KPD-TAY COMPRESSION PROJECT

Tender Enquiry No.: PROC/FC/PROJ/KPD-TAY/COMP/5313/2022

PRE-BID CLARIFICATION # 16

One of the bidder has asked following queries, OGDCL/ENAR's response is as follows:

Sr. No.	Tender Documents Reference	Bidder's Query	OGDCL/ENAR's Response
1	**3- Volume-IIC (Electrical) 165-4-DER-008 Rev.-0 Existing Basis of Design.** 9.0 Anti-condensation heaters shall be provided to motors greater than 75kW rating.	There are conflicts in these two documents, please clarify which one should be followed.	Motors equal and greater than 22 kW and above shall be provided with anti-condensation heaters as mentioned in Electrical basis of design Doc# 0258-ELA-6500 and Specification for LV A.C Induction Motor Doc# 0258-ELA-6502.
2	**3- Volume-IIC (Electrical) 0258-ELA-6502.** 4.3.2. Space Heater Motors anti-condensation heater shall be as per manufacturer recommendation in view of ambient condition (refer sec.3) and motor winding life. However; motors equal and greater than 22 kW and above shall be provided with anti-condensation heaters irrespective of manufacturer recommendation.		
3	**3- Volume-IIC (Electrical) 0258-ELA-6500-1** The degree of protection shall be IP 42 for motors indoor in non-hazardous area; whereas IP 55 (motor enclosure), and "IP56" (motor terminal box - irrespective of mentioned in other documents) for motors outdoor & hazardous area, auxiliaries and bearing housings.	For motor terminal box protection, please confirm if IP65 could be accepted.	The degree of protection for motor terminal Box shall be "IP56" minimum. However, IP65 is also acceptable.
4	**2- Volume-IIB (Mechanical)\Specifications 165-4-SPM-055-SPECIFICATION FOR SKID MOUNTED PACKAGES.** P5 2.2 Project Specifications 165-4-SPM-034-Specification for Welding	There is no 165-4-SPM-034-Specification for Welding,please provided.	Please find attached specification for welding as **Attachment-I**
5	**2 Volume-IB (Mechanical)/Specifications/Specification for Reciprocating Compressor** Page 27 Sec. 2.14.5 Coupling guards shall be non-sparking, brass lined.	It is recommended that the coupling guards shall be non-sparking, aluminum alloy.	Please follow tender document.
6	**2- Volume-IIB (Mechanical) - Specifications** **165-4-SPC-018-Specification for structure steel works page 4** Para.2.0 CODES,STANDARDS AND SPECIFICATIONS AWS D1.1 American Welding Society. Structural Welding Code. ASTM American Society for Testing & Matericals	Bidder propose to substitue the usage of American (ASTM) material standards with China Standard,the offered material is higher standard as compared to required ASTM and be used in OGDCL past project.	Please follow tender document.
7	**Appendix-N (Approved Vendors List)** 2.05 STEEL STRUCTURE AND CARBON STEEL PLATE (iii)Others may be proposed for OGDCL's Approval	We will use some Chinese material suppliers who have been used in previous OG projects including shansteelgroup\laiganggroup\bensteelgroup and so on please confirm.	Bidder/EPCC Contractor will submit the details alongwith the technical information during execution of the Project. Considering the technical requirements, OGDCL/ENAR will review and approve accordingly.
8	**Appendix-N (Approved Vendors List)** 1.04 PRESSURE VESSELS (xxvi)Vendor having ASME U & S stamp certification and relative experience	In our understanding, vendor who has U stamp certification and pressure vessel manufacturing experience can be treated as qualified manufacturer please confirm.	Noted. However, technical documents and required experience would be submitted by Bidder/EPCC Contractor during execution of the Project to OGDCL/ENAR for review and approval.

ATTACHMENT-I

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OIL & GAS DEVELOPMENT COMPANY LTD.

SPECIFICATION FOR

WELDING

0	15-04-2012	Issued for Tender	MIAH	MAJ	MAS
Rev.	**Date**	**Description**	**Prepared By**	**Checked By**	**Approved By**

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1.0 GENERAL

1.1 Scope

This Specification covers the basic requirements for welding, heat treating, and non-destructive examination of certain pressure-containing components. This includes piping, pressure vessels, steam generators, fired heater coils, heat exchangers, pumps and compressors etc. requirements also apply to structural attachment welds in such equipment.

1.2 Definitions

Following definitions apply throughout this document:

OWNER / COMPANY:	Oil & Gas Development Company Ltd. (OGDCL)
CONSULTANT	M/s. Zishan Engineers (Pvt.) Ltd. (ZEL).ZEL have been awarded the work of Engineering, Procurement Assistance and Project Management.
CONTRACTOR:	Means the construction company to be engaged by the COMPANY to perform the Construction work.
VENDOR / SUPPLIER:	The organization, firm or agency with whom order for the supply of equipment and or material has been placed.

1.3 Errors or Omissions

1.3.1 Review and comment by the CONSULTANT / COMPANY of any CONTRACTOR / SUPPLIER's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the CONTRACTOR/SUPPLIER of its obligations to comply with the requirements of this specification and other related parts of the contract documents.

1.3.2 Any errors or omissions noted by the CONTRACTOR/SUPPLIER in this Specification shall be immediately brought to the attention of the CONSULTANT / COMPANY.

1.4 Deviations

All deviations to this specification, other specifications or attachments shall be brought to the knowledge of the CONSULTANT / COMPANY in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of the CONSULTANT prior to execution of the work. Such deviations shall be shown in the documentation prepared by the CONTRACTOR/SUPPLIER.

1.5 Conflicting Requirements

In the event of conflict, inconsistency or ambiguity between the contract scope of work, this Specification, National Codes & Standards referenced in this Specification or any other documents, the CONTRACTOR/ SUPPLIER shall refer to the CONSULTANT whose decision shall prevail.

2.0 REFERENCES

The following Guides and industry publications are referenced herein and shall be considered a part of this Specification. Refer to the latest editions unless otherwise specified.

