National Aeronautics and Space Administration

NASA**facts**

Reinforced Carbon-Carbon (RCC) Panels

The Vision for Space Exploration is being made a reality by the Space Shuttle Program at Kennedy Space Center.

During re-entry into Earth's atmosphere, the Space Shuttle travels more than 17,000 miles per hour. Exterior surface temperatures can reach up to 3,000 degrees Fahrenheit.

To protect the orbiter during re-entry, all external surfaces are covered with various types of Thermal Protection System (TPS) materials. The TPS also protects the airframe and major systems from the extremely cold conditions experienced when the vehicle is in the night phase of orbit.

The main types of thermal materials are Reinforced Carbon- Carbon (RCC), Low- and High-Temperature Reusable Surface Insulation tiles, Felt Reusable Surface Insulation blankets, Fibrous Insulation blankets and Inconel honeycomb panels.

The RCC panels are used on the orbiter's wing leading edges; the nose cap and an area immediately aft of the nose cap on the lower surface (chin panel); and the area immediately around the forward orbiter/external tank structural attachment point. The panels are manufactured by Lockheed-Martin's Missile and Fire Control Facilities in Dallas, Texas.

Engineers from around NASA are working on improving the RCC panels used on the leading edge of the wing of the orbiters. In the Orbiter Processing Facility, astronaut Scott E. Parazynski joins some of them in front of the panels on Atlantis.

The leading edges of each of the orbiters' wings have 22 RCC panels. They are light gray and made entirely of carbon composite material. The molded components are approximately 0.25-inch to 0.5-inch thick. During fabrication, the RCC panels are treated so they are resistant to oxidation and covered with a silicon carbide coating and a final coating of a glass sealant. They can withstand temperatures up to 3,220 degrees Fahrenheit.

Although the RCC panels are strong and capable

United Space Alliance worker Dan Kenna positions a Reinforced Carbon-Carbon panel on the table to perform flash thermography. In the background, Paul Ogletree observes the monitor.

of withstanding extreme temperatures, they are thermally conductive. This brings a need to extensively use insulating blankets and tiles behind the RCC panels to protect the structure and attach fittings from heat radiated from the backside.

Prior to each Space Shuttle mission, the RCC panels undergo three inspections to ensure their integrity. The first is a post-flight, visual micro detail inspection of the TPS, which includes the RCC. During this inspection, all exterior surfaces of the orbiter are closely examined and any damage is documented for repair.

The second is a pre-rollout inspection of TPS that also includes the RCC. This visual inspection checks again for any external damage. The third is a "tactile test," or hands-on test, that examines the hottest panels (panels 6-17) for evidence of loose or separated coating. These inspections are required and performed for every flight.

If damage is seen, the RCC section is removed and returned to the vendor for repair and refurbishment. Also, after a specified number of missions, the RCC panels are sent back to the vendor to be recoated.

During return-to-flight activities, all RCC panels undergo extensive nondestructive inspections (NDI) and nondestructive evaluations (NDE). NDI inspections include the use of thermography and CAT scan to detect imperfections or cracks in the structures on and below the surface. Thermography, a relatively new procedure at KSC, uses high intensity light to heat areas of the panels. The panels are then immediately scanned with an infrared camera. As the panels cool, internal flaws are revealed. This form of NDI is in the development stage at KSC as RCC panel testing proceeds.

Computer-aided CAT scan uses magnetic resonance to scan the internal structure of the RCC panels. Panels are sent to a lab in Canoga Park, Calif., where a much larger machine is used to detect flaws.

NDE methods include eddy current, ultrasound and X-ray. Eddy current is a technique that measures coating thickness and density properties of the panels. An electronic field detects disturbances in the panels, such as cracks and imperfections.

During an ultrasound inspection, sound pulse waves are sent out to the component. As they are received back, defects and discontinuities are detected. X-rays of panels are performed at Lockheed Martin facilities in Dallas, Texas.

In addition, several inspections of the metal components behind the RCC panels are performed. First, a visual inspection reveals any flaws to the naked eye. A dye-pen test, using a dye of red or purple, is applied to the component. Then, a blacklight is used to reveal any liquid that has penetrated the components, indicating cracks on or deeper than the surface. Current requirements state KSC will inspect all of the thermal protection system and RCC to verify integrity before flight.

United Space Alliance worker Mike Hyatt attaches a Reinforced Carbon-Carbon (RCC) panel onto the leading edge of the wing of the orbiter Atlantis.

National Aeronautics and Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Fla. 32899

www.nasa.gov