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Featured Projects

NASA Engineers Evaluate Innovative Technique to Detect Hidden Corrosion

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On April 12, 1981, atop rocket engines providing 1.2 million pounds of thrust, Space Shuttle *Columbia* escaped the hold of Earth's gravity and entered orbit more than 160 miles above the Earth's surface. This historic space flight, named STS-1 (Space Transportation System—NASA's official name for the Shuttle), was the first-ever mission for the Space Shuttle fleet. The successful launch and landing cleared the path to space for four other Shuttles—*Challenger*, *Atlantis*, *Discovery*, and *Endeavour*, which was built after *Challenger* was tragically destroyed in 1986.

Over the course of more than a quarter-century since the inaugural launch, the Shuttle fleet has flown nearly 120 missions to space. NASA has Shuttle missions on their launch schedule into the year 2008, and the fleet is currently planned to serve until retirement in 2010. Since safety is a very high priority for NASA, the proper operation and maintenance of every system is exceedingly important. As the most complicated machines ever built, highly advanced technology and expert skill are required to ensure the aging fleet operates safely.



On April 12, 1981, the Space Shuttle Columbia became the first shuttle to orbit the Earth. Photo Courtesy of NASA



Mission Specialist Andy Thomas inspects thermal protection tiles on the Space Shuttle in 2005. Photo courtesy of NASA.

Before every launch and after each landing, NASA's experts inspect all Space Shuttle systems thoroughly, including the thermal protection tiles. The thermal protection system is critical to the Space Shuttle's ability to travel to and from space. The system not only allows the Shuttle to withstand the thermal cycles experienced in space, but it also enables it to return through the Earth's atmosphere, when temperatures reach as high as 3,000°F. As effective as the tiles are, however, they cause problems for NASA inspectors.

The Shuttle tiles are relatively straightforward to inspect for damage. The problem for NASA inspectors arises because the tiles get in the way of inspection underneath them, where there may be hidden corrosion or other damage.

The thermal protection tiles are built to survive each mission undamaged so that they can be re-used on multiple missions. This successful design actually creates a problem for NASA engineers who need to inspect the substructure, because they must avoid disturbing the undamaged tiles. On the very infrequent occasion when a tile is damaged, it is removed and replaced before the next mission, and the engineers can inspect the

substructure. With only a few tiles (at most) damaged per mission and the enormous surface area of the substructure that must be inspected, NASA personnel have been searching for an effective way to look for possible corrosion underneath the tiles.

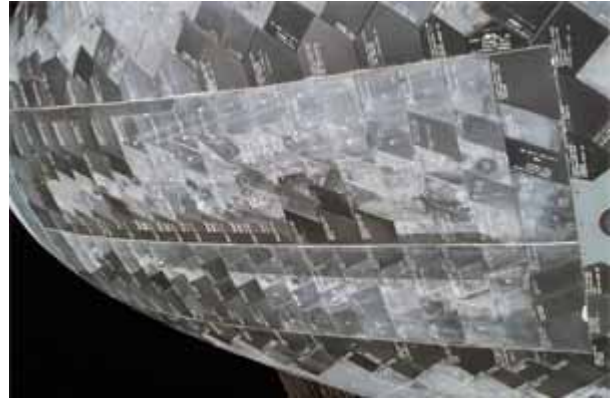
A High-Tech Solution to Extremely Harsh Mission Environments

The tiles provide almost complete coverage of the substructure, but there are very small gaps between tiles that are filled with a ceramic-coated fabric. While these tiles and gap fillers are an excellent barrier to the extreme thermal environments of space and re-entry, the substructure is not completely protected from the various extreme environments the Shuttle encounters. Therefore, the metallic structure is still susceptible to corrosion, wear, and damage.

Without access to the structure's surface underneath the tiles, inspectors can only visually examine one side of it for corrosion. Consequently, any corrosion underneath the tiles goes undetected. To overcome this obstacle, NASA engineers have looked at alternative approaches, such as nondestructive inspection (NDI) methods that allow them to detect hidden corrosion without disturbing the thermal protection tiles. For this purpose, traditional NDI techniques such as eddy current, ultrasonic, and infrared methods are considered deficient.

NASA engineers have turned to a relatively new NDI method developed for astronomy, medicine, and drug and weapons detection. Called pulsed terahertz NDI, the method uses a device that generates extremely high-frequency electromagnetic waves to scan and generate images of objects. For Shuttle inspectors, the technique's main advantage is that high-frequency signals penetrate through non-conductive materials (e.g., thermal protection tiles) and reflect off of metallic surfaces. This technology allows NASA engineers to send a signal through the thermal protection tiles to evaluate the integrity of the metallic substructure's surface. This method can help determine if there is an abnormality—a corrosion flaw, for instance—on the substructure beneath the Shuttle tiles.

True to form, NASA engineers faced with a difficult problem have found a promising and innovative solution. This pulsed terahertz NDI technology, which has been under evaluation, allows NASA inspectors to detect hidden corrosion. Such corrosion, if gone undetected, could pose an imminent threat to the Shuttle fleet and their astronauts. This highly advanced technology, along with all other inspection processes and safety procedures, will allow the Shuttle fleet to conduct their missions and land safely in retirement.



A close-up of thermal protection tiles on the Space Shuttle. Photo courtesy of NASA.



The Space Shuttle Atlantis returns safely from a successful mission in 2002. Photo courtesy of NASA.