2.1 ASME - American Society of Mechanical Engineers

▪ ASME B31.3	Process Piping
▪ ASME SEC I	BPVC SECTION I Rules for Construction of Power Boilers
▪ ASME SEC II-C	Material Specifications - Welding Rods, Electrodes and Filler Metals
▪ ASME SEC V	BPVC SECTION V Nondestructive Examination
▪ ASME SEC V B SE-94	STANDARD GUIDE FOR RADIOGRAPHIC EXAMINATION
▪ ASME SEC VIII	Rules for Construction of Pressure Vessels
▪ ASME SEC IX	Qualification Standard for Welding and Brazing Procedures, Welding and Brazing Operators

2.2 AWS - American Welding Society

3.0 WELDING PROCEDURE AND WELDER QUALIFICATIONS

3.1 Welding Procedures

3.1.1 Welding procedures shall be in writing and shall be qualified in accordance with ASME SEC IX and this Specification, using the latest revision in effect on the date of the purchase order for the equipment being fabricated. All welding procedures shall include a weld procedure specification (WPS) and a procedure qualification record (PQR).

3.1.2 Complete welding procedures for all materials to be welded shall be submitted to the CONSULTANT for review and approval prior to use. These procedures shall include the following: Welding Procedure Specifications, Procedure Qualification Test Records, ranges of variables qualified, a weld map or description identifying which welding procedure will be used for each weld and the method and extent of inspection. The CONTRACTOR/SUPPLIER shall furnish complete information for each applicable item, as required. For piping a typical drawing representing all applicable weld procedures to be used on the work shall be submitted to the CONSULTANT for approval prior to work commencing.

3.1.3 Complete welding procedures shall be submitted for approval sufficiently in advance of the actual welding, so as to allow for adequate review and approval. A typical weld map (or specific weld map) where each procedure will be used shall be included with this submittal. No welding shall be performed until all such welding procedures are approved by the CONSULTANT.

3.1.4 The information contained in each welding procedure specification and in the procedure qualification test records shall include, but not be limited to, the information contained on forms QW 482 and QW 483 shown in ASME SEC IX.

3.1.5 All welding procedures shall be identified by number and referenced on all applicable fabrication drawings.

3.2 Qualification of Welding Procedures

3.2.1 P-number shall be considered an essential variable for all welding processes. Materials that do not have P-numbers (not listed in QW 422 of ASME SEC IX) shall be qualified individually.

3.2.2 Welding position shall be considered an essential variable for groove welds in all automatic welding processes.

3.2.3 All welding consumables not listed in ASME SEC II-C shall be individually qualified.

3.2.4 For submerged arc welding, brand name and grade of flux shall be considered an essential variable, together with changes in speed or heat input beyond the range qualified. The procedure qualification test record shall indicate the name of the manufacturer, plus the trade name of the wire and flux used to qualify the procedure.

3.2.5 Postweld heat treatment (time and temperature) shall be considered an essential variable for P-3, P-4, P-5, and P-6 materials. A decrease in time of more than 15 percent and/or in temperature of 10 percent or more, from the range qualified, will require a separate welding procedure qualification.

3.2.6 Impact testing of welds and heat-affected zones (HAZ) for ferritic materials at minimum design temperature is required for welding procedure qualification under the following conditions:

a) When the base material requires impact testing

b) When the base material does not require impact testing, but the material thickness exceeds 12.7 mm (1/2 in) and the minimum design temperature is 0°C (32°F) or lower.

c) When the base metal does not require impact testing, but the submerged arc welding process is used with weld pass thickness greater than 9.5 mm (3/8 in).

3.2.7 When impact testing is required, the Charpy V-notch impact values for parent material, weld metal, and heat-affected zones shall be not less than those specified in ASME B31.3, Table 323.2.2. The impact test shall be performed on the same type (ASTM or other similar specification) and grade of material as will be used in fabrication.

3.2.8 Procedure qualifications for weld overlay deposits shall include a complete chemical analysis of the overlay, procedure qualification test record, and unless specifically waived by the CONSULTANT, a sample of the overlay. Specimens taken for chemical analysis shall be representative of material 2.5 mm (0.1 in) below the surface. The weld metal chemical composition shall be within the nominal range specified for the alloy. Monel overlays shall have a maximum iron content of 4.5 percent. The procedure qualification tests shall include the following:

a) Dye penetrant examination of the completed weld

b) Side bend tests per QW 453 for weld metal soundness

c) Chemical composition analysis per QW 462.

3.2.9 Excessive fissuring shall be caused for rejection. Fissures shall not exceed four per specimen, nor shall they exceed 1.6 mm (1/16 in) in length. Cracks in corners shall not be considered part of the examination.

3.2.10 The welding procedure qualification tests shall include hardness tests of base, HAZ, and weld for the following materials:

a) Quenched and tempered carbon steel

b) High-strength, low-alloy (HSLA) steel

c) Carbon-molybdenum (C-Mo), manganese-molybdenum (Mn-Mo), and chromium-molybdenum (Cr-Mo) steels.

d) Other air-hardenable materials.

3.2.11 Procedure qualification tests for welding carbon steel shall also include a hardness survey, if any of the following conditions exist:

a) Submerged arc welding is performed with F8XX or higher flux designation.

b) Shielded metal arc welding is performed with covered electrodes of E80XX or higher classification.

c) Filler metal contains at least 1.6 percent manganese, or manganese and silicon exceed 1.4 and 0.8 percent, respectively.

d) The job specifications or data sheets require a maximum specified hardness in the weld and/or heat-affected zone.

e) Process conditions (wet hydrogen sulfide, amine, caustic) require production hardness testing.

3.2.12 The hardness testing for welding procedure qualification shall be performed on the base metal, weld, and heat-affected zone, with an instrument having an indentor not larger than 1.6 mm (1/16 in) in diameter. The hardness shall be reported as Brinell (HB) or Vickers (HV) equivalent numbers. Hardness surveys shall be performed along two lines parallel to the outer and inner surfaces of the weld, and located approximately 2 mm (0.08 in) below them. The type of hardness test instrument shall be reported and the test results shall meet the hardness requirement in accordance with ASME B31.3.

3.2.13 Welding procedure tests shall demonstrate that all details are capable of producing satisfactory full-penetration butt welds, unless the weld joints are specifically designated as fillet welds.

3.2.14 For gas tungsten arc and gas metal arc welding, the qualification record shall include the composition and flow rate of the shielding and inert gas backing, if used.

3.2.15 For the gas metal arc process, the electrode diameter and extension, amperage, voltage, wire feed rate, and travel speed shall be specified in the welding procedure.

3.2.16 Base material used in qualification tests shall have the nominal chemistry and mechanical properties of the material to be welded. For carbon steel, the carbon content of base material shall be at the higher end of the specification range.

