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 Chemical, Metallurgical, Mechanical, Nondestructive, Environmental Testing, Analyses and Field Service.

FERMILAB
 P.O. Box 500, MS 344
 Batavia, IL 60510

September 20, 2021
 Lab No. 21P-3590
 P.O. No. PRN251097
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Attention: Antonios Vouris

REPORT OF WELD PROCEDURE QUALIFICATION

MATERIAL: 2 Ea. Welded Coupons, Identified as "Long MIG FEB-2021" (1 Tested)

RESULTS:

VISUAL EXAMINATION: Acceptable per ISO 5817 Level B, EN13445-5 S:6.6.3.2

REDUCED SECTION TENSILE – ASME QW-150

Sample ID	Width Inches	Thickness Inches	Area Sq. Inches	Actual Lbs.	Tensile Strength PSI	Fracture
T1	0.7540	0.3330	0.2511	23420	93300	Ductile / Weld Metal
T2	0.7510	0.3310	0.2486	22490	90500	

GUIDED BEND TEST – ASME QW-160

SAMPLE ID	BEND	RESULTS
F1	Face	Acceptable – No Discontinuities @ 180°
R2	Root	Acceptable – No Discontinuities @ 180°
F3	Face	Acceptable – No Discontinuities @ 180°
R4	Root	Acceptable – No Discontinuities @ 180°

REDUCED SECTION ALL WELD TENSILE – ASME QW-150

Sample ID	Diameter Inches	Area Sq. Inches	ROA %	Yield Strength PSI	Tensile Strength PSI	Elongation %
C1	0.2550	0.0511	48.5	70100	98400	29.0


 Karl Schmitz, Director Materials Testing
 CWI 92120161/D17.1 Endorsement 19100111
 ACCP VT Level II 280554

KS/edn

St. Louis Testing Laboratories decision rule is "Simple Acceptance"



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Attention: Antonios Vouris

REPORT OF WELD PROCEDURE QUALIFICATION

MATERIAL: 2 Ea. Welded Coupons, Identified as "Circ MIG FEB-2021" (1 Tested)

RESULTS:

VISUAL EXAMINATION: Acceptable per ISO 5817 Level B, EN13445-5 S:6.6.3.2

REDUCED SECTION TENSILE – ASME QW-150

Sample ID	Width Inches	Thickness Inches	Area Sq. Inches	Actual Lbs.	Tensile Strength PSI	Fracture
T1	0.7460	0.2430	0.1813	17420	96100	Ductile / Weld Metal
T2	0.7470	0.2470	0.1845	17740	96200	

GUIDED BEND TEST – ASME QW-160

SAMPLE ID	BEND	RESULTS
F1	Face	Acceptable – No Discontinuities @ 180°
R2	Root	Acceptable – No Discontinuities @ 180°
F3	Face	Acceptable – No Discontinuities @ 180°
R4	Root	Acceptable – No Discontinuities @ 180°

REDUCED SECTION ALL WELD TENSILE – ASME QW-150

Sample ID	Diameter Inches	Area Sq. Inches	ROA %	Yield Strength PSI	Tensile Strength PSI	Elongation %
C1	0.2450	0.0471	60.0	62700	87200	31.0


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REPORT OF ANALYSIS

MATERIAL: 2 Ea. Welded Coupons, Identified as "Long MIG FEB-2021" (1 Tested)
 2 Ea. Welded Coupons, Identified as "Circ MIG FEB-2021" (1 Tested)

SUBJECT: Magnetic Permeability

SPECIFICATION: ASTM A342/A342M-21

METHOD: Test Method 3 – Low-MU Permeability Indicator; Severn Gauge
 The standards used in calibrating the inserts were measured by the National Institute of Standards and Technology, using Test Method A342/A342M-21. Measurements were made in a magnetic field strength of 100 Oe [8 kA/m] at 25°C.

NOTE: Unable to perform Test Method 4; reading greater than 2.

