Simplified Precision Welding Technique

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Overview

- Project Team
- Project Background
- Project Progress
- Conclusions
- Questions

Project Team

- EWI (prime)
  - Jim Hansen (PI), Tim Moore (Engineering support), Paul Blomquist (Business Development Director)
  - Zane Bogosian (PM), Mark Schimming (VP Govt Business)
- ATI PM
  - Ryan Schneider
- NSRP Program Technical Representative (PTR)
  - Cody Whiteley
- Participant
  - HII-Ingalls – Jeffery Cook
  - NSWCCD – Kyle Lamone

Background

- Corrosion pit and scar repairs frequently result in oversized welds when using flux cored arc welding (FCAW) or gas metal arc welding (GMAW) processes
  - Excess heat may damage coatings and cause distortion
- Semi-automatic gas tungsten arc welding (GTAW) has been demonstrated as a potentially viable method to tack fillets and repair corrosion pits
  - This work will take established data from ManTech project S2831 – Semi-Auto GTAW Weld Process coupled with information from the equipment supplier to establish parameters and demonstrate weld quality necessary for implementation

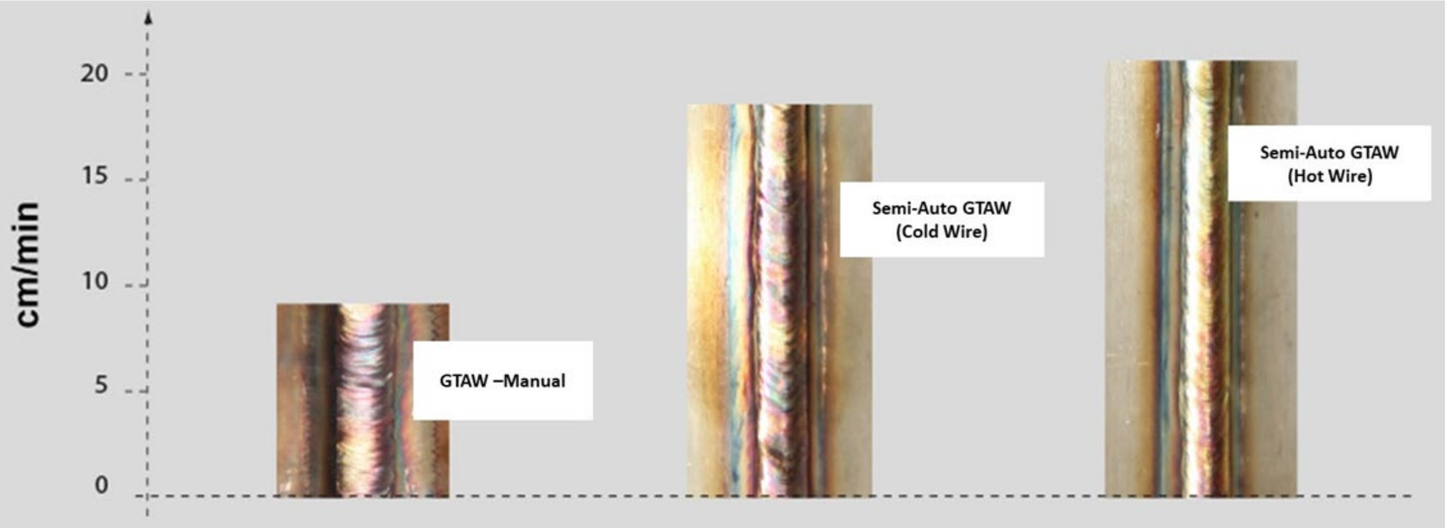
Goals

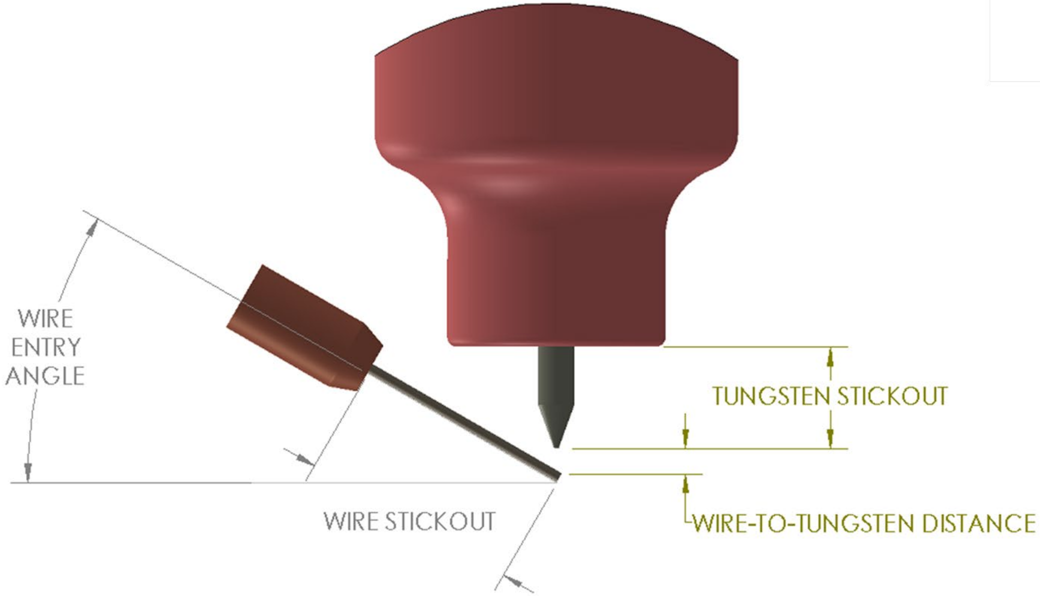
- Develop semi-automatic GTAW procedures for corrosion pit repair
- Design and produce a fixture to aid the operator in the tacking or repair operation
- Determine qualification requirements for the process and complete testing to display a pathway to implementation

Background on the TigSpeed Process

Semi-Auto GTAW Advantages

- Up to 60% higher deposition rates
