



General Welding and Inspection Requirements

FOR THE

CARTAGENA REFINERY EXPANSION PROJECT

CB&I CONTRACT NO. 166000

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1.0 SCOPE

This specification governs welding procedure qualification and fabrication for purchased piping, tanks, pressure vessels and process equipment and components. Welding of buildings or load bearing structures is not governed by this specification. Manufacture and inspection of raw material such as pipe and plate at the mill is not covered by this specification.

This specification augments the requirements of ASME Section IX and the applicable code of construction in Section 2.1

In case of conflict between this specification and other codes, standards or offer documents, supplier shall notify company for resolution.

2.0 REFERENCES

The codes and specifications listed in this section or reference herein are considered to be part of this document. The latest addition and addenda of these standards apply unless otherwise indicated in the offer.

2.1 ASME-American Society of Mechanical Engineers

ASME B31.1	(Power Piping)
ASME B31.3	(Process Piping)
ASME Sec. II C	(BPVC Section IIC-Materials Part C-Specifications for Welding Rods, Electrodes and Filler Metals)
ASME Sec. V	(BPVC Section V-Nondestructive Examination)
ASME Sec. VIII D1	(BPVC Section VIII-Rules for Construction of Pressure Vessels-Division 1)
ASME Sec. VIII D2	(BPVC Section VIII-Rules for Construction of Pressure Vessels-Division 2 Alternate Rules)
ASME Sec. IX	(BPVC Section IX-Qualification Standard for Welding and Brazing Procedures, Welders, Brazers and Welding and Brazing Operators)

2.2 AWS-American Welding Society

AWS A5.XX-(Filler Metal Specification Series)

2.3 ASNT-American Society for Nondestructive Testing

ASNT SNT-TC-1A-(Guidelines to Personnel Qualification and Certification in NDT)

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3.0 DEFINITIONS AND ACRONYMS

3.1 Definitions

Term	Description
Company	CB&I/Technip
Supplier	The party supplying equipment to the Company/Owner.
Owner	The ultimate user of the equipment (synonymous with Client)
Inspector	Company's Representative

3.2 Acronyms

Term	Description
CMTR	Certified Material Test Report
FCAW	Flux Cored Arc Welding
FCAW-GS	Flux Cored Arc Welding – Gas Shielded
FCAW-SS	Flux Cored Arc Welding – Self Shielded
GMAW	Gas Metal Arc Welding
GMAW-S	Gas Metal Arc Welding – Short Circuiting Transfer
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
MDR	Manufacturer's Data Report
MT	Magnetic Particle Testing
NDE	Nondestructive Examination
NPS	Nominal Pipe Size
PQR	Procedure Qualification Record
PT	Liquid Penetrant Testing
RT	Radiographic Testing
SAW	Submerged Arc Welding
SMAW	Shielded Metal Arc Welding
VT	Visual Inspection
WFMT	Wet Fluorescent Magnetic Particle Testing
WPQ	Welder Performance Qualification
WPS	Welding Procedure Specification

4.0 REQUIREMENTS

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4.1 General

- 4.1.1 All welds shall be made in accordance to the applicable code of construction in section 2.1 and this specification.
- 4.1.2 All WPSs shall be qualified in accordance to ASME Section IX, the applicable code of construction in section 2.1 and this standard.
- 4.1.3 All welders and welding operators shall be qualified in accordance to ASME Section IX, the applicable code of construction in section 1.0 and this standard.
- 4.1.4 All WPSs and supporting PQRs shall be submitted to Customer for review and approved prior to start of fabrication. If a weld map is required by offer documents, it shall contain the following details:
- Drawing of the equipment
 - WPS to be used on each joint type including butt welds, fillet welds, temporary and permanent attachments and cladding.
 - PWHT requirements for each joint type.
- 4.1.5 All WPSs and PQRs shall contain all information required by forms QW-482 and QW-483 of Article IV of ASME Sec. IX including non-essential and supplementary variables.
- 4.1.6 All welder and welding operator qualifications shall be available for review by customer prior to start of fabrication.
- 4.1.7 Backing rings, bars or straps shall not be used unless specifically approved by Customer. When allowed, the backing material nominal chemistry shall be noted on the WPS or drawing. For joining similar materials, the backing material shall nominally match the material to be joined.
- 4.1.8 Hot or cold peening of welds or base metal is not allowed. Mechanical cleaning of welds is not considered peening.
- 4.1.9 Welding shall not be performed in atmospheres that may detrimentally affect weld quality.
- 4.1.10 All arc strikes and weld starts and stops shall be confined to the weld joint. Arc strikes outside the weld joint shall be removed by grinding and examined for cracks using MT or PT. Any grinding shall not reduce the wall thickness of the weldment to less than the design minimum plus applicable corrosion allowance.

