NASA Facts

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

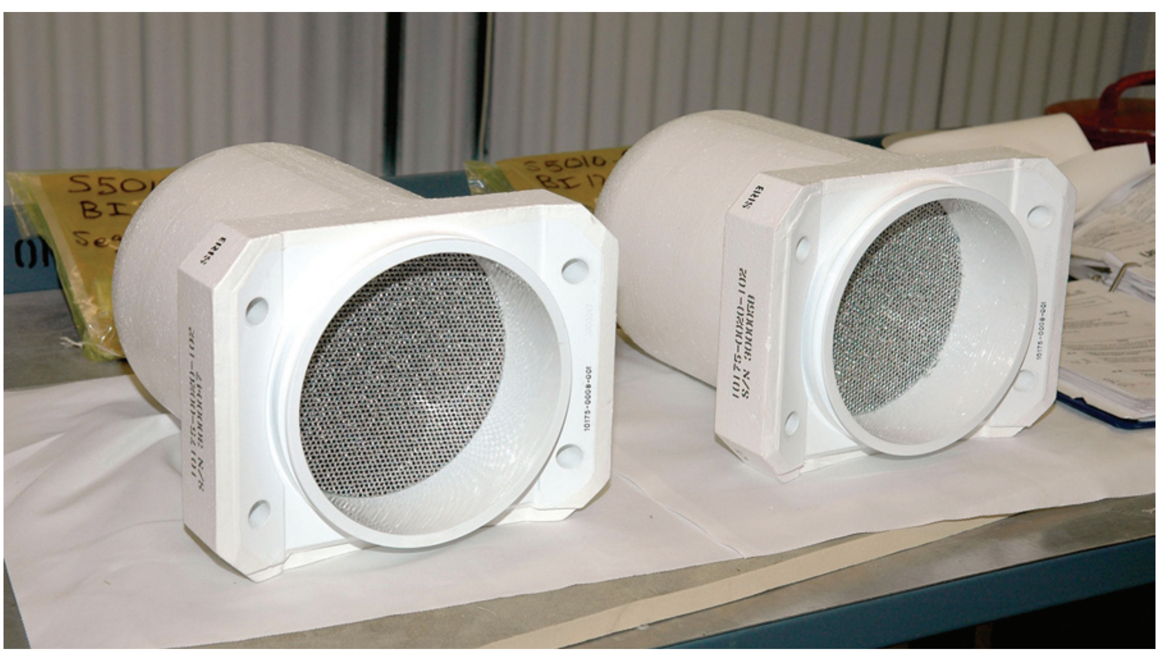
Return to Flight Focus Area

Bolt Catcher Modifications on the Solid Rocket Booster

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.

As part of NASA's effort to return to safe, reliable spaceflight, the Space Shuttle's Solid Rocket Booster Project Office is modifying the bolt catcher from a two-piece welded design to a one-piece machined design. The bolt catcher captures part of the bolt that attaches the boosters to the Shuttle's External Tank.

Each Space Shuttle flies with two bolt catchers fixed to the forward, or top, area of the External Tank at the Solid Rocket Booster/External Tank forward attach point. At approximately two minutes after launch, booster separation begins when pyrotechnic devices fire to break the bolts that hold the tank to the boosters. The forward bolt is vertically attached to both the Solid Rocket Booster and the External Tank. The canister-like bolt catcher captures the part of the bolt that is retained with the External Tank; the other half of the bolt remains with the booster, secured within the forward skirt thrust post.



These two bolt catchers are ready for installation on orbiter Discovery's External Tank.

Though the bolt catcher is mounted on the External Tank, it is considered part of the Solid Rocket Booster element design. The redesigned bolt catcher is built by General Products of Huntsville, Ala., and insulated by United Space Alliance at the Kennedy Space Center at Cape Canaveral, Fla.

The original bolt catcher design consisted of an aluminum dome welded to a machined aluminum base and bolted to the External Tank's fittings. It is about 12 inches tall, 8 inches in diameter and weighs about 11 pounds. The inside of the bolt catcher is filled with a metal, honeycomb-like energy absorber to limit the impact of the bolt as it is caught.

The bolt, known as a separation bolt, is about 25 inches long, approximately 3 inches in diameter and weighs about 70 pounds. It has a groove, or separation plane, about 11.5 inches from the top that allows it to break when the pyrotechnic devices fire.

The part of the bolt that remains on the Solid Rocket Booster is inspected after flight to ensure the break was clean. The bolt catcher and the bolt half it captures disintegrates with the External Tank as the tank falls toward the ocean.

Following the loss of the Space Shuttle Columbia and its crew, a series of tests were performed by the Solid Rocket Booster Project Office to replicate the loads, or the forces, which the bolt catcher is subjected to during launch. The testing and analysis revealed the bolt catcher had a safety margin that was less than had been previously assessed.

Consequently, the Solid Rocket Booster Project Office reviewed camera and video coverage available of the separation on the External Tank side. The coverage revealed that the bolt catchers functioned properly on all flights where camera footage was available.

To achieve the desired safety margin, a redesign effort was undertaken, incorporating a comprehensive testing program.

In the Return to Flight modifications, the bolt catcher housing will be made from a single piece of aluminum forging, thus eliminating the weld from the original design. In addition, the wall thickness on the catcher will be increased from .125 to .25 inches and it will be made with a stronger aluminum alloy, AL7050.

The Booster Project Office is also changing the energy-absorbing material to one that better accepts the amount of load transferred into the bolt catcher when the bolt is released. The original material was a corrugated sheet of aluminum wrapped spirally on a mandrel to attain the cylindrical shape that fit into the bolt catcher. The new design has a more open cell texture, much like a bee's honeycomb.

The thermal protection material is also being changed from the original super lightweight ablator to a machined cork covered with a protective paint finish. An ablator or ablative is a material that erodes to dissipate heat, offering a potential for debris during liftoff. Machined cork was selected as its replacement because it has a strong adhesive system that has a proven record of success in other areas on the Solid Rocket Booster. A layer of hypalon paint will protect the cork from moisture.

The External Tank attachment bolts and inserts—those that hold the bolt catcher in place—also are being resized from three-eighths inch to nine-sixteenths inch. The larger attachment bolts and inserts will add strengthen to this area.

A series of static, dynamic and environmental tests have been conducted to determine the design loads and demonstrate the bolt catcher meets the 1.4 factor of safety requirement.

The aft end of the Solid Rocket Booster is attached to the External Tank by three struts, made out of Inconel 718 and designed to react to lateral loads induced during flight. The struts are made in two halves and are held together by a bolt—called aft separation bolts—that is housed inside the struts. When the boosters separate from the tank, the bolts are fractured at a pre-determined spot by a pyrotechnic device, thus splitting the bolt. The two halves of the bolt are caught inside the strut halves by honeycomb energy absorbers on each end of the struts. During the past year, the Booster Project tested the strut honeycomb to confirm its capability and its load transfer characteristics. The tests revealed that modifications to the existing hardware were not needed because the current configuration is robust and there are no load or strength concerns.

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

Explore. Discover. Understand.

April 2005 FS-2005-04-033-MSFC Pub 8-40391