

Bath Iron Works

A GENERAL DYNAMICS COMPANY

**Single Pass Pipe Socket Welds with GMAW-P
Interim Status Report
To NSRP Welding Technology Panel**

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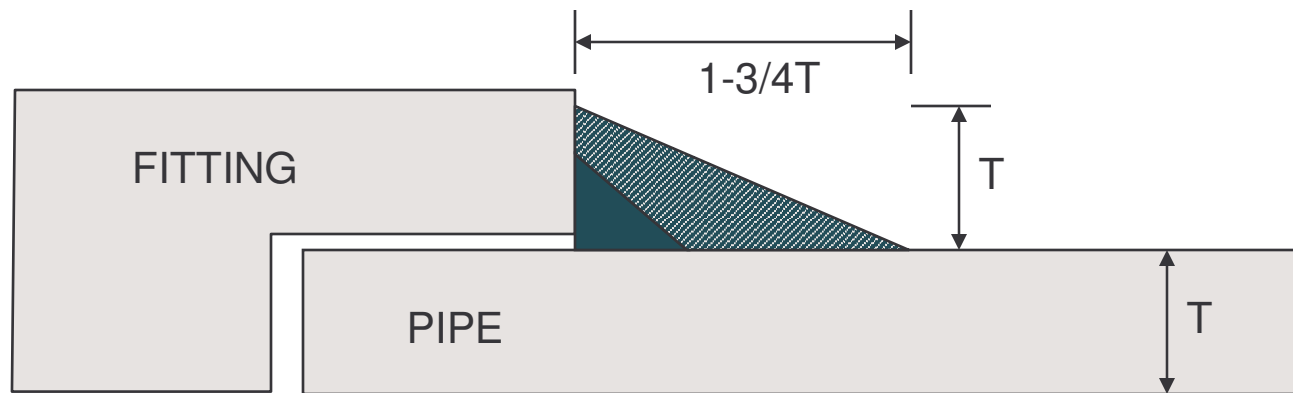
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Single Pass Pipe Socket Welds with GMAW-P

● Background:

- ▶ Specifications require pressure containing pipe socket joints have two weld layers.
 - An historic requirement, two layers are designed to eliminate continuous porosity leak paths.
 - Currently, pipe socket welds are done with manual GTAW which is very high quality, but labor intensive.
 - When configurations allow Fixed Head GTAW can be used
 - Some yards may use GMAW or FCAW on heavy walled larger diameter pipe.
- ▶ In Process of Developing Implementation Plan for Single Pass GTAW socket welds

Single Pass Pipe Socket Welds with GMAW-P



**Typical two layer pipe socket weld
with $T \times 1-3/4T$ weld size**

Single Pass Pipe Socket Welds with GMAW-P

● Opportunity and Issues:

▶ There are cost advantages to using a semi-automatic welding process such as GMAW-P (Pulsed Arc).

- However, Navy ship's Class P-2 piping is typically thin walled CRES Sch 10 or CuNi (90/10) Class 200 in various diameters.

▶ 6" diameter	0.134" wall	5/32" x 1/4" fillet
▶ 8" diameter	0.148" wall	5/32" x 9/32" fillet

- It is difficult to make a two layer GMAW-P weld on thin walled pipe because of the small required weld size.