3.3 Qualification of Welders and Welding Operators

3.3.1 Welders and welding operators shall be qualified in accordance with ASME SEC IX and local requirements, as a minimum. Qualification shall be completed prior to start of fabrication. Performance qualification records shall be made available to the CONSULTANT / COMPANY upon request. At the CONSULTANT / COMPANY option, witnessing of performance qualification, welding, and testing may be required.

3.3.2 Qualification of welders and welding operators solely by means of radiography of a weld sample is subject to the COMPANY approval.

3.3.3 Qualification of welders using the GMAW process shall be by mechanical testing only.

4.0 WELDING PROCESSES

4.1 Welds shall be made by the shielded metal arc, gas tungsten arc, gas metal arc, or submerged arc welding process. All other welding processing, including electro-gas, electro-slag, oxyacetylene and the flux cored process, require prior to the CONSULTANT / COMPANY approval.

4.2 The flux cored arc welding (FCAW) process may be used, subject to the CONSULTANT / COMPANY review and approval (proposal to use FCAW must be submitted prior to order placement), provided the following conditions exist:

4.2.1 Gas shielding is used.

4.2.2 Material to be welded is carbon steel or for application of weld overlay on carbon steel or low alloy steel.

4.2.3 FCAW process is not "short arc"

4.2.4 FCAW process is not used for the root pass in single-sided welding.

4.2.5 Production consumables are restricted to the manufacturer and grade qualified.

4.2.6 Only EXXT-1 or EXXT-5 (flat or horizontal position only) welding wires are used.

4.2.7 Service is not hot hydrogen [over 260°C (500°F)], wet hydrogen sulfide, or hydrogen fluoride

4.2.8 At least five percent of the individual welds are 100 percent radiographed or ultrasonically examined.

4.2.9 Ten percent of the nozzle to shell or head welds (including at least one of each size) shall be 100 percent radiographed or ultrasonically examined.

4.2.10 Low hydrogen electrodes are used

For all other applications not meeting the above conditions, FCAW process may be considered on a case-by-case basis. The review will include the evaluation of the specific application, verification of the fabricator's experience, additional qualification and/or NDE requirements, and the CONSULTANT / COMPANY witnessing of welding procedure and/or welder qualification.

4.3 The gas metal arc process (GMAW) in the "short circulating transfer" (short arc) mode may be used for the following purposes:

4.3.1 Root pass welding in a combination process.

4.3.2 Fit-up welding that will subsequently be completely removed by back gouging, chipping, or grinding

4.3.3 Weld metal overlays made in the flat position

4.3.4 Non-pressure retaining fillet welds made in the flat, horizontal, or vertical-up positions.

4.4 The short arc process shall not be used under the following conditions:

4.4.1 Where the joint geometry or large mass can affect the integrity of the weld; for example, on nozzles, couplings, slip-on flanges, socket-welded flanges, O-type branch fittings, or extended surface (FIN) attachments.

4.4.2 With ferritic or martensitic filler metal for design service below 0°C (32°F).

4.5 During GMAW short arc welding of the root pass, the root gap (including tolerance) shall not be less than 2.4 mm (0.1 in) wide. The root face thickness (including tolerance) shall not exceed 0.8 mm (3/32 in). All tack welds shall have both ends ground to feather edge.

4.6 Except for piping, double-welded butt joints shall be used wherever possible in pressure-containing equipment. Where access or wall thickness precludes the use of double-welded butt joints, single-welded joints may be made. This requires a root pass deposited by the GTAW process or (subject to the CONSULTANT approval) by the GMAW process.

4.7 A gas tungsten arc root pass is required for the following circumstances:

4.7.1 Single-welded, full-penetration butt joints in C-Mo, Mn-Mo, and Cr-Mo steels; in all non-ferrous alloys; and in carbon steel for hydrogen fluoride service.

4.7.2 All heater tubes

4.7.3 All carbon steel single-welded, full-penetration butt joints over 38 mm (1.5 in) thick.

4.8 In an inert gas welding process, inert gas backing (argon or helium) is not required for carbon steels, carbon-molybdenum steels, or low-alloy chromium-molybdenum steels with a chromium content not exceeding 1½ percent by weight. Inert gas backing shall be used for all other alloy materials, including aluminum and copper alloys. The use of nitrogen, however, for gas shielding of stainless steel shall not be allowed.

4.9 The following restrictions and limitations apply to all welding processes.

4.9.1 All welding processes shall be protected from wind, rain, and other harmful weather conditions that can affect weld quality. CONTRACTOR/SUPPLIER shall provide habitat arrangements that afford full weather protection as approved by the CONSULTANT.

4.9.2 Welding techniques shall be selected to ensure that specified tolerances for straightness and out-of-roundness are not exceeded. If such tolerances are not stated in the drawings, standards, or specifications, the applicable section of the relevant code shall govern.

4.9.3 Welded joints shall be made by completing each layer before succeeding layers are deposited. Block welding is prohibited.

4.9.4 Vertical welding shall be performed vertically up, downward vertical position welding shall not be permitted unless specifically approved in writing by the CONSULTANT.

4.10 The following limitations shall apply when welding aluminum:

4.10.1 The gas tungsten arc process shall not use thoriated tungsten electrodes. Electrode configuration shall be shown in the welding procedure and shall be considered an essential welding variable.

4.10.2 Except for piping, the gas metal arc process shall employ run on and run off tabs in all groove welding.

4.10.3 For all processes, the welding procedure shall contain a detailed cleaning treatment indicating joint preparation prior to welding. All full-penetration joints shall be back-purged with argon or helium.

5.0 MATERIALS

5.1 Filler Materials and Flux

5.1.1 Filler metal for welding similar materials shall be of the same nominal analysis as the base material, except as follows:

a) AWS Type 347 filler metal shall be used for welding Type 321 stainless steel material.

b) AWS Type 308 filler metal shall be used for welding Type 304 stainless steel material. (Type 308L shall be used for Type 304L.)

c) The following filler metals shall be used for welding 11 to 13 percent chromium steels: Inco-Weld A; Inconel 82 or 182; AWS E309, E410, or E410Cb. However, for 11 to 13 percent steels in cyclic service, or for design temperatures over 350°C (660°F), only Inco-Weld A, Inconel 82, or Inconel 182 are acceptable.

d) For chromium-molybdenum steel, filler materials such as Inconel 82 or 182 or Inco-Weld A may be used, if approved by CONSULTANT.