4.2 Welding Processes

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4.2.1 The following welding processes are approved for use under this specification. All other processes shall be submitted to customer for approval prior to start of fabrication.

- SMAW
- GTAW
- GMAW
- SAW

4.2.2 GMAW-S welding may only be used on the root pass of single sided welds or on fit-up welds where the weld will be removed by chipping, grinding or gouging. All other uses of GMAW-S require customer approval.

4.2.3 FCAW-GS may be allowed with approval but shall not be used for the weld root pass unless the root pass is removed to sound metal and welded from the second side.

4.2.4 GTAW welding shall be performed with the addition of filler metal.

4.2.5 For GTAW, the addition or deletion of consumable inserts requires a separate WPS and PQR.

4.2.6 Welding of the root pass in single sides joints on stainless steel, aluminum or nickel based alloys using flux coated or cored electrodes is generally prohibited. It may be allowed on a case basis with company approval.

4.3 Filler Metal / Consumables

4.3.1 Supplier shall develop a welding consumable storage and handling procedure to ensure proper receipt, storage and usage of all welding consumables. This procedure shall be submitted to customer for review prior to start of fabrication.

4.3.2 All welding consumables shall be supported by the consumable manufacturer's Material Test Reports. These reports shall represent the actual manufacturer's lot of material to be used.

4.3.3 Filler metals and fluxes shall be maintained in their original containers until required for use or placed in electrode or flux bake-out ovens. Unopened containers shall be protected from deterioration. Materials in damaged or deteriorated containers shall not be used and will be removed from the work area.

Electrode and flux shall only be removed from heated ovens and exposed to the environment for a maximum time as dictated by the manufacturer or AWS instructions. All unused electrodes and flux shall be returned to heated ovens and reconditioned per AWS requirements and/or manufacturer recommendations.

4.3.4 For SAW, all fluxes shall be neutral. Active fluxes shall not be used.

4.3.5 Re-crushed SAW slag shall not be used.

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- 4.3.6 Alloyed fluxes shall not be used for welding low alloy steels.
- 4.3.7 Electrodes, filler wire or fluxes that are damp, greasy or oxidized shall not be used and shall be removed from the work area.
- 4.3.8 When impact testing of the WPS is required, the manufacturer and trade name of the consumables shall be listed on the WPS and supporting PQRs. Supplier will be limited to the use of this specific consumable during fabrication. Alternately, welding consumables may be purchased with certified impact values for the batch to be used.
- 4.3.9 Filler metals shall be specified on the WPS by AWS classification. Filler metals that do not have an AWS classification or have special requirements shall be identified by manufacture and type.
- 4.3.10 ASME P-1 materials shall be welded using ASME PBV Section IX A-1 filler material.
- 4.3.11 Filler metals designed for single pass welding shall not be used for multiple pass welds.
- 4.3.12 When joining similar metals, the filler metal shall match the chemistry of the base metal as close as possible. Use of dissimilar filler metal to the base material or joining dissimilar base metal requires company approval.
- 4.3.13 When welding austenitic stainless steel, filler metal with a ferrite number of 4-12 as predicted by the WRC ferrite diagram shall be used. For weld overlays when a ferrite number is specified by offer documents, the actual overlay shall be tested using a calibrated ferritescope or magnetic instrument in accordance AWS A4.2 / A4.2M. Measurements shall be:

- Nozzles- two (2) readings
- Shell and Head- the greater of four (4) readings per shell ring or head or one (1) reading per 10 ft².

4.4 Shielding and Purging Gases

- 4.4.1 Nitrogen shall not be used as a shielding or purge gas.
- 4.4.2 Inert gas backing shall be used for all alloy materials including aluminum and copper alloys except for the following:
- Carbon Steels
 - Carbon-Molybdenum Steels
 - Low-alloy Chromium-Molybdenum steels with a Chromium content ≤ 1.5 percent.

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4.4.3 Internal purge shall be maintained for the root pass and second pass on all materials requiring back purge.