- Better seam quality – reduced dilution when weld cladding
- Less weld operator fatigue in not having to manage wire feed
- Increased arc on time enables greater productivity
- "Hot-Wire" capability enables 100% faster travel speed than conventional GTAW
- Controllable weld pool through superimposed forward/backward motion of the wire





Task 1 – Pathway to Qualification

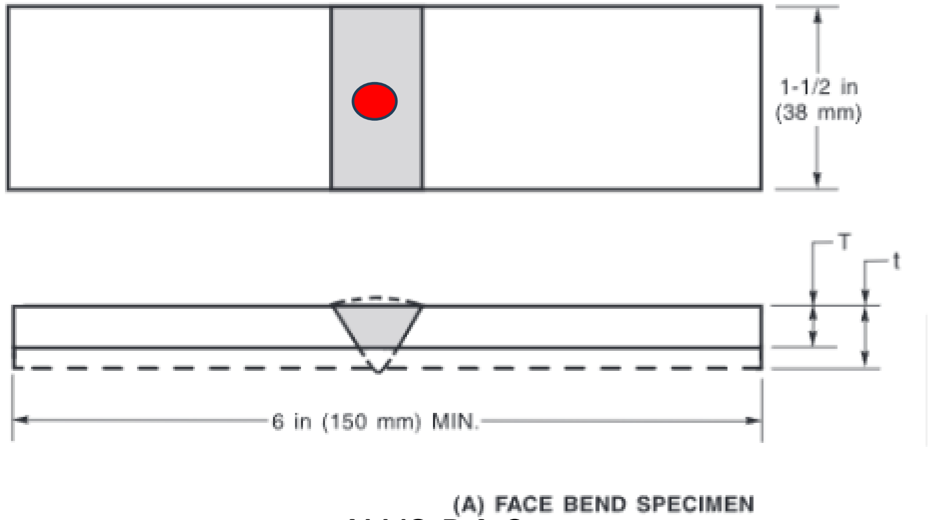
- EWI developed pit repair parameters in the flat (1G), horizontal (2G) and overhead (4G) weld positions
  - Repairs were validated by macrographs, microhardness tests and bend tests
  - Heat input for the repair weld parameters was recorded for each position
- To demonstrate the ability to qualify the process in the shipyard, a 1/2” thick groove was welded in the vertical weld position (3G) with upward progression
  - The groove was welded at a heat input that is representative of the pit repair procedures developed earlier in the project
  - The plate was inspected to Tech Pub 271 and evaluated to MIL-STD-2035A class 1 acceptance criteria per Tech Pub 248 requirements
    - All weld metal tensile, face and root bends, macroetch specimens, and weld metal centerline Charpy v-notch tests were analyzed

Task 2 – Development of Corrosion Repair Parameters in Flat, Vertical and Overhead Positions

- Pit repair parameter sets were developed in the flat, horizontal and overhead weld positions
- Heat input ranges were recorded for each position and a vertical qualification plate was welded with upward progression at an average of these heat input ranges