Single Pass Pipe Socket Welds with GMAW-P

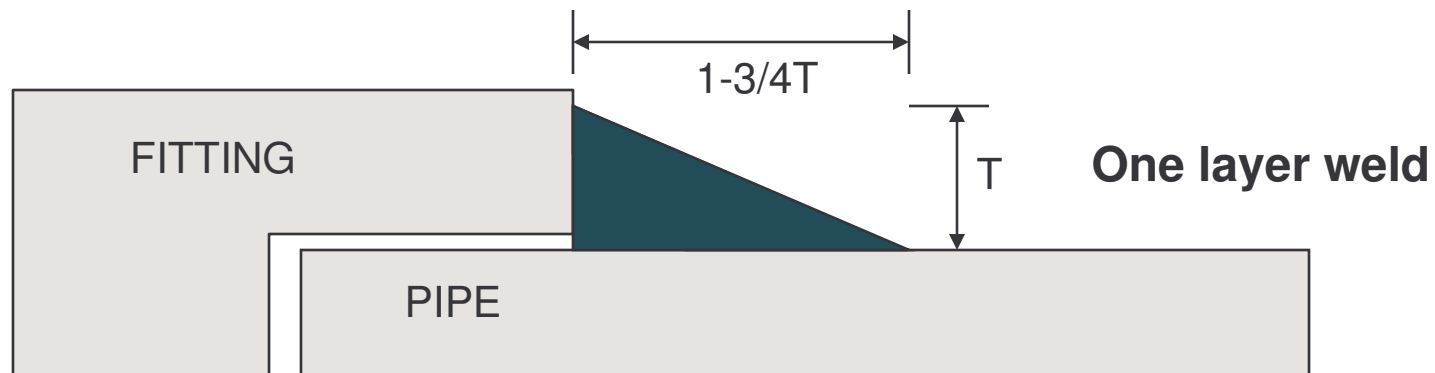
- **Need:**

- ▶ A more cost effective higher deposition process was needed.
- ▶ Based on recent advances in pulse arc control technology the decision was made to develop GMAW-P parameters & techniques that could produce porosity free single pass socket welds of required size
- ▶ and then get NAVSEA approval.

Single Pass Pipe Socket Welds with GMAW-P

● Proposal:

- ▶ BIW proposed to the NSRP SP-7 Welding Technology Panel a project to:
 - Develop techniques to weld pipe welds in a single layer
 - Use the semi-automatic GMAW-Pulsed Arc process
 - Limit welds to Class P-2 socket type joints only
 - Weld in the 2F position (using a pipe welding positioner)



Single Pass Pipe Socket Welds with GMAW-P

● Rationale:

- ▶ GMAW-P deposition rate is higher than GTAW.
- ▶ Single layer socket welds eliminate interpass temperature cool down and the labor for second layer.
- ▶ Porosity free welds will ensure good production pressure test results
 - New GMAW-P digital power supplies can control the arc to produce consistently high quality welds.

● Approval:

- ▶ NSRP Executive Control board approved and funded the project.

Single Pass Pipe Socket Welds with GMAW-P

● Project Plan:

- ▶ Step 1: Develop parameters for single layer pipe socket welds with GMAW-P.
- ▶ Step 2: Perform testing (VT, PT, Pressure, Macro-Etch).
- ▶ Step 3: Submit PQR to NAVSEA for approval.
- ▶ Step 4: Develop welder training package for production implementation.
- ▶ Step 5: Monitor production pressure test data to ensure single layer GMAW-P process does not exceed two layer leak rates.
- ▶ Step 6: Provide final report to NSRP SP-7 Panel.

Single Pass Pipe Socket Welds with GMAW-P

● Welding Equipment

- ▶ Use new GMAW-Pulsed Arc technology
 - Fronius Model TP3200
 - ESAB Aristo

- ▶ New digital equipment:
 - Allows refinement of weld parameters
 - Produces good bead contour and weld edge wetting
 - Minimizes spatter
 - Provides program storage



Single Pass Pipe Socket Welds with GMAW-P

● Welding Trials

- ▶ CRES parameter development for bead size and shape was straight forward.
 - The historical variations in penetration pattern with CRES materials did caused variations in pipe wall melt-through.
 - Variations in melt-through are similar to GTAW process.
 - The lowest usable heat input parameters were used to weld the test assemblies.

Single Pass Pipe Socket Welds with GMAW-P

● Welding Trials

- ▶ CuNi parameters were more consistent.
 - No melt-through.
 - Primary effort was to minimize spatter and achieve good wetting action.
 - Arc Control helped with eliminating ropey beads

Single Pass Pipe Socket Welds with GMAW-P

● Resulting Joints

- ▶ Pipe assemblies consist of two pipe pieces socket welded to a standard pipe sleeve with a T x 1-3/4T weld size.

4" & 8" nps
CuNi (90/10)

3" & 8" nps
CRES



Single Pass Pipe Socket Welds with GMAW-P

- Resulting Joints



Single Pass Pipe Socket Welds with GMAW-P

● NDT Tests

- ▶ NDT (VT & PT) complete and satisfactory for all assemblies to S9074-AQ-GIB-010/248 and MIL-STD-2035A

● Pressure Tests

- ▶ 135% of design pressure rating
- ▶ Scheduled week 03-26-07

● Mechanical Tests

- ▶ Four (4) Macro-Etch specimens per assembly
- ▶ Scheduled week 03-26-07

Single Pass Pipe Socket Welds with GMAW-P

● Interim Conclusion

- ▶ GMAW-Pulsed Arc process has been able to produce single pass socket welds that are:
 - Visually satisfactory
 - Free of porosity
 - Wetted into the base material

Single Pass Pipe Socket Welds with GMAW-P

● Continued Effort:

- ▶ PQR submittal to NAVSEA
- ▶ Development of welder training package
- ▶ Production implementation
- ▶ Pressure test leak rate data comparison
- ▶ Final report to NSRP

Single Pass Pipe Socket Welds with GMAW-P

Questions?