4.4.4 Shielding gases shall be stored away from temperature extremes that may affect their performance.

4.5 Pre-heat and Interpass Temperature

4.5.1 Pre-heat and interpass temperature may be maintained by air-fuel or oxy-fuel torches, electrical induction or electrical resistance methods.

4.5.2 Preheating and interpass temperature shall be monitored through the use of temperature indicating crayons, thermometers or thermo-couples.

4.6 Post Weld Heat Treatment (PWHT)

4.6.1 For equipment that is to be PWHT, all attachments to the PWHT area shall be welded on prior to PWHT. This includes any lifting attachments and gussets.

4.6.2 With approval by customer, attachments may be welded to austenitic cladding or weld overlay after PWHT.

4.6.3 Supplier shall provide a PWHT procedure to customer for approval prior to fabrication including the following minimum information:

- 1) Type of PWHT (ie. Furnace or local)
- 2) Place of PWHT
- 3) Sequence and location of support
- 4) Thermocouple types, number and locations
- 5) Method of thermocouple attachment
- 6) Full heat treatment cycle and calibration method including heating / cooling rates, hold temperature / time and cooling method.

4.6.4 All PWHT shall be in accordance with the applicable code of fabrication unless specifically agreed on in offer documents. Code exemptions for PWHT are not allowed if specified in the material requisition based on service requirements.

4.6.5 All WPSs specifying PWHT shall indicate the maximum heating rate, holding temperature (maximum and minimum), holding time and maximum cooling rate.

4.6.6 All machines surfaces shall be protected by a suitable compound to prevent scaling during PWHT.

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4.6.7 To minimize warping, all assemblies shall be properly supported and flanges properly braced during PWHT.

4.6.8 If hardness requirements are included in the material requisition, these shall be measured and recorded after PWHT.

4.7 Cleaning

4.7.1 Methods for cleaning the welding surfaces prior to welding shall be detailed in the WPS.

4.7.2 Cleaning shall be conducted in a manner that shall not lead to further contamination of the weld area or the base material.

4.7.3 All scale, paint, oil, rust, dirt, oxides and other foreign matter shall be removed prior to welding, including tack welding. Weldable primers may be left in place if qualified and specified in the WPS and supporting PQRs.

4.7.4 Only stainless steel brushes and tools shall be used on stainless steel and nickel based surfaces. These tools shall have never been used on carbon steel or low alloy material.

4.7.5 All oxy-fuel or plasma cut bevels and ends shall be smooth and free of scale.

* note: Oxy-fuel cutting and bevelling not allowed on low alloy or high alloy material.

4.7.6 All pipes shall be cleaned internally to remove debris prior to welding.

4.7.7 For double sided joints, the back side of the joint shall be cleaned to sound metal prior to welding the second side unless it can be demonstrated weld can be made without this operation.

5.0 WELDING PROCEDURE SPECIFICATION QUALIFICATION

5.1 All WPSs and supporting PQRs shall be documented in writing and qualified in accordance with ASME Section IX, the applicable design code and this specification. Procedure qualification shall be conducted by a laboratory independent of equipment fabrication responsibility.

5.2 All WPSs and supporting PQRs shall be written in the English language.

5.3 For the SAW process, the WPS and PQR shall state the manufacturer and trade name of the flux. This flux manufacture and trade name will be limited for use on fabrication.

5.4 Repair welding, if different from the WPSs submitted for approval, shall be qualified separately and approved by customer prior to performing repairs.

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- 5.5 For weld over-lay, the PQR chemical analysis shall report all elements for which specific values are given in ASME Section II, part C.
- 5.6 Weld over-lay shall have the required chemistry to a minimum depth from the exposed surface of 1/8" or 1/2 the cladding thickness, whichever is less. The weld bead sequence shall be recorded on the PQR and WPS and duplicated in production.
- 5.7 Weld overlay PQRs shall be subjected to the maximum PWHT to be used in production.