Task 2 – Weld Development

- The EWM TigSpeed system was set up in EWI's Columbus laboratory
- Ingalls provided pitted plate, shown below
  - Per shipyard requirements, individual pits were cleaned to fresh steel prior to repair
- Bend test diagram included to gain team concurrence on testing



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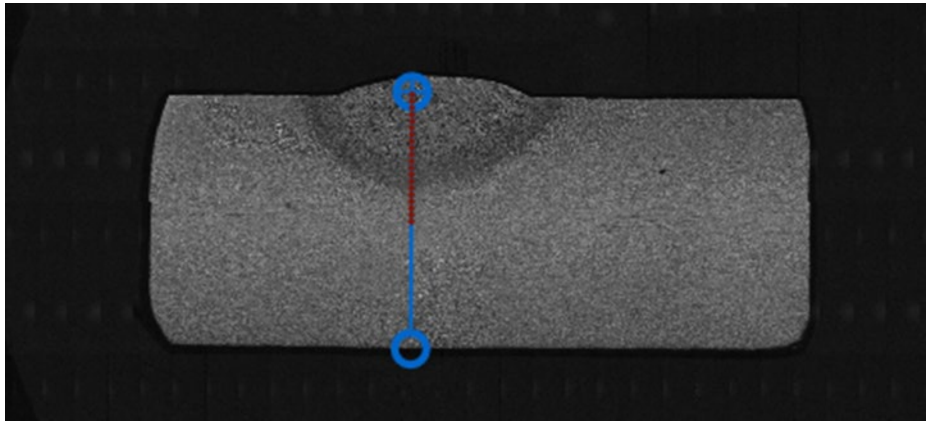
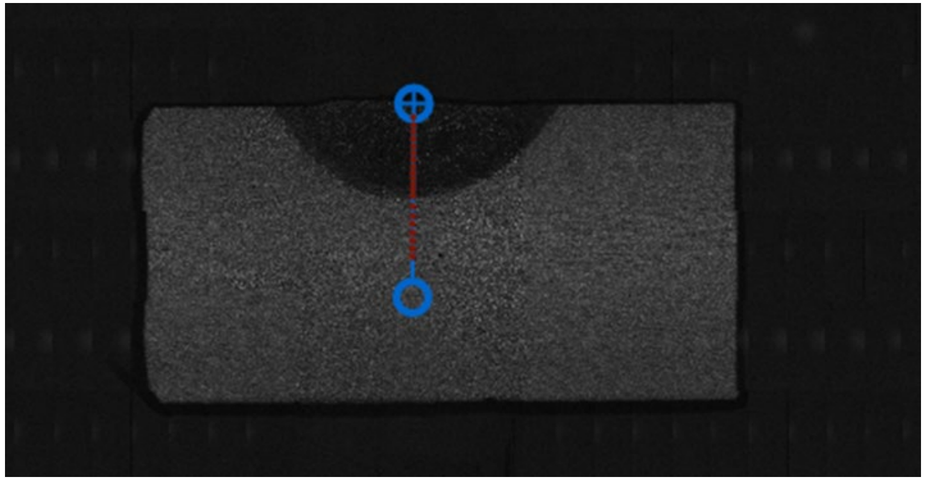
Flat Position Development



Average	Maximum	Minimum
271 HV	338 HV	198 HV

Amps (A)	161
Volts (V)	11.1
Wirefeed Speed (ipm)	39
Wirefeed Frequency (hz)	16
Gas Flow Rate (cfh)	35
Tungsten Type	2% Lanthanated (Blue)
Tungsten Diameter (in)	1/8”