5.1.2 Filler metals for welds joining dissimilar materials shall be in accordance with Table 1. Filler metals for combinations of materials other than those in Table 1 shall be submitted to CONSULTANT / COMPANY for approval.

Table 1: Filler Metal for Welds Joining Dissimilar Materials

Base Matl Num	Nominal Analysis of Base Materials	Base Material Number																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Carbon Steel		A	A	A	A	A	A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	C	D	C
2	Carbon-Molybdenum Steel	A		E	C	E	E	E	E	E	E	B	B	B	B	B	B	B	B	B	B	B	C	D	C
3	2 1/2% Nickel & 3 1/2% Nickel Steel	A	E		C										B	B	B	B	B	B	B	B	C	C	C
4	9% Nickel Steel	A	C	C											C	C	C	C	C	C	C	C	C	C	C
5	1% Cr-1/2% Mo Steel	A	E				F	F	F	F	F				B	B	B	B	B	B	B	B	C	D	C
6	1 1/4% Cr-1/2% Mo Steel	A	E			F		F	F	F	F				B	B	B	B	B	B	B	B	C	D	C
7	2 1/4% Cr - 1% Mo Steel	A	E			F	F		F	G	G				B	B	B	B	B	B	B	B	C	C	C
8	5% Cr-1/2% Mo Steel	A	E			F	F	H	H		H	H			B	B	B	B	B	B	B	B	C	C	C
9	7% Cr-1/2% Mo Steel	A	E			F	F	G	H		I				B	B	B	B	B	B	B	B	C	C	C
10	9% Cr-1% Mo Steel	A	E			F	F	G	H	I			J	J	B	B	B	B	B	B	B	B	C	C	C
11	Type 405 Stainless Steel	B	B										K	K	B	B	B	B	B	B	B	B	C	C	C
12	Type 410S Stainless Steel	B	B								J	K		K	B	B	B	B	B	B	B	B	C	C	C
13	Type 410 Stainless Steel	B	B								J	K	K		B	B	B	B	B	B	B	B	C	C	C
14	Type 304 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B		L	L	P	L	L	O	O	C	C	C
15	Type 304L Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	L		M	M	L	M	O	O	C	C	C
16	Type 321 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	L	M		N	L	M	O	O	C	C	C

Base Matl Num	Nominal Analysis of Base Materials	Base Material Number																							
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
17	Type 347 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	P	M	N		P	M	P	P	C	C	C
18	Type 316 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	L	L	L	P		Q	O	O	C	C	C
19	Type 316L Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	L	M	M	M	Q		O	O	C	C	C
20	Type 309 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	O	O	O	P	O	O		R	C	C	C
21	Type 310 Stainless Steel	B	B	B	C	B	B	B	B	B	B	B	B	B	O	O	O	P	O	O	R		C	C	C
22	Alloy 800 (Incoloy 800)	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C		C	C
23	Monel 400	D	D	C	C	D	D	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C		C
24	Inconel 625	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	

Legend (Table 1)

A AWS A5.1, classification EXX15, EXX16, or EXX18.

B AWS A5.4 and AWS A5.11, classification E309-XX, ENiCrFe-3 (Iconel182), or ENiCrFe-2 (Inco-Weld A).

C AWS A5.11, classification ENiCrFe-3 (Inconel 182) or ENiCrFe-2 (Inco-Weld A).

D AWS A5.11, classification ENiCrFe-3 (Inconel 182), ENiCrFe-2 (Inco-Weld A), or ENiCr-7 (Monel 190).

E AWS A5.5, classification E7015-A1, E7016-A1, or E7018-A1.

F AWS A5.5, classification E8016-B2, E8018-B2, or E8015-B2L, E8018-B2L.

G AWS A5.5, classification E9015-B3, E9016-B3, E9018-B3, or E9015-B3L, E9018-B3L.

H AWS A5.4, classification E502-XX.

I AWS A5.4, classification E7Cr-XX.

J AWS A5.4, classification E505-XX.

K AWS A5.4 and AWS A5.11, classification E410-XX, E410 Cb-XX, E309-XX, ENiCrFe-3 (Inconel 182), or ENiCrFe-2 (Inco-Weld A).

L AWS A5.4, classification E308-XX.

M AWS A5.4, classification E308L-XX.

N AWS A5.4, classification E347-XX.

O AWS A5.4, classification E309-XX or E308-XX.

P AWS A5.4, classification E308-XX or E347-XX.

Q AWS A5.4, classification E316-XX or E316L-XX.

R AWS A5.4, classification E309-XX.

Notes:

1. Blank spaces in Table 1 indicate combinations that are considered unlikely or unsuitable. For these combinations, consult COMPANY / CONSULTANT to approval.
2. Table 1 refers to coated electrodes. For bare wire welding (SAW, GMAW, GTAW), use equivalent electrode classifications (AWS A5.9, AWS A5.14, AWS A5.18, AWS A5.20, AWS A5.23, and AWS A5.28).

5.1.3 Filler metals for welds shall meet the same minimum impact test requirements as those imposed on the base metal.

5.1.4 In all welding processes, the filler wire shall contain all alloying elements and shall meet all chemical composition requirements for the wire classification. Exceptions are subject to CONSULTANT approval.

5.1.5 For gas metal arc welding of carbon steels, base wire filler metals shall conform to AWS A5.18.

5.1.6 For gas tungsten arc welding of carbon steels, the filler metal shall meet the chemical and physical test requirements of AWS A5.18.

5.1.7 For flux cored arc welding of carbon steels (when permitted by Section 5.2), the electrodes shall conform to AWS A5.20. These electrodes shall be used with an external shielding gas.

5.1.8 Carbon steels shall not be welded with C-1/2 Mo weld metal, unless the weld is post weld heat treated and the procedure qualification record includes weld hardness data. These data shall show that the weld and heat-affected zone have not exceeded with reference Codes and Standards.

5.1.9 Filler metals and consumable inserts for austenitic stainless steel welds shall be selected to produce weld deposits, which fall within the ferrite ranges and numbers, in accordance with reference Codes and Standards. This restriction is intended to prevent problems associated with sigma-phase formation and micro-fissuring in fully austenitic welds.

5.1.10 For cryogenic service with temperatures of -100°C (-150°F) and lower, the ferrite content of all austenitic stainless steel welding materials shall be in the range 2 to 5 percent (FN2 to FN5).

5.1.11 Austenitic stainless steel filler metals for service temperatures -100°C (-150°F) and below shall meet the impact requirements.

