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Sandia National Laboratories

Nonproliferation Legacy Technology and Artifact Collection: NASA Space Shuttle Tiles

Todd Alan Pitts, Jason Bolles, and Kristen Reynolds

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico
87185 and Livermore,
California 94550

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ABSTRACT

The NASA Space Shuttle Tiles were used by Sandia in the process of developing the Laser Dynamic Range Imager (LDRI) in support of NASA's Return to Flight following the 2003 Space Shuttle Columbia disaster. The heat shield tiles, provided to Sandia by NASA, are identical to those that were located on the underbelly of the Space Shuttle Columbia's orbiter. Sandia used the tiles to test the efficacy of the LDRI's imaging capabilities. The LDRI was utilized during every space shuttle mission between 2005 and 2011. The tiles are currently located in Building 891 and need to be moved to free up space for operational use. Given their technical significance, Sandia would like to archive them as historically significant items in long-term storage until such time as they can be appropriately displayed or employed as a demonstration artifact.. This document provides basic information about the provenance of this artifact.

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ACRONYMS AND DEFINITIONS

Abbreviation	Definition
ft.	feet
in.	inches
LIDAR	Light Detection and Ranging
LDRI	Laser Dynamic Range Imager
NASA	National Aeronautics and Space Administration
OBSS	Orbiter Boom Sensor System
OUO	Official Use Only
RCC	Reinforced carbon-carbon
TPS	Thermal Protection System
UUR	Unclassified Unlimited Release

1. SUMMARY

The NASA Space Shuttle tiles were loaned to Sandia in support of NASA's Return to Flight effort following the 2003 Shuttle Columbia disaster. The tiles were used by Sandia to test the efficacy of the newly developed Laser Dynamic Range Imager (LDRI), which provided NASA with the technology to scan space shuttle orbiters for damage prior to reentry. The tiles are currently located in Building 891, but the space they occupy is needed for operational use. NASA was not receptive to the tiles being returned. Given their technical significance, Sandia would like to archive them as historically significant items in long-term storage until such time as they can be appropriately displayed or employed as a demonstration artifact.

2. PROVENANCE AND DESCRIPTION

Preserving legacy items beyond their immediate operational life requires balancing their legacy value with requirements stemming from information management, safety, security, and space concerns. Sandia maintains processes and policies governing the retention and disposal of materials and records that must also be considered. Corporate processes provide for access to such options as corporate storage. Basic information for the NASA Space Shuttle Tiles is covered below.

The tiles were provided by NASA in association with Sandia's development of the LDRI. Made of fused silica, the heat shield tiles are identical to those that were located on the underbelly of the Space Shuttle Columbia orbiter. The LDRI was an imaging device developed by Sandia for NASA in the wake of the 2003 Shuttle Columbia disaster.

Columbia Flight STS-107 was the Space Shuttle Program's 113th mission, and the orbiter's 28th flight. During the 2003 launch, pieces of insulating foam fell off the left bipod ramp section of the shuttle's external fuel tank. Launch video indicated a large piece of foam had struck the orbiter's left wing. The impact damaged the RCC (reinforced carbon-carbon) heat shield material on the wing. The heat shield material was part of the orbiter's Thermal Protection System (TPS), a combination of materials protecting the underlying structure from the excessive temperatures experienced during reentry. During the Columbia's reentry, plasma leaked through the hole in the left wing, destroying the orbiter and causing the deaths of seven astronauts.

Following the incident, the Columbia Accident Investigation Board recommended that future shuttles have the capability for on-orbit TPS inspections. Sandia's LDRI was an instrumental contribution to the requested capability and the Return to Flight effort. The LDRI is a LIDAR system, generating 3D images from 2D video. It was capable of detecting damage to an orbiter's TPS as small as 0.020-in crack. The NASA tiles artifact was used by Sandia during development to test the LDRI's ability to image the heat shield tiles and any damage they might sustain.

The LDRI was mounted at the end of the Orbiter Boom Sensor System (OBSS), and was used to inspect each shuttle's TPS immediately after achieving orbit and prior to reentry. The OBSS was a 50-ft. boom carried on board all of NASA's space shuttles from the 2005 Return to Flight by the Space Shuttle Discovery to the 2011 retirement of the Space Shuttle fleet. During the Discovery flight, a first-of-its-kind spacewalking repair was made possible by the OBSS and LDRI.

Sandia's project lead for the effort at that time was Bob Habbit. As of 2020, Center 6700 (Monitoring Systems) bears program management responsibility for the equipment.

2.1. Specifications

2.1.1. Description

The NASA Space Shuttle Tiles (Figure 1, Figure 2) are made of fused silica. The tiles are mounted on a piece of aluminum plate, attached to a Unistrut structural framework. The artifact in total measures roughly 90 inches (in.) long, 50 in. wide and 14 in. in depth. In its current configuration the artifact weighs less than 150 pounds.

Figure 1 – Tiles and Rack

Figure 2 – Tiles and Rack

3. ES&H AND SECURITY

3.1.1. Safety Considerations

There are no safety concerns. Should the tiles be used for demonstration purposes, additional assistance will be necessary from the technical subject matter experts.

3.1.2. Security Considerations

To the best of all parties' knowledge, this object is not sensitive and can be shown at a UUR level.

4. CONTENT DEVELOPMENT

4.1. Available Information

At present, we possess a set of LDRI slides titled *LDRI Orbiter Inspection System* [1] created in 2011, and a set of slides on *Remote Sensing and Verification* [2] created in 2017. Sandia Labs news releases from 2005, 2006, 2013, and 2018 [3-5] provide good information on the purpose and scope of Sandia's work on the LDRI.

4.2. Relevant Topics for NASA Shuttle Tiles

The NASA Space Shuttle Tiles are most relevant as an object of discussion on Sandia's contributions to U.S. space exploration. From the resumption of shuttle flights in 2005 until the final Shuttle Atlantis flight in 2011 – 22 missions in all – Sandia engineers protected astronauts with space-based inspections of the orbiters' heat shields using the LDRI.

REFERENCES

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[7] Space.com, "Columbia Disaster: What Happened, What NASA Learned," February 1, 2019.

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