WELD PROCEDURE QUALIFICATION REQUIREMENTS

1.0 SCOPE

1.1 The purpose of this document is to outline the requirements for developing the Weld Procedure Specification (WPS) used when welding SARA SAE parts/materials.

1.2 This document shall cover all SARA SAE parts/materials that require welding including fabrication, repair, overlay, and cosmetic welds.

1.3 This document is intended for use by SARA SAE and SARA SAE authorized Vendors engaged in the process of qualifying the Weld Procedure Specification (WPS). FCAW and GMAW can not be used for pressure containing welds. A single GMAW pass may be used in the root of a pressure containing weld, provided the root can be inspected after welding.

1.4 This document covers SMAW, SAW, GTAW, GMAW, and FCAW welding processes.

1.5 Welding Procedure Specifications approved prior to the release of this document need not be requalified per this new document unless the essential or supplementary essential variables are changed.

1.6 No deviation from this procedure shall be permitted without the written approval of SARA SAE Engineering.

2.0 APPLICABLE SPECIFICATIONS AND REQUIREMENTS

2.1 Applicable Specifications

2.1.1 ABS Guide for the Certification of Drilling Systems (Latest Edition)

2.1.2 ANSI B31.3

2.1.3 API Spec 6A, 16A, 8C, 8B, 16R, 16C, 16D, 16E, RP53 (Latest Edition)

2.1.4 ASME Boiler and Pressure Vessel Code Section II-C (Latest Edition)

2.1.5 ASME Boiler and Pressure Vessel Code Section IX (Latest Edition)

2.1.6 ASTM A-370, and ASTM E-140 (Latest Editions)

2.1.7 DNV Rules for Classification of Ships Part 2 Chapter 3 Welding Section 2 Part B and D (Latest Edition)

2.1.8 NACE MR-01-75 (Latest Edition)

2.1.9 SARA SAE Material Specifications

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3.0 GENERAL PROCEDURE QUALIFICATION REQUIREMENTS

3.1 All fabrication, repair, overlay, or cosmetic welds, shall be qualified per the welding requirements of Section 2.0.

3.2 In the event there is a conflict between two of the above specifications SARA SAE

Engineering will determine which specification is applicable.

3.2 When a filler metal does not have an AWS classification number as defined by ASME Boiler and Pressure Vessel Code Section II-C the following requirements shall apply:

3.2.1 No other brand name of weld filler metal may be substituted in place of the brand name of weld filler metal used to qualify the procedure.

3.2.2 A round, all weld metal tensile test shall be performed and the results shall be documented in the Procedure Qualification Record (PQR).

3.3 Weld filler metals shall conform to the guidelines and definitions given in ASME Boiler and Pressure Vessel Code Section II-C.

3.4 It is the vendor's responsibility to obtain the most recent copy of this specification prior to qualifying a weld procedure.

3.5 Welding Machines must be equipped with calibrated volt and amp meters in good working condition.

3.6 When post weld heat treatment (PWHT) is required the part shall be PWHT one hour per inch of thickness. The thickness used to determine PWHT time shall be the greatest thickness of the parts being welded.

3.7 When PWHT is required a minimum and maximum PWHT time shall be listed on the welding procedure specification. The minimum PWHT time for parts less than one inch thick is one hour.

3.8 The PWHT range shall be ±25°F (±14°C).

3.9 The PWHT shall be less than tempering temperature of base metal.

3.10 The deposited weld metal mechanical properties, as determined by the PQR, shall meet or exceed the minimum specified mechanical properties of the base material specification.

4.0 VENDOR WELDING DOCUMENTATION SUBMITTALS

4.1 All submittals of WPS and PQR documents for review and approval shall be in English.

4.2 The Vendor shall provide copies of the WPS, and PQR, including all test results, material certificates for the base metal, weld filler metal, and the post welding heat treatment history shall be submitted to SARA SAE Engineering for review/approval.

4.3 SARA SAE Engineering has final say as to whether the documentation supplied meets the requirements of specifications listed in Section 2.0.

4.4 Vendors shall provide SARA SAE Engineering with a point of contact within their company.

5.0 REQUIRED TESTING FOR GROOVE WELDS, WELD REPAIRS, OR WELD BUILD UP

5.1 Two full thickness tensile tests per ASME Boiler and Pressure Code Section IX.

NOTE: SARA SAE requires the YIELD STRENGTH to be recorded in the PQR.

5.2 Four bend tests per ASME Boiler and Pressure Code Section IX QW 451.1 and QW 160

5.3 Hardness survey per NACE MR0175/ISO 15156 Section 7.3.3.2.

NOTE: No averaging of hardness readings per NACE MR-0175 allowed without prior approval from SARA SAE Engineering.

5.4 Nondestructive testing per DNV Rules for Classification of Ships Part 2 Chapter 3 Welding Section 2-B 302.

5.4.1 100% Visual Examination.
5.4.2 100% Ultrasonic or 100% Radiographic Examination.
5.4.3 100% Magnetic Particle (MP) or 100% Liquid Penetrant (LP) Examination.

5.5 Macro section per DNV Rules for Classification of Ships Part 2 Chapter 3 Welding Section 2-B 307. Note this can be incorporated into the hardness survey.