5.1.12 For welding carbon steel, submerged arc welding wires shall be limited to AWS classifications ELXX and EMXXX.

5.1.13 All completed weld joints (except for 5 through 9 percent nickel steels) shall be within the mechanical property limits specified for the base materials to be joined.

5.1.14 All welding consumables shall be used within the limits recommended by their manufacturers. The welding parameters shall be as used in the welding procedure qualification.

5.1.15 Low-hydrogen electrodes are required for all shielded metal arc welding when any of the following conditions apply:

a) Design temperature is below 0°C (32°F).
b) Valve or flange rating is Class 400 or higher.
c) Base metal has a carbon equivalent exceeding 0.43 percent, based on:

$$CE = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

d) Base metal has a minimum specified tensile strength greater than 415 Mpa (60,000 psi).
e) Thickness of butt welds and fillet welds (throat) exceeds 12.7 mm (1/2 in).
f) Castings are weld repaired.

5.1.16 For root pass welding of P-1 and P-3 steel piping materials, AWS cellulose electrode shall be used.

5.1.17 Electrodes, filler wires, and fluxes shall be kept clean, dry, and properly stored according to the manufacturer's recommendation.

5.1.18 For welding 5 through 9 percent nickel steels, the filler materials shall be reviewed and approved by CONSULTANT and qualified by procedure testing in the maximum plate thickness specified for each job.

5.1.19 Equivalency to AWS specifications of other national specifications for welding consumables shall be verified. The basis for equivalence shall be subject to CONSULTANT approval. Equivalence may be determined by review of consumables (electrodes and fluxes) and manufacturers' catalogs, and/or by chemical analysis and mechanical testing of weld deposits.

5.2 **Backing Rings and Consumable Inserts**

Permanently installed backing rings or strips shall not be used. Consumable inserts shall be used only with prior CONSULTANT / COMPANY approval.

6.0 JOINT PREPARATION, SPACING, AND ALIGNMENT

6.1 Edge Preparation

6.1.1 Welding bevels shall be suitable for the welding process to be used. For pressure-containing welds, the contour shall permit complete fusion throughout the joint. Bevels shall conform reasonably to those used in the procedure qualification.

6.1.2 All weld bevels and weld surfaces shall be free from cracks, porosity, slag inclusions, and other defects indicative of inferior workmanship.

6.1.3 Weld bevels shall be made by machining, grinding, or thermal cutting, and the surfaces shall be smooth, free of burning dross or fluting and true. Materials that require preheat for welding (refer to Section 10.1) shall be preheated in the same manner for thermal cutting or gouging.

6.1.4 Special weld bevel preparation is required for quenched and tempered carbon steels, HSLA steels, and steels containing more than 1/2 percent chromium. The steels shall be machined or ground back to clean and sound metal if they are flame or arc cut. At least 1.6 mm (1/16 in) of metal shall be removed.

6.1.5 Socket-welded joints shall have a gap between the bottom of the socket and the end of the pipe to be welded. The gap opening shall be at least 1.6 mm (1/16 in). The pipe for socket welding shall be square cut.

6.2 Cleaning

6.2.1 All surfaces to be welded shall be clean and free from paint, oil, dirt, scale, oxides, and other contaminants detrimental to welding. Cleaning shall be performed in a manner that will not lead to additional contamination of the weld or adjoining base metal.

6.2.2 Only stainless steel brushes and tools shall be used on stainless steel and nickel-alloyed materials.

6.2.3 Grinding disks containing sulfur (iron sulfide) shall not be used on steels with 5 through 9 percent nickel, stainless and alloy steels, or on non-ferrous materials.

6.2.4 Cleanliness shall be maintained after completion of welding. All stubs, rods, flux, slag, and foreign material shall be removed from the vicinity of the equipment or piping.

6.3 Butt Joints

6.3.1 Full penetration welds are required for single-sided welded joints.

6.3.2 Double-welded joints shall be prepared for back welding by grinding, arc-air gouging and grinding or chipping, so as to allow complete penetration and fusion. The depth of the back cut shall be sufficient to remove all the initial 1st pass welds but not deep enough to cause distortion in the welded joint by excess 2nd side welding.

6.4 Tack Welds

6.4.1 All tacks in the weld groove shall be performed by qualified welders (in conformance with ASME SEC IX), according to an approved welding procedure. Tack welding procedures, including for bridge and bullet tacks shall be qualified prior to fabrication operations.

6.4.2 Non-groove tack welds to be incorporated into the main weld seams shall have the ends ground and feathered.

6.4.3 Tack welds made by non-ASME SEC IX welders shall be completely ground out. The ground areas shall be examined by the magnetic particle or dye penetrant method prior to completing the permanent weld.

7.0 WELD CONTOUR AND FINISH

7.1 Weld beads shall be contoured to permit complete fusion at the sides of the bevel and to eliminate inter run and side wall slag inclusions. Flux and slag shall be removed completely from weld beads and from the surface of completed welds and adjoining base material. The flux removal shall be performed in a manner that will not cause the weld or adjoining base material to become contaminated or overheated.

7.2 Weld reinforcement and finish shall be as required by the applicable codes and standards. Undercutting of base metal is prohibited, except for piping fabricated according to ASME B31.3, undercutting shall be removed by smooth profile toe grinding, where allowed.

7.3 After removal of temporary welded attachments on all materials, except carbon steel (P-1) and austenitic stainless steel (P-8), the weld area shall be dressed and examined by magnetic particle or dye penetrant for the detection of cracks. Any defects found shall be removed and repaired.

7.4 Peening of partial or completed welds shall not be permitted, unless prior approval is given by CONSULTANT and the CONTRACTOR/SUPPLIER can demonstrate that the final weld joint integrity has not been affected.

7.5 All arc strikes, starts, and stops shall be confined to the welding groove. Arc strikes outside the welding groove shall be removed by grinding and examined by magnetic particle or liquid dye penetrant.

8.0 ALLOY LINING

8.1 VENDOR/SUPPLIER approval is required for any proposed alloy overlay system.

8.2 For both integrally clad plate and weld overlay, the surface of base plate welds that would be exposed to the corrosive environment shall be protected by depositing not less than two layers of corrosion-resistant weld metal.

8.3 In austenitic stainless steel overlays, where the base metal requires PWHT or the design temperature exceeds 450°C (840°F), the first weld layer shall be made with Type 309L. Subsequent layers of deposit shall be made with low-carbon, 18 Cr-8 Ni stainless steel, or stabilized grades of austenitic stainless steel, depending upon service conditions.