6.0 WELDER AND WELDING OPERATOR QUALIFICATION

- 6.1 Supplier shall provide at their cost all facilities, equipment and materials used for testing and qualifying welders and welding operators.
- 6.2 All welders and welding operators shall be qualified and certified in accordance with ASME Section IX unless specifically allowed by Customer agreement.
- 6.3 Customer retains the right to witness all welder and welding operator test. Supplier will maintain documentation of welder qualification tests for review by customer.
- 6.4 Supplier will supply a list of all qualified welders to be employed on purchased equipment for either prior review or verification at the time of inspection. This list will include the welder's ID mark, date of qualification and extent of qualification.
- 6.5 All welding shall be conducted by a qualified and approved welder using an approved WPS. This includes all attachment and tack welds.
- 6.6 Supplier will immediately remove any welder or welding operator from work on customer's equipment when, in the opinion of customer, the welder does not possess the required competency or attention to produce acceptable welds.
- 6.7 Supplier shall maintain a welding log that tracks and identifies the weld number and appropriate WPS used.
- 6.8 The welding log shall be available to Customer upon request and shall be maintained throughout the completion of fabrication.

7.0 FIT- UP AND ALIGNMENT

- 7.1 Welding techniques shall be selected to ensure that all specified tolerances are not exceeded. If tolerances are not stated in offer documents, relevant codes and standards shall govern.

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- 7.2 Weld joint preparation, spacing and alignment shall be in accordance with the WPS, applicable code, offer drawings and this specification.
- 7.3 Tack welds in the weld joint is, allowed for carbon steel only, provided they conform to the ASME code.
- 7.4 Tack welds shall either be totally removed or completely fused into the final weld.
- 7.5 Temporary attachment welds, or tack welds in the weld joint, shall be performed in the same manner as the approved WPS for the parent material.
- 7.6 Material for the temporary attachment shall be of the same type as the parent material.
- 7.7 Temporary attachments shall only be removed by grinding or flame cutting and ground smooth with the parent material. If flame cutting is employed, a minimum 1" of attachment material shall be left after thermal cutting and then ground to the parent material.
- 7.8 For pressure vessels, all areas of temporary attachment welds shall be examined by MT or PT after removal.

8.0 REPAIRS

- 8.1 Supplier shall submit a procedure detailing weld and base material repair. This procedure shall describe excavation of the area, weld repair procedure, NDE and PWHT to be performed. This procedure requires customer approval prior to any repairs being performed. The repair procedure will define both a "major" and "minor" repair.
- 8.2 Customer shall be notified of any major weld repairs as defined by the repair procedure.
- 8.3 Defects may be repaired from either side of the weld provided this is detailed in the approved weld procedure.
- 8.4 Examination of the repaired area will use, as a minimum, the same NDE method that discovered the defect. If an alternate method of inspection is needed, an inspection procedure shall be submitted by supplier to customer for approval.

9.0 NONDESTRUCTIVE EXAMINATION

9.1 General

- 9.1.1 Inspection and Nondestructive Examination (NDE) shall be performed in accordance with ASME section V, the applicable code of fabrication and this specification.

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- 9.1.2 Supplier shall submit all NDE procedures to customer for approval prior to use. NDE processes allowed by code case require customer approval.
- 9.1.3 Supplier shall provide to customer all NDE records required by the applicable code and this standard.
- 9.1.4 All NDE functions shall be open to customer inspection during fabrication or final acceptance.
- 9.1.5 Materials that are annealed or normalized shall be cleaned of any scale prior to inspection.
- 9.1.6 NDE technicians shall be certified by an ASNT SNT-TC-1A, level III examiner or equivalent standard approved by customer.
- 9.1.7 Extent of NDE will be specified in offer documents and applicable codes / standards.

9.2 Visual Inspection

All welds shall be 100 percent visually inspected.

9.3 Radiographic Testing

- 9.3.1 All radiographic film shall be at least grade Type 1 or 2.
- 9.3.2 Fluorescent intensifying screens shall only be used with customer's approval.
- 9.3.3 RT film marking shall include the minimum information:
- 1) Job Number
 - 2) Item Number
 - 3) Weld Number
 - 4) Welder Identification

9.4 Magnetic Particle Testing

MT shall be performed with either the AC or DC yoke or prod method and shall include a band of base metal at least 1 inch on each side of the weld.

9.5 Penetrant Testing

- 9.5.1 Penetrant materials shall meet the requirements of ASME section V, Paragraph T-630 of article 6 for sulphur and halogen content.
- 9.5.2 PT of welds shall include a band of base metal at least 1 inch on each side of the weld.

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10.0 Special Material Requirements

- 10.1 The material requisition and offer document may contain additional requirements concerning the base material and fabrication of equipment.
- 10.2 When welding clad material, the alloy cladding shall be stripped back 1/4" at all seams prior to welding the base metal. The stripped back area shall be tested with either nitric acid or copper sulfate to ensure complete removal of the alloy cladding.