

## **Robust Welding Parameter Development for Narrow Gap Tandem GMAW**

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### **Abstract**

Narrow-gap welding (NGW) has traditionally been used on 25-300 mm plate using specialized equipment dedicated to the application. The primary concern with NGW has historically been sidewall penetration and fusion at the joint root. Robotic Tandem-arc GMAW is a promising technology, which offers high deposition rates and manufacturing flexibility for a variety of welding joints. Combining Robotic Tandem-arc GMAW with a narrow groove joint offers higher welding deposition rates while minimizing the required deposition area. Tandem-arc is currently being used to weld a 30 ft long, 25 mm wide square groove on 16mm plate in a heavy equipment application. The goal of this research was to develop welding parameters to minimize groove width and required weld time. This was accomplished utilizing statistical analysis to determine robustness of developed welding parameters to sidewall fusion and root penetration. A nominal set of welding parameters was successfully developed that reduced the joint width from 25 mm to 12 mm. The welding consisted of a three-pass root design including two fillet welds in the corners followed by one pass in the center. The nominal parameter set produced acceptable sidewall and root penetration. A Box-Behnken statistical Design of Experiment (DOE) with 3 Factors at 3 Levels and 16 runs (including 4 nominal welds) was chosen for this experiment. The output measurements were selected as the depth of horizontal and vertical sidewall penetration. Regression analysis of the DOE data was performed using MINITAB 13, which generated a quadratic relationship model for joint centering, CTWD, gap width. Response surfaces from the regression model showed robustness to variations in joint centering, CTWD, and gap width.