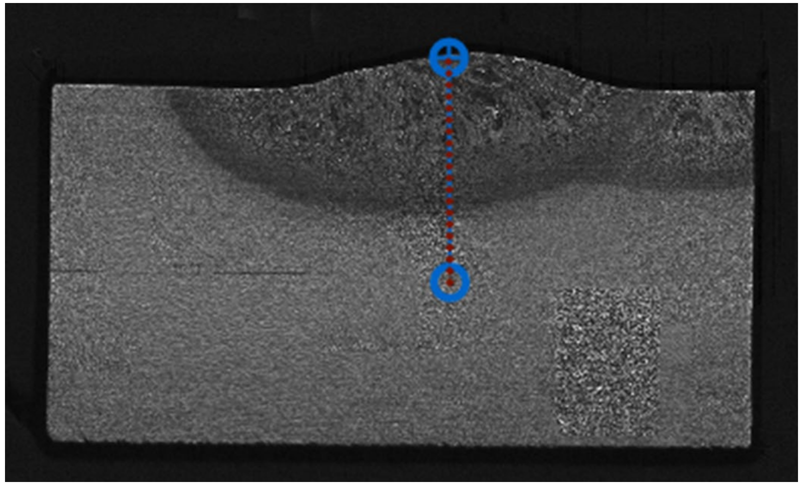
Horizontal Position Development



Average	Maximum	Minimum
276 HV	352 HV	182 HV

Amps (A)	161
Volts (V)	12.0
Wirefeed Speed (ipm)	39
Wirefeed Frequency (hz)	16
Gas Flow Rate (cfh)	35
Tungsten Type	2% Lanthanated (Blue)
Tungsten Diameter (in)	1/8”

Overhead Position Development



Average	Maximum	Minimum
261 HV	338 HV	194 HV

Amps (A)	161
Volts (V)	11.6
Wirefeed Speed (ipm)	31
Wirefeed Frequency (hz)	16
Gas Flow Rate (cfh)	35
Tungsten Type	2% Lanthanated (Blue)
Tungsten Diameter (in)	1/8”

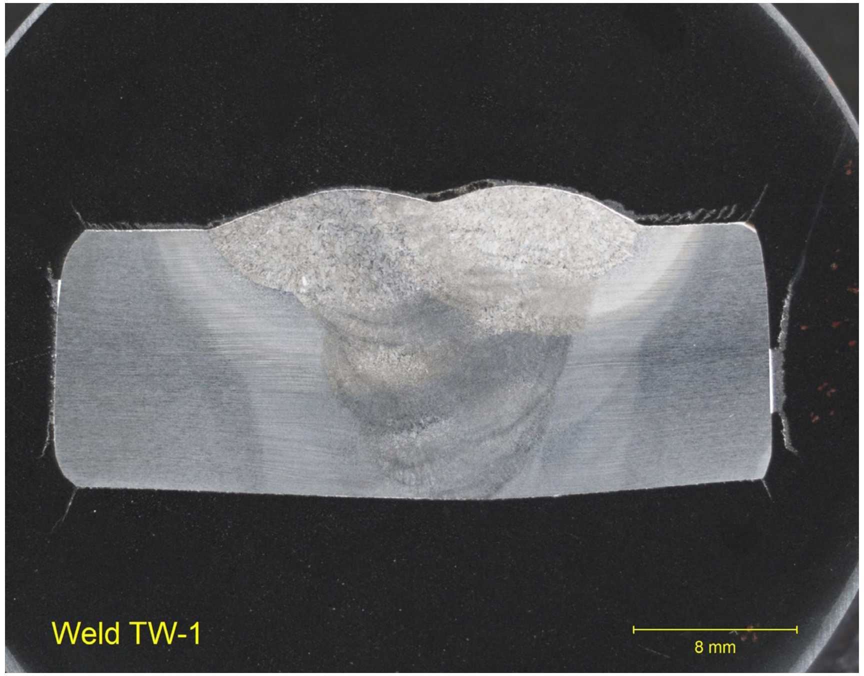
Tech Pub 248 Qualification Demonstration Plate

- ½" thick HSLA 65 plate welded in the vertical weld position with upward progression to demonstrate the ability to qualify to Tech Pub 248 requirements
- B1V.1 bevel design with a 60-degree included angle and 3/8" root opening with a HSLA 65 backing bar
- 6 layers with 11 passes to complete weldment

Amps (A)	161
Wirefeed Speed (ipm)	31 - 39
Wirefeed Frequency (hz)	16
Tungsten Extension (mm)	12.2
Gas Flow Rate (cfh)	35
Tungsten Type	2% Lanthanated (Blue)
Tungsten Diameter (in)	1/8"

Qualification Demonstration Plate Results

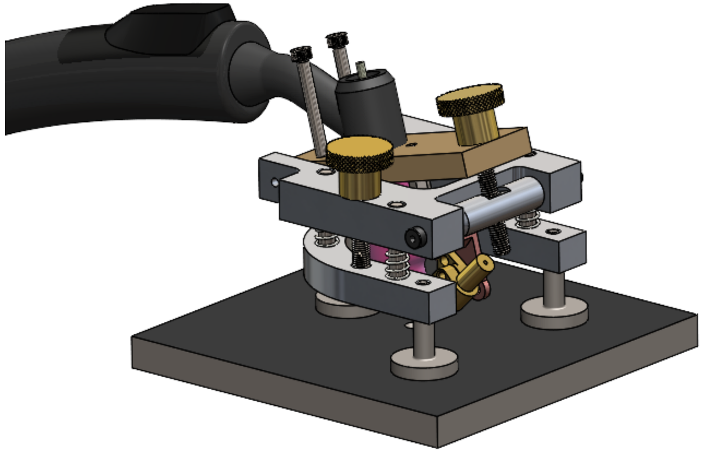
- Weldment inspected to MIL-STD 2035, Class 1
  - VT, MT, UT, RT
- 2 Tensile Tests – Pass
  - Average UTS: 80,750 psi
- 2 Face Bends – Pass
- 2 Root Bends – Pass
- Charpy V-Notch – -20° F Test Temperature
  - 3 Weld Centerline – Pass
    - Average Impact: 166 J
- Macro Specimen – Pass

