Thermal Protection System Application for the Structural Heat Intercept, Insulation Vibration Evaluation Rig (SHIIVER)

The Structural Heat Intercept, Insulation Vibration Evaluation Rig (SHIIVER) is a test tank created to hold cryogenic propellent to test next generation insulation materials. The test article holds cryogenic propellant for the test facility at Glenn Research Center. One of the challenges with the use of cryogenic propellant is the evaporation. The thermal protection system (TPS) that is used on Space Launch System (SLS) works to mitigate the loss of propellant from evaporation until launch. For long duration missions, the need for storage and fueling in space is a pivotal to go farther to Mars. SHIIVER tests insulation materials that could be used for the insulation of propellant tanks as well as potential low earth orbit tank re-fueling insulation capabilities.



The SHIIVER tank was sent to MSFC for TPS application. The 13’ diameter stainless steel tank was brought to EM41’s TPS Development Facility for processing.

Using a process developed and qualified at MSFC by EM41 Nonmetallic Materials and Space Environmental Effects team for use on SLS, technicians applied a manual spray on foam insulation to the tank. The process uses a portable dispensing system that was designed for the External Tank close out operations.

The polyurethane foam used is the third-generation blowing agent that had reduce environmental effects compared to the previous generations of foam. The foam is used on the domes and various close outs on SLS, and the Launch Vehicle Stage Adaptor (LVSA) for Spacecraft/Payload Integration Evolution (SPIE) for Artemis.





The application was performed in several spray operations to complete the insulation on both domes and barrel section of the SHIIVER tank.

Once the TPS application was completed, the foam was machined to final dimensions. Sanding operations can be performed manually or automated using the Fanuc robot in the Facility. Due to the tight tolerances required for the SHIIVER tank, the process was automated. The Fanuc robot was outfitted with a sanding end effector and programmed to sand the domes and barrel section. Although the dome substrate was not spherical, the use of the robot allowed for the TPS to be within 0.1” of the nominal thickness.

The final product was completed by the multidisciplinary team of EM41. All operations were completed in the TPS Development Facility and successfully met the requirements for the SHIIVER design.

The SHIIVER tank was delivered to Plum Brook Station that is managed Glenn Research Center for installation into the test bed.



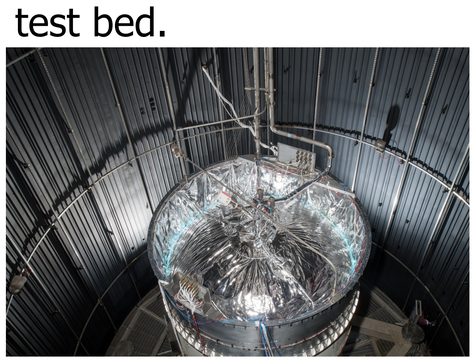


Photo courtesy of www.nasa.gov

Testing of SHIIVER included thermal vacuum testing of the bare spray foam insulation. The SHIIVER tank had multi-layer insulation (MLI) blankets added to the skirts and the foam to further insulate the tank before additional thermal vacuum testing.

TPS Development Facility Capabilities (Building 4765)

- Booth is capable to processing hardware up to 20’x27’x70’ in size
  - The booth was designed for the thermal protection system (TPS) application to the upper stage of ARES I
  - Other large hardware that has been processed in the booth include Multi-Purpose Crew Vehicle (MPCV) Stage Adaptor (MSA), hydrogen storage tank for the MSFC test areas, as well as long length of pipes for test area
  - Small scale activities include process development and qualification for paints, primers, and TPS for Space Launch System (SLS)
- Temperature and Humidity Controlled
  - Capable of 65-130°F temperature range and 5-80% humidity range
- External heating capabilities and ducting for elevated temperature heating of substrate of hardware
- Booth is Class I Division I rated, allowing for spraying of flammable materials
- 9-axis Fanuc M710iC 70 robot system
  - Robot has modular end effector to be able to spray foam with various applicators, spray paints, and machining/sanding attachment
- Materials that have been used include primers, paints, robotic and manual spray on foam insulation, and pour on foam insulation



The spray booth is capability of the large hardware in the background as well as the development application stand on the right shows the versatility of the facility.



The Fanuc robot is on a track that runs the length of the booth and has a tower to go the height of the room.

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