



National Aeronautics and  
Space Administration



## TECHNOLOGY SOLUTION

### Manufacturing

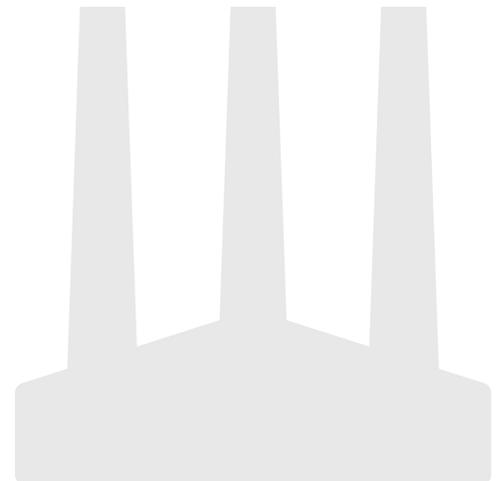
# Predicting Plug Weld Quality

[NASA software helps welders predict and verify the quality of friction plug welds in near real time](#)

NASA is committed to friction plug welding (FPW) to close out the termination hole on Self-Reacting Friction Stir Welds for circumferential welds on its pressure tanks, rockets and other structures. Plug welds close holes left by the friction stir weld pin tool as it completes and pulls out of a weld. This new NASA software enables improved control and predictability of plug weld properties. NASA's team of plug welding experts have more years of FPW expertise than perhaps any other welders in the nation, having completed over 1,500 welds. NASA's operators have codified their years of FPW experience into software to control and predict the quality of a FPW in near real-time. The software works with the feedback system of standard plug weld equipment to collect data for each weld. By using the process and performance curve, the operator can be assured that tensile properties of the resulting weld will be in limits.

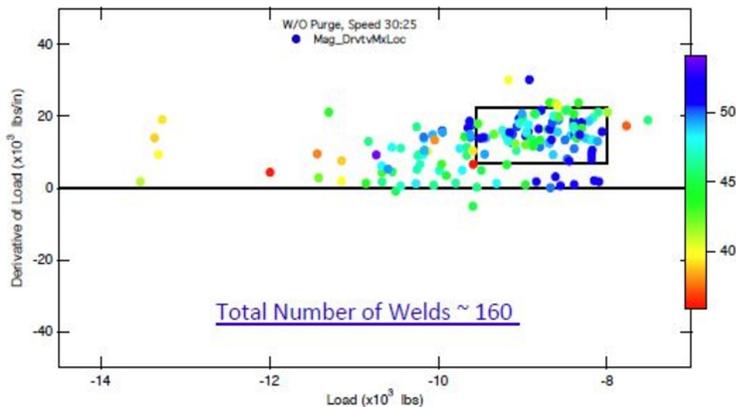
#### BENEFITS

- Predictive: enables process control and improved quality
- Analytical: is the only known analytical tool for FPW quality control and improves upon current trial and error methods.
- Reliable and Real-time: removes unknowns and risks of a relatively new process, FPW.
- Proven: NASA has a team of welders trained to use the software, control the process, and get quality welds
- Versatile: works with several Al alloy types, different plug profiles, and plate thicknesses



## THE TECHNOLOGY

Friction plug welding is a process in which there is a small rotating part (plug) being spun and simultaneously pulled (forged) into a larger part to fill or repair a hole or join two pieces (functioning like a rivet). Learning from 1,500+ quality "known" plug welds, NASA's experts build a load curve that, when combined with the welders' knowledge of strain size, predicts the properties of a plug weld. The software monitors load, spindle speed, torque, displacement speed and distance, and the material properties and dimensions of the sample. The software correlates changes in the process parameters to mechanical testing of ultimate tensile strength. The software works for several Aluminum alloys such as 2015, 2195, and 2219. NASA is using the technology in its current work for closing out the termination hole of some friction stir welds. FPW is also used for repairs and as a potential replacement for rivets.



NASA's Software is Based on a Performance Curve "box" that helps Operators Obtain High Quality Welds by Monitoring and Keeping Weld Properties within Limits

## APPLICATIONS

The technology has several potential applications:

- FPW is primarily used to close out the ends of flat plate and circumferential welds, and as a potential rivet replacement for the following industries:
- Large pressure tanks
- Shipbuilding
- Oil and Gas
- Heavy Automotive - Tractor trailers

## PUBLICATIONS

Patent Pending

National Aeronautics and Space Administration

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