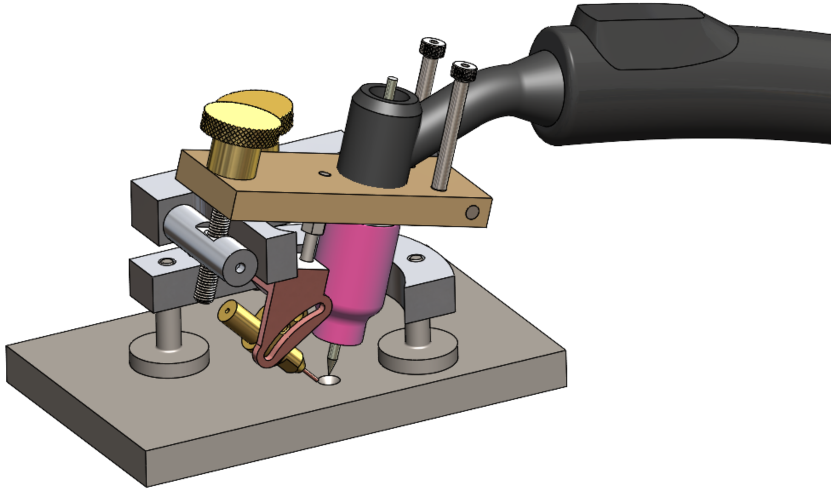


Fixture Development for GTAW Torch

- This task developed an apparatus for the semi-automatic GTAW torch that will allow for use by a less experienced operator
  - With a torch fixture, the process will be able to operate more like a stud welder than a traditional welding torch
  - The TigSpeed system allows for one button control where the weld size can be set to accommodate the required tack or repair

Fixture Development for GTAW Torch





- Torch fixture allows for adjustment of torch standoff and torch angle to adjust for location and size of repair

Heat Study

- Thermocouple tacked to back side of pitted plate to assess ability to complete repairs near insulation or painted surfaces
  - Flat repair parameters utilized on 3/8" HSLA 65 plate
  - Back side temperature did not exceed 80.6 °F

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Shipyard Demonstration and Technology Transfer

- EWI conducted a shipyard demonstration at HII – Ingalls in Pascagoula, MS
  - Demonstrated corrosion pit repair procedures
  - Reviewed project results
  - Discussed next steps to support implementation
  - Tech Transition
    - Procedures and data will be available to potential U.S. shipbuilding industry users
    - Progress reports will be made to NSRP Panels throughout the project
    - Project results will be documented in a final written report and disseminated via NSRP

Conclusions

- Corrosion pit repair parameters were developed in the flat, horizontal, and overhead weld positions
  - These parameters were validated by welding a groove in the vertical weld position on ½" HSLA 65 plate and evaluating through macrograph, bend, and hardness testing
    - This evaluation demonstrated the ability to qualify these parameters to Tech Pub 248
- The designed fixture and programmability of the TigSpeed machine allowed for an operator with minimal GTAW experience to complete the repair

Future Work

- Implement semi-auto GTAW process in the pipe shop
    - Extensive use of rotary positioners allows for the welding torch to remain in one place allowing for potential increases in productivity with automatic wire feeding
- Automate pit repair process
    - Utilize measurements of pitted plate to create automated repair schedules based on the pit size
    - Interface the TigSpeed process with a robotic system to allow for automated repair

Project Deliverables

Period of Performance: 2/21/24 – 3/7/25 (12 months)

Deliverable	Due Date	Date Submitted
Project kick-off meeting	3/20/24	3/13/24
Quarterly Report #1	5/15/24	5/15/2024
Quarterly Report #2	8/9/24	8/9/2024
Quarterly Report #3	11/4/24	11/6/2024
Briefing at Spring Panel Meeting	2/25/25	2/25/25
Final Report	3/7/25	

Questions?