ABSTRACT

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Title: Inspection of Steel Bridge Welds Using Phased Array Ultrasonic Testing
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The objective of this research is to develop recommendations on calibration standards, scanning procedures, and acceptance criteria for phased array ultrasonic testing (PAUT) of complete joint penetration butt welds within the AWS D1.5 Bridge Welding Code. These recommendations include the development of a rational acceptance criteria which is based in engineering analysis and fracture mechanics. It is expected that the updated scanning procedures and acceptance criteria will result in improved reliability for bridges and improved consistency in bridge fabrication quality.

While PAUT was included in the 2015 edition of AWS D1.5 in Annex K, the acceptance criteria for this procedure was developed as an adaptation of an existing conventional ultrasonic testing (UT) acceptance criteria in AWS D1.1. Therefore, the acceptance criteria in AWS D1.5:2015 is a workmanship-based criteria and is not based on engineering analysis of the criticality of weld flaws. The scanning procedures and application of PAUT inspections of bridge welds according to this procedure differ greatly from the scanning procedures used in traditional AWS D1.5 conventional UT inspections. Previous research has shown that differences in flaw rejection are possible for PAUT and conventional UT ultrasonic methods under the AWS D1.5:2015 approach.

In order to develop recommendations for improved calibration standards, scanning procedures, and acceptance criteria for PAUT within AWS D1.5, this research project utilized both analytical techniques and experimental testing. This research project included determination of target critical flaw sizes for routine detection and rejection through fitness-for-service evaluations. This was followed by a round robin ultrasonic testing program in order to collect data on the variability of inspection results of eleven weld samples with nineteen weld flaws using different ultrasonic inspection techniques. Next, calibration requirements were developed to account for differences

in ultrasonic attenuation and shear wave velocity between calibration blocks and test objects. Development of these requirements included experimental testing of base metals and weld metals, along with simulations of ultrasonic inspection using commercial software. Finally, minimum requirements for weld scanning procedures, reference standard reflectors, and corresponding amplitude limits for detection and rejection of target critical weld flaws were developed using ultrasonic inspection simulations and verified through experimental testing of weld samples with known weld flaws.