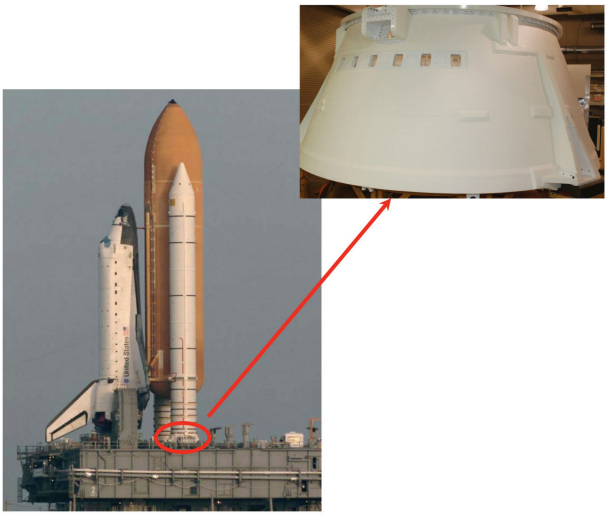
Space Shuttle Solid Rocket Booster

Frangible Nut Crossover System

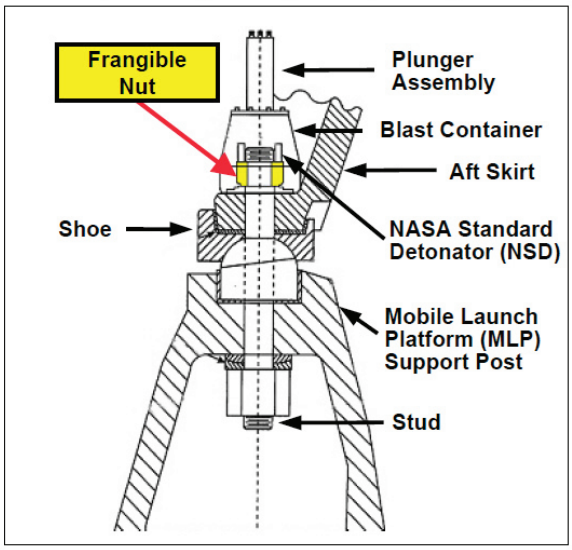
The space shuttle assembly, consisting of the external tank, twin solid rocket boosters (SRBs) and orbiter, is attached to the mobile launch platform (MLP) by the hold-down post system at eight locations at the base of the solid rocket boosters. The hold-down post system is a relatively simple and functional design. Prestressed studs are held in place at the base by standard nuts and at the top with frangible nuts.



SRB Aft Skirt

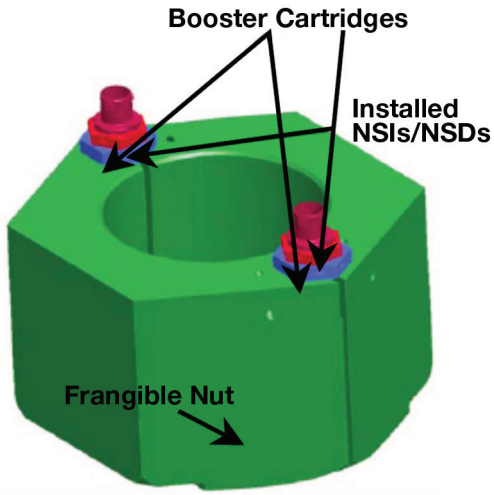
At launch, two pyrotechnic, or explosive, devices "break" a frangible nut into two halves, allowing the stud, which is under high tension, to eject into the hold-down post system and release the space shuttle from the MLP. A number of factors work to slow or interrupt the stud's ejection velocity. At liftoff, a stud not ejected prior to the first space shuttle movement, which occurs approximately 200—250 milliseconds after ignition, becomes bound and/or pinched and results in a hang-up.

During the space shuttle program, 25 stud hang-ups have randomly occurred on 23 launches. Multiple hang-ups on a single mission have only occurred twice, on STS-2, which flew in November 1981, and STS-92, which flew in October 2000. Each had two hang-ups. Concerns have been raised that four or more hang-ups on a mission could exceed the space shuttle load-carrying capability. During the space shuttle Return to Flight, an investigation was conducted to determine the cause of stud hang-ups. Based on the findings of this investigation, a decision was made to redesign the frangible nut to alleviate the leading contributing factor to stud hang-ups.

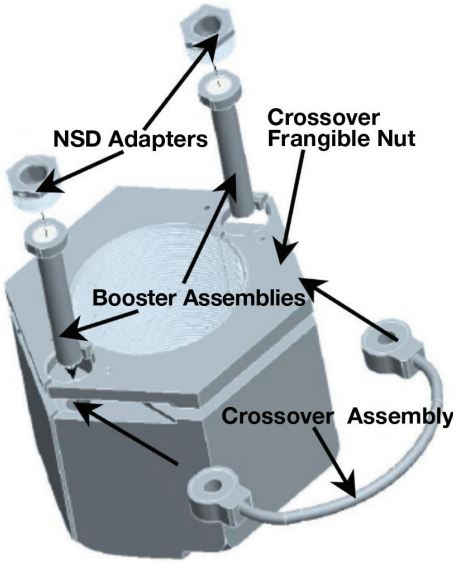


SRB Hold-down Post Assembly

frangible nut crossover system



Old Configuration,
Frangible Nut/Booster Cartridge Assembly



New Design,
Frangible Nut Crossover Assembly

Each frangible nut has two recesses 180 degrees apart, where a pyrotechnic device, or booster cartridge, and detonator are installed. At liftoff, each detonator receives a "fire" signal, which in turn initiates the booster cartridges, causing the frangible nut to fracture. Although only one is actually required to fire and break the frangible nut, two booster cartridges/detonators are used for redundancy. The difference in the booster cartridge function time of the two sides has been determined to decrease initial stud velocity and is determined to be a major contributor to stud hang-ups.

The frangible nut has been modified to incorporate a crossover assembly which pyrotechnically "links" the two booster cartridges/detonators in each frangible nut, resulting in detonation of both sides within 50 microseconds or less, versus a typical difference of approximately 250 microseconds experienced prior to this design modification. With the time reduction, a greater initial velocity is achieved, thereby reducing the probability of a stud hang-up.

After completion of extensive component qualification and system certification testing to prove the design goal of 50 microseconds or less had been achieved, the crossover system design was approved for flight.

The first flight of this new design is on STS-126. The crossover system is installed in all eight hold-down locations on the solid rocket boosters.

Steve Roy, Marshall Space Flight Center,
256-544-0034 (office); 256-684-4791 (cell)

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

www.nasa.gov

NP-2008-09-143-MSFC
8-388221

November 2008