASA**facts**

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812

FS-2006-08-114-MSFC Pub 8-40640

August 2006