8.4 For Monel overlays on carbon or low-alloy steel, the first layer shall be made with a high-nickel consumable (nickel or Inconel). The second and any successive layers shall be made with a filler metal that nominally matches the Monel chemistry. The first layer of high-nickel deposit shall be applied over bright, clean, oxide-free steel.

8.5 When integrally clad stainless plates are being joined, the following shall apply:

8.5.1 The clad layer shall be stripped for a minimum distance of 8 mm (0.31 in) from the bevel. In addition, the base material shall be etched with nitric acid or copper sulfate to ensure prevention of austenitic weld dilution.

8.5.2 When the cladding is removed, the base material thickness shall not be reduced below the design thickness by more than 1 mm (0.04 in).

8.5.3 The procedure for back-cladding of internal attachments and nozzle welds requires approval by CONSULTANT**.** This procedure shall include base metal examination, welding sequence, and final inspection.

8.6 All internal exposed alloy welds joining clad components, and all alloy weld overlays inside vessels and heat exchangers shall be fully examined by the liquid dye penetrant method.

8.7 A certified report of the chemical analysis of production as-deposited alloy weld overlays, or alloy welds covering base metal welds in clad plates, shall be furnished to CONSULTANT. The weld metal chemistry shall be within the nominal range specified for the alloy. At least three drillings from each vessel section (vessel can), each heat exchanger, and each head shall be made to obtain sample material for analysis. One sample shall be taken at the beginning of the overlay and two samples at locations to be designated by the inspector. The samples shall be taken 2.5 mm (0.1 in) below the surface of the material.

Welding overlays shall be qualified in accordance with the WPS and PQR requirements specified herein. The Procedure Qualification Record shall also include corrosion testing of the weld overlays, specifically the ASTM G48 test and the ASTM A262 test. The G48 test shall yield a corrosion rate of 5 mpy or less. The A262 test shall show no evidence of cracking or pitting at 100x magnification.

9.0 THERMAL TREATMENT

9.1 Preheat and Interpass Temperature

The minimum preheat temperatures for thermal cutting, arc-air gouging, and welding (including butt, fillet, socket, seal, and tack welds) shall be in accordance with the requirements of the applicable code. Exceptions are as follows:

9.1.1 No welding shall be performed when metal temperature is 0°C (32°F) or lower.

9.1.2 Carbon steel shall be preheated to 10°C (50°F) , minimum, unless low-hydrogen electrodes are to be used.

9.1.3 Carbon steel shall be preheated to 93°C (200°F), minimum, when any of the following conditions apply:

a) Base metal thickness exceeds 25.4 mm (1 in)
b) Carbon content exceeds 0.30 percent
c) Carbon equivalent exceeds 0.43 percent, based on:

$$CE = C + \frac{MN}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

d) The material is highly restrained; for example, nozzles or major attachments.
e) All ferritic alloy materials shall be preheated in accordance with Table 2.
f) The maximum interpass temperature for austenitic stainless steels shall be 180°C (350°F).

9.1.4 The maximum preheat and inter-pass temperature for carbon steel and low-alloy steel shall be 300°C (572°F), unless otherwise approved by CONSULTANT.

9.1.5 During the welding of a casting, an area extending 300 mm (12 in) on either side of the weld shall be maintained at the approved preheat and inter-pass temperature.

9.1.6 The preheat and inter-pass temperature shall be determined by temperature-indicating crayons, contact pyrometers, thermocouples, or other equally suitable means. Temperature-indicating crayons used on austenitic stainless steels and nickel-base alloys shall cause no corrosive or other harmful effects. They shall not contain more than one percent by weight of total halogens or sulfur, or 200 ppm by weight of inorganic halogens. It is the fabricator's responsibility to determine suitable brands and melting temperatures that may be used. This information shall be made available to CONSULTANT upon request.

9.1.7 When the specified preheat temperature is 150°C (300°F) or higher, the metal shall be maintained at preheat temperature until the welds are completed. The preheat temperature shall be maintained until the start of post weld heat treatment or unless an intermediate tempering treatment is performed, for welds in thickness over 50 mm (2 in) or under a high degree of restraint (at nozzles, branch connections, and the like). CONSULTANT shall be consulted if uncertainties exist regarding the degree of restraint. An intermediate tempering heat treatment shall consist of heating to 600°C (1100°F), minimum, holding for a minimum of 15 minutes, and cooling slowly to the ambient temperature.

9.1.8 As an alternative for butt welds only, a hydrogen out-gassing treatment can be substituted for the intermediate tempering treatment. The hydrogen out-gassing procedure shall consist of either raising the preheat temperature to 260°C - 300°C (500°F - 570°F) and holding for four hours, or raising the preheat temperature to 325°C - 400°C (620°F -750°F) and holding for two hours. All other pressure welds, such as nozzle and manhole attachment welds, shall be given the full 600°C (1100°F) tempering treatment. The foregoing out-gassing procedure does not apply to 5 through 9 percent nickel steels.

Table No. 2: Minimum Preheat Temperatures for Ferritic Materials

Material (Nominal Analysis)	P-No.	Minimum Preheat Temperature	
		°C	°F
Carbon Steel	1	(Refer to Paragraph 10.1)	
Manganese-Molybdenum	3	150	300
C - 1/2 Mo	3	95	200
1/2 Cr - 1/2 Mo	3	95	200
1 Cr - 1/2 Mo	4	150	300
1 1/4 Cr - 1/2 Mo	4	150	300
2 1/4 Cr - 1 Mo	5	200	400
3 Cr - 1 Mo	5	200	400
5 Cr - 1/2 Mo	5	200	400
7 Cr - 1/2 Mo	5	200	400
9 Cr - 1 Mo	5	200	400
12 Cr (martensitic)	6	200	400
12 Cr (ferritic)	7	10	50
2 1/4 Ni	9A	150	300
3 1/2 NI	9B	150	300
5 Ni	11A	150	300
9 Ni	11A	150	300

9.2 Postweld Heat Treatment (PWHT)

9.2.1 PWHT shall conform to the applicable construction code, except as follows:

a) Minimum PWHT of ferric materials shall conform to Table 3.

b) All ferritic piping materials, except carbon steel piping with wall thickness 19 mm (3/4 in) or less (nominal thickness), shall be post-weld heat treated.

