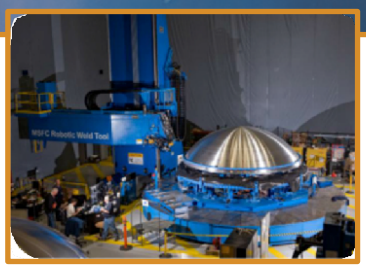
National Aeronautics and Space Administration

Marshall Space Flight Center
Advanced Metal Joining Facility

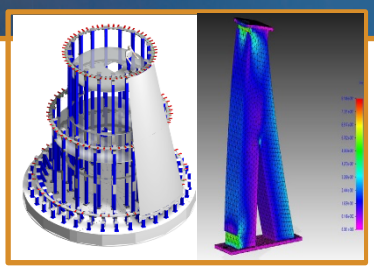
A One-stop-shop for Aerospace Welding and Manufacturing Solutions

The Space Launch System Launch Vehicle Stage Adapter Manufactured in the Advanced Joining Facility

Gas Tungsten Arc Welding the Cryogenic Propellant Storage and Transfer Tank



The Robotic Weld Tool Friction Stir Welding a Ring Frame to Dome Body



Large-scale Novel Tooling Designed for NASA Spaceflight Hardware Manufacturing

Advanced Weld Process Development and Manufacturing

The Welding and Manufacturing Team is responsible for developing metal joining and manufacturing processes for a wide variety of applications including large propellant tanks and primary vehicle structures. During the 1980's and early 1990's, MSFC led the development of the first variable polarity plasma arc welding systems. MSFC also developed and patented a plasma welding torch that was used for External Tank production and is still widely used in launch vehicle industry today. Engineers at MSFC matured the Friction Stir Welding process to full implementation on NASA flight programs. Most recently, a Self-Reacting Friction Stir Welding (SRFSW) process was developed to manufacture the SLS Launch Vehicle Stage Adapter, and a Friction Pull Plug Welding process was developed to perform close-outs of SRFSW welds on the Space Launch System (SLS) Core Stage fuel tanks. Engineers specialize in the optimization of advanced joining processes and transfer of the technologies from laboratory scale to flight hardware including full scale manufacturing of very large, complex structures. From welding process development, process qualification, tooling design, full scale implementation, and flight hardware manufacturing – the MSFC welding and manufacturing team is truly your one-stop-shop for aerospace welding and manufacturing solutions

Capabilities

Welding and Manufacturing

- Manufacturing facilities including major high bays capable of accommodating the assembly of full-scale launch vehicle structures.
- Seven operational friction-stir welding systems that can accommodate small-scale process development up to full-scale assembly. Systems include the Vertical Weld Tool for assembly of 40-foot-diameter barrel sections up to 25-feet tall and the Robotic Weld Tool for complex-curvature weldments up to 36-feet in diameter and 22.5-feet tall.
- Welding capabilities include two friction plug welding systems, two Variable Polarity Plasma/Gas Tungsten Arc welding systems, manual-arc welding systems, and a machine shop to support welding and manufacturing process development.
- Significant experience with alloy selection and procedure development for brazing applications. Complex brazing procedures have been developed for joining heat exchangers to high-temperature, heat-pipe cooled nuclear reactors. Capabilities include two highly portable handheld laser-brazing systems that were developed for in situ repair of nozzle cooling tubes on the space shuttle main engine.
- Laser and electron-beam welding techniques have been developed for manufacturing flight hardware components for ECLSS and ISS. Laboratory engineers supported procedure development and qualification for the hardware, which was manufactured and welded in-house at MSFC.
- Weld analytical modeling tools have been developed and used extensively to solve process anomalies and push the state of the art for advanced joining techniques.
- Extensive experience developing tooling and fixtures for large-scale, high-value, manufacturing projects.
- Application of nondestructive examination (NDE) inspection processes including dye penetrant, film radiography, ultrasonic, and visual techniques. Currently evaluating new NDE advancements such as phased array ultrasonic testing, eddy current, and digital X-ray.
- Cross-disciplinary, vehicle-level manufacturing planning for optimizing flows, facility utilization plans and requirements, tooling concepts, and cost estimates.

Experience

- In-house manufacture of the Launch Vehicle Stage Adapter and Multi-purpose Crew Vehicle Stage Adapter for the Space Launch System. Developed welding processes, designed novel modular tooling, fabricated structures, and performed final dimensional verifications with advanced metrology techniques.
- Manufactured aluminum test tanks for the Cryogenic Propellant Storage and Transfer (CPST) project using gas tungsten arc welding and simplified tooling.
- Fabricated several 27.5 foot-diameter and 8-foot-diameter Shell Buckling Barrel Assemblies for testing to validate and update models for launch vehicle core structures.
- Development of Thermal and Ultrasonic stir Welding processes Thermal stir welding of 0.5" thick titanium gun turrets have been successfully completed for the Navy.
- Friction stir weld development for high temperature alloys such as GRCop-84, Haynes 230, Incoloy 903, A286, and JBK75 for large rocket engine nozzles and components.
- Glovebox fusion welding of niobium and tantalum refractory metal assemblies for Nuclear Thermal Propulsion components.

Key Benefits

> Advanced in-house facilities and tools

> Widely recognized welding engineering expertise

> Cross-discipline integrated approach

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