RESULTS:

SAMPLE ID	TEST CONDITIONS	RELATIVE PERMEABILITY
Weld - Longitudinal	23°C / 45% RH	>1.2 (≈ 1.7 - 2.0)
Weld - Circumferential		>1.2 (≈ 1.7 - 2.0)

KS/edn


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Attention: Antonios Vouris

REPORT OF ANALYSIS

MATERIAL: 2 Ea. Welded Coupons, Identified as "Circ MIG FEB-2021" (1 Tested)
2 Ea. Welded Coupons, Identified as "Long MIG FEB-2021" (1 Tested)

SUBJECT: Macrostructure and Microstructure Analysis

CONCLUSION:

The submitted weld coupons met the requirements for a Quality Level B per ISO 5817.

The base metal for both weld coupons exhibited a fully austenitic microstructure with no evidence of residual delta ferrite or sigma phase.

The weld metal exhibited residual delta ferrite in a matrix of austenite throughout the cross section. Additionally, the weld exhibited complete penetration.

PROCEDURE AND RESULTS:

Cross sections transverse to the welds were removed from one of the "Circ MIG" weld coupons and one of the "Long MIG" weld coupons. The sections were sanded and etched for macroscopic examination in accordance with ASTM E340-15. The sections were etched with a 50% hydrochloric acid and water solution with hydrogen peroxide.

Visual examination of the macro etched transverse cross sections revealed no imperfections, which exceeded the requirements per ISO 5817 Quality Level B. The typical appearance of the cross sections is shown in Figures 1 (Circ MIG) and 2 (Long MIG).

A cross section transverse to the welding direction was removed from the one of the "Circ MIG" weld coupons and one of the "Long MIG" weld coupons. The cross sections included the weld metal, heat affected zone (HAZ), and adjacent base metal. The cross sections were encapsulated, ground, and polished for microscopic examination in accordance with ASTM E3-11(2017). The cross sections were examined in the etched condition. Etching was in accordance with ASTM E407-07(2015)e1, Table II, Composition 219 and ASTM A923-14 (Sodium Hydroxide Etch).

Circ MIG:

Microscopic examination of the etched cross section disclosed adequate weld penetration and no evidence of non-fusion. The base metals were labeled "A" and "B" for identification purposes. The typical appearance of the weld joint is shown in Figure 3 (10X, Original Magnification, Etchant 219).

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Microscopic examination of the etched cross section in base metal "A" disclosed an equiaxed microstructure consisting of austenite grains and no evidence of delta ferrite or sigma phase. The typical appearance of these conditions is shown in Figures 4 (100X, Etchant 219), 5 (500X, Etchant 219), 6 (100X, Sodium Hydroxide), and 7 (500X, Sodium Hydroxide).

Microscopic examination of the etched cross section in the weld disclosed a dendritic microstructure consisting of ferrite in a matrix of austenite. The typical appearance of this condition is shown in Figures 8 (100X, Etchant 219), 9 (500X, Etchant 219), 10 (100X, Sodium Hydroxide), and 11 (500X, Sodium Hydroxide).

Microscopic examination of the etched cross section in base metal "B" disclosed an equiaxed microstructure consisting of austenite grains and no evidence of delta ferrite or sigma phase. The typical appearance of these conditions is shown in Figures 12 (100X, Etchant 219), 13 (500X, Etchant 219), 14 (100X, Sodium Hydroxide), and 15 (500X, Sodium Hydroxide).

Long MIG:

Microscopic examination of the etched cross section disclosed adequate weld penetration and no evidence of non-fusion. The typical appearance of the weld joint is shown in Figure 16 (10X, Original Magnification, Etchant 219).

Microscopic examination of the etched cross section in the base metal disclosed an equiaxed microstructure consisting of austenite grains and no evidence of delta ferrite or sigma phase. The typical appearance of these conditions is shown in Figures 17 (100X, Etchant 219), 18 (500X, Etchant 219), 19 (100X, Sodium Hydroxide), and 20 (500X, Sodium Hydroxide).

Microscopic examination of the etched cross section in the weld disclosed a dendritic microstructure consisting of ferrite in a matrix of austenite. The typical appearance of this condition is shown in Figures 21 (100X, Etchant 219), 22 (500X, Etchant 219), 23 (100X, Sodium Hydroxide), and 24 (500X, Sodium Hydroxide).

NDH/edn


Nicholas Holtmann, Manager
Metallurgical Testing

St. Louis Testing Laboratories decision rule is "Simple Acceptance"