c) The PWHT for welds joining austenitic stainless steels to dissimilar materials shall be as specified in the qualified welding procedure and approved by CONSULTANT prior to the start of fabrication.

d) Under special circumstances (non-critical service), PWHT of field welds in low-alloy steels (C-Mo, Mn-Mo, and Cr-Mo) made with Inconel filler metal may be omitted, subject to CONSULTANT approval.

e) For P-6 materials, the PWHT temperature used shall be the lowest possible to avoid overheating and hardening on cooling.

f) Holding time at PWHT temperatures shall be one hour per 25.4 mm (1 in) of thickness, with a one-hour minimum. For chromium-molybdenum steels (1/2 to 9 percent chromium) and 12 percent chromium stainless steels, the minimum holding time shall be two hours.

g) For P-3, P-4, P-5, and P-6 materials, the production PWHT (time and temperature) shall be essentially the same as in the welding procedure qualifications.

h) A sufficient number of thermocouples or other acceptable measuring devices shall be attached, so as to accurately indicate metal temperature in all critical areas during PWHT.

i) Direct flame impingement by torch or furnace burner during PWHT is not permitted.

j) No exothermic heat treatment shall be allowed without prior written approval from CONSULTANT.

Table No. 3: Post Weld Heat Treatment for Ferritic Materials

Material (Nominal Analysis)	P-No.	PWHT Temperature Range	
		°C	°F
Carbon Steel	1	610 - 665	1130 - 1230
Manganese-Molybdenum	3	620 - 720	1150 - 1325
C - 1/2 Mo	3	620 - 720	1150 - 1325
1/2 Cr - 1/2 Mo	3	620 - 720	1150 - 1325
1 Cr - 1/2 Mo	4	705 - 745	1300 - 1375
1 1/4 Cr - 1/2 Mo	4	705 - 745	1300 - 1375
2 1/4 Cr - 1 Mo	5	720 - 760	1325 - 1400
3 Cr - 1 Mo	5	720 - 760	1325 - 1400
5 Cr - 1/2 Mo	5	720 - 760	1325 - 1400
7 Cr - 1/2 Mo	5	720 - 760	1325 - 1400
9 Cr - 1 Mo	5	720 - 760	1325 - 1400
12 Cr (martensitic)	6	720 - 790	1325 - 1450
12 Cr (ferritic)	7	None	None
2 1/4 Ni	9A	595 - 635	1100 - 1175
3 1/2 NI	9B	595 - 635	1100 - 1175
5 Ni	11A	550 - 585	1025 - 1085
9 Ni	11A	550 - 585	1025 - 1085

Notes:

1. The temperature of any part of weldment during PWHT shall not be less than shown above. The minimum holding time at temperature shall be one hour.
2. This table does not apply to normalized and tempered materials or to quenched and tempered materials. The PWHT of such materials shall be approved by CONSULTANT. It shall be such that the weld and HAZ hardnesses do not exceed with ASME B31.1, and the mechanical properties are not less than the specification minimum.

9.2.2 The maximum Brinell hardness of welds and heat-affected zones in all steels after heat treatment shall be in accordance with ASME B31.3. If welds are furnace heat treated, a sufficient number (10 percent) shall be tested to verify that the hardness criterion has been met. If local heat treatment has been applied, each weld shall be tested.

10.0 INSPECTION AND EXAMINATION

10.1 General

Examinations of welds shall conform to procedures and acceptance standards required by the ASME Code. The exception is piping, which shall be in accordance with specification for fabrication/installation of piping and the paragraphs of this section.

Table 4: Weld Examination Procedures and Acceptance Standards

Method	Standard, ASME Code	
	Section I	Section VIII
Radiography: - Complete - Random	PW-51	 Par. UW 51 Par. UW 52
Magnetic particle	N/A	Appendix 6
Liquid penetrant	N/A	Appendix 8
Ultrasonic	PW-52	Appendix 12

Notes:

1. Examination of piping welds fabricated in accordance with ASME B31.3 shall be in accordance with Specification for Fabrication/Installation of Piping.
2. Detailed weld inspection procedures and acceptance criteria shall be reviewed and approved by CONSULTANT.

10.2 All inspection and non-destructive examination (NDE) procedures shall be in writing and submitted to CONSULTANT for approval. All inspections and NDE shall be performed in accordance with the approved procedures. The NDE operators shall be at least ASNT Level – II certified for the examination they are performing.

10.3 Welds that are to be examined by non-destructive methods shall be finished as required by the applicable code.

10.4 Radiographic Examination

The following are additional requirements for radiographic examination:

10.4.1 ASME SEC V-B-2-SE-94 Type 1 fine-grain film (Kodak AA or equivalent) shall be used.

10.4.2 Only lead screens shall be used.

10.4.3 Use of penetrameters other than those specified in ASME SEC V-B-2-SE-94, Article 2 and 22 (ASTM SE 94), (such as DIN/IIW wires) is permissible. However, the thickness sensitivity and hole sensitivity shall be equivalent to those required by the applicable ASME Code, and prior approval shall be obtained from CONSULTANT.

10.4.4 Suitable film density shall be used.

10.4.5 Radiography of welds in NPS 2½ pipe or smaller may be performed by the elliptical projection technique. At least two separate exposures are required at locations 90 degrees apart.

10.5 Magnetic Particle Examination

Following are additional requirements for magnetic particle examination:

10.5.1 Only the yoke method shall be used after final postweld heat treatment.

10.5.2 Permanent magnets or yokes shall be used on air-hardening steels.

10.5.3 In examination by the prod method, the control switch shall be built into the prod handles, so as to prevent arcing.

10.5.4 Severe arc strikes resulting from magnetic particle examination shall be removed by grinding and the area subject to 100% MPI or DPI.

10.5.5 Magnetic particle inspection shall not be used on 5 through 9 percent nickel steels.

10.6 Liquid Penetrant Examination

Following are additional requirements for liquid penetrant examination:

10.6.1 Except for piping, liquid penetrant shall only be used for non-magnetic materials and 5 through 9 percent nickel steels, unless otherwise approved by CONSULTANT.

10.6.2 Cleaning and developing solutions with a combined total residual sulfur and halogen content of one percent by weight or greater shall not be used.