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5.6 Impact test per DNV Rules for Classification of Ships Part 2 Chapter 3 Welding Section 2-B 308. The specimens are to be sampled 2 mm below the surface of the parent metal and transverse to the weld. The v-notch is to be perpendicular to the surface of the plate. If two different base metals are used the impact test listed bellow shall be performed on each base metal. Test temperatures for the impact tests shall be per the SARA SAE Material Specification. **Lateral expansion is required on all impact tests.** The impact specimens are to be located in the weld joint as follows:

5.6.1 Three specimens with the notch along the weld metal centerline.

5.6.2 Three specimens with the notch in the fusion line.

5.6.3 Three specimens with the notch 2 mm from the fusion line.

5.6.4 Three specimens with the notch 5 mm from the fusion line.

5.6.5 For plate thickness greater than 20mm, one additional set of specimens is to be taken in the weld metal root area. The impact specimens on the root side shall be taken 2 mm below the surface of the parent metal and transverse to the weld. The v-notch is to be perpendicular to the surface of the plate.

5.6.6 Weld coupons with a plate thickness greater than 50 mm contact SARA SAE Engineering for further instruction.

5.7 Material certification documentation of the test coupons and the weld filler metal used are required. If material certification documentation cannot be obtained, a chemical analysis of the base metal and the weld filler metal is required.

5.8 When welding Duplex Stainless steel, the following requirements apply:

5.8.1 The Ferrite content in the weld shall be determined per ASTM E-562. The Ferrite range shall be 30% to 65%.

5.8.2 The microstructure shall be examined at 400X or greater to verify that no deleterious amounts of intermetalic phases or precipitates are present. The root, weld, HAZroot, HAZcap and HAZcenter of weld shall be examined.

5.8.3 Impacts per ASTM A-923 Test Method B shall be run.

NOTE: These impacts are independent from design temperature. Their purpose is to detect the presence of sigma phase.

6.0 REQUIRED TESTING FOR CORROSION RESISTANT OVERLAYS THAT ARE NOT CONSIDERED PART OF THE API DESIGN CRITERIA

6.1 Four bend test per ASME Boiler and Pressure Code Section IX QW 451.1 and QW 160

6.2 Rockwell Hardness Tests (12) per API 6A, 6.5.1.2.1.c, and figure 6.3

6.3 Nondestructive testing

6.3.1 100% Visual Examination per API 6A, 7.5.2.2.11

6.3.2 100% Magnetic Particle (MP), or Liquid Penetrant (LP) Examination per API 6A, 7.5.2.2.12

6.4 Macro section per DNV Rules for Classification of Ships Part 2 Chapter 3 Welding Section 2-B 307. Note this can be incorporated into the hardness survey from API 6A.

6.5 Material certification documentation of the test coupons and the weld filler metal used are required. If material certification documentation cannot be obtained, a chemical analysis of the base metal and the weld filler metal is required.

6.6 One OES chemistry on the weld metal per ASME Boiler and Pressure Vessel Code Section IX. SARA SAE Engineering must be contacted for this test in order to obtain the distance from the base metal to where the chemistry is to be taken.

7.0 REQUIRED TESTING FOR HARD FACING OVERLAYS THAT ARE NOT CONSIDERED PART OF THE API DESIGN CRITERIA

7.1 Rockwell Hardness Tests (12) per API 6A, 6.5.1.2.1.c, and Figure 6.3. SARA SAE Engineering must be contacted for this test in order to obtain the minimum thickness and hardness of the overlay.

7.2 Nondestructive testing

7.2.1 100% Visual Examination per API 6A, 7.5.2.2.11

7.2.2 100% Magnetic Particle (MP) or Liquid Penetrant (LP) Examination per
API 6A, 7.5.2.2.12

7.3 Macro section with photo per ASME Boiler and Pressure Code Section IX QW-453 Note 8.

7.4 Material certification documentation of the test coupons and the weld filler metal used are required. If material certification documentation cannot be obtained, a chemical analysis of the base metal and the weld filler metal is required.

7.5 One OES chemistry on the weld metal per ASME Boiler and Pressure Vessel Code Section IX. SARA SAE Engineering must be contacted for this test in order to obtain the distance from the base metal that the chemistry is to be taken.

8.0 COMMON PROBLEMS ASSOCIATED WITH WPS/PQR REVIEWS

8.1 The **yield strength** of the weld joint was not reported with the ultimate tensile test results.

8.2 The **yield strength reported did not meet** SARA SAE Material Specification requirements.

8.3 **Hardness surveys were not performed** or the **results exceeded the hardness limits of NACE MRO175.**

NOTE: All weld procedure qualifications require a hardness survey regardless of whether NACE is a requirement of the production part.

8.4 The **qualification test coupon was not stress relieved in accordance to NACE MRO175.**

8.5 The **weld filler metal contained over 1% Nickel** and thus violated NACE MRO175 section 5.3.2.

8.6 **The Post Weld Heat Treatment (PWHT) time and temperature on the WPS are different than the time and temperatures listed on the PQR.**

8.7 The Charpy V-notch **Impact test were not performed in accordance to DNV Rules** for Classification of Ships Part 2 Chapter 3 Welding Section 2-B 308.

8.8 **Corrosion overlays did not meet the chemical composition requirements of API 6A and 16A.**

8.9 **The PWHT did not take into account the thickness of the base material.**

8.10 PWHT time and temperature not listed on WPS.

8.11 SARA SAE requires that a minimum PWHT time, a maximum PWHT time and number of hours per inch be listed on the WPS.

9.0 OTHER WELD PROCESSES

9.1 Welding processes and weld joint configurations not listed in this specification **must have the prior approval of SARA SAE Engineering.**