Development and Application of Flux Assisted Gas Tungsten Arc Welding on Aerospace Components

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Introduction

This paper will describe the results of GTAW Flux application development work being performed by Edison Welding Institute (EWI) for the Navy Joining Center (NJC) under the direction of General Electric Aircraft Engines, General Electric Gas Turbines, and Rolls-Royce Corporation. The applications include GTAW Flux welding of turbine frames, combustion liner transition ducts, and pressure piping for commercial and military engines. This paper will describe the development of welding procedures and process specifications, mechanical property data, the production of prototype hardware, and the transfer of new welding technology into manufacturing through hands-on welder training.

The work described is being performed under a Navy Dual Use Science and Technology Project, “Teaching Factory for Advanced Turbine Engine Welding”. A “Dual Use” technology is one that has both military utility and sufficient commercial potential to support a viable industrial base. An objective of a Dual Use project is to partner government with industry to jointly develop technologies needed to maintain technological superiority and be competitive in the marketplace.

This project builds on work performed by the NJC on development of fluxes for austenitic stainless steels, carbon-manganese steel, and copper-nickel alloy, and nickel alloys and titanium alloys, which primarily focused on developing an applying flux GTAW for Navy piping applications.

Project partners include the NJC at EWI, The Boeing Company, General Electric Company, and Rolls-Royce Corporation. The project is focused on developing and applying flux assisted gas tungsten arc welding to a variety of aerospace components to reduce total process cycle time, distortion, and cost for hardware that are currently gas tungsten arc welded (GTAW) or electron beam welded (EBW). Benefits result primarily from the ability of the GTAW Flux process to increase weld penetration and reduce weld width compared to conventional GTAW. The improvement in weld penetration allows square groove weld preparations to be used versus the typical V-groove joint, which minimizes weld preparation time and cost. The narrow bead profile minimizes weld shrinkage stress and resultant distortion, which reduces post weld machining material allowances, straightening, and finishing operations.

Conclusions

- Tensile and stress rupture properties of single pass Flux GTAW were equivalent to multipass GTAW.

- Low cycle fatigue performance of Flux GTAW was slightly lower than multipass GTAW at room temperature (RT), 1000°F and 1200°F. Both the Flux GTAW and multipass GTAW exceeded the design requirement by an order of magnitude.

- Fatigue crack growth rate of Flux GTAW was equivalent to multipass GTAW at RT and 800°F.

- Single pass Flux GTAW significantly reduced distortion compared to multipass GTAW.

- GEAE approved the use of Flux GTAW for IN 718 turbine rear frames and 321 stainless steel steam manifold piping.