10.7 Ultrasonic Examination

Following are additional requirements for ultrasonic examination:

10.7.1 The weld shall be examined from at least two different probe angles.

10.7.2 Welds are not acceptable if the echoes from discontinuities exceed the reference curve. Each weld groove face shall be completely examined from both sides of the joint. If, however, complete examination can be performed from one side only, echoes that exceed 50 percent of the reference curve are not acceptable. Echoes exceeding 20 percent of the reference curve shall be fully evaluated and accurately sized.

10.7.3 All echoes from discontinuities that exceed 50 percent of the reference curve shall be recorded in the examination report and transmitted to CONSULTANT. This record shall locate each area, the echo height, the dimensions, the depth below the surface, and the classification.

10.8 Extent of Inspection

The minimum inspection shall be as follows:

10.8.1 All welds shall be visually inspected after completion and inspected per the construction code and this specification.

10.8.2 For piping, the extent and type of examination shall be as required in accordance with reference Codes and Standards.

10.8.3 All final non-destructive examinations shall be performed after post weld heat treatment, unless otherwise approved by CONSULTANT. Final radiography or ultrasonic examination for vessels shall be performed no sooner than 48 hours after the vessel has cooled to ambient temperature. In special cases, based on equipment type, materials, and process conditions, NDE examination may be separated; some performed before PWHT and some after.

10.8.4 Where CONSULTANT allows non-destructive examination to be performed before the final post weld heat treatment, the welds shall also be examined on all accessible surfaces by the magnetic particle method (dye penetrant method for non-magnetic materials and all piping) after PWHT.

10.8.5 The attachment welds between structural components and pressure parts of quenched and tempered carbon steel, HSLA steel, and ferritic alloy materials shall be examined by the magnetic particle method (dye penetrant for piping) after PWHT. This requirement does not apply to 5 through 9 percent nickel steels.

10.8.6 All pressure-containing equipment designed with 100 percent joint efficiency, irrespective of material, shall have all nozzle and reinforcing pad attachment welds examined by the magnetic particle or liquid penetrant method, as applicable. Inspection shall be performed on all accessible weld surfaces (inside and outside).

10.8.7 After completion of welding. This final inspection shall be made after post weld heat treatment, if any.

10.8.8 When examination by radiography is specified but is not practical, ultrasonic examination or an alternative non-destructive test method shall be proposed for CONSULANT approval.

10.8.9 For all piping and heater coils requiring radiography, the minimum number of shots per circumferential seam shall be as follows:

a) Up to and including NPS 2 1/2 diameter: two shots (90 degrees apart)
b) Over 2 1/2 NPS diameter: three shots (120 degrees apart)

10.8.10 Where random non-destructive examination is specified, at least one weld shall be examined for every material grouping, each welding process, and each welder. For each weld found to be defective, two additional representative welds shall be examined. If these additional welds are free from defects, only the defects indicated in the first examination shall be repaired and re-examined. However, if either of the two additional welds shows defects, all welds represented shall be either (1) fully non-destructively examined and repaired as necessary, or (2) completely replaced.

10.8.11 For spot radiography, at least one of each type and position of weld made by each welder shall be examined.

10.9 **Hardness Tests**

10.9.1 The hardness of welds and HAZ, when used in the as-welded condition or after post weld heat treatment, shall not exceed with reference Codes and Standards.

10.9.2 Where the following conditions occur, hardness tests of P-1 and P-3 materials shall be taken on the center of the inside surface of weld seams, where possible; otherwise, on the outside surface of the weld seams at the weld centre line and also the HAZ interface between the weldmetal and base material. (including nozzle, manhole, and attachment welds):

a) Submerged arc welding is performed with F70 or higher flux classification.

b) Shielded metal arc welding is performed with covered electrodes of E80XX or higher classification.

c) Filler metal contains at least 1.6 percent manganese, or when manganese and silicon exceed 1.4 and 0.8 percent, respectively.

10.9.3 For carbon steel in critical service, such as wet H_2S, amine, HF, and caustic, the hardness of deposited weld metal shall not exceed 200 HB.

11.0 REJECTION AND REPAIR

11.1 Defects that are outside the limits of the codes, job specifications, or other requirements stated on the purchase order shall be cause for rejection. The CONTRACTOR/SUPPLIER shall provide rectification procedures and take such remedial action as is necessary to re-establish the weld integrity and secure acceptance by. CONSULTANT. The cost of the remedial action shall be borne by the CONTRACTOR/SUPPLIER. The CONTRACTOR/SUPPLIER shall only attempt 2 repairs of a defective weldment before the complete weld is removed and replaced.

11.2 Repairs of major defects, and all repairs in plate or forgings, require prior approval by CONSULTANT. Repairs of weld defects are considered major when the defect size exceeds one-half the wall thickness and the thickness of the component is over 25.4 mm (1 in); or when the defect resulted in leakage during a hydrostatic test. The repair procedure shall be in writing and shall include information on methods used for defect removal, inspection of cavity, welding procedures, welding techniques and details of non-destructive examination of the excavated and repaired area.

11.3 All welds (including weld overlays) that are found by inspection to be unsound or that are deposited by procedures differing from those properly qualified shall be rejected. They shall be completely removed from the equipment and replaced in accordance with an approved procedure or be repaired, subject to CONSULTANT written approval.

11.4 Repair of local cavities in overlay welds that penetrate the base metal by more than 10 percent or 4.8 mm (3/16 in), whichever is the smaller, shall include having the base metal re-welded. The welding procedure and materials used shall be compatible with the original base metal.

11.5 Removal of defects by chipping, grinding, or gouging shall be done in such a manner as to avoid reducing the adjacent base material thickness. If the adjacent material thickness is reduced, it shall be restored to its original condition. Complete removal of defects shall be verified by non-destructive examination before repair is started. Repair welding shall be performed only by qualified welders using qualified procedures.

11.6 When a welder's or welding operator's welding is judged unsatisfactory by CONSULTANT, the welder shall be removed from the work. All such welding by that welder or operator shall be inspected by non-destructive examination and removed or repaired at CONTRACTOR/SUPPLIER expense, as directed by CONSULTANT. The welder may be reassigned after additional training and the completion of satisfactory re-qualification tests, but only with the approval of CONSULTANT.

12.0 REPAIRS AND ALTERATIONS

All repairs or alterations of existing welded equipment shall be done in accordance with the latest addition of the applicable code for new construction. For pressure vessels, both code and non-code repairs and alterations shall conform to ANSI NB-23 or other national requirements.

13.0 WELD IDENTIFICATION

In field and shop welding, each qualified welder or welding operator shall have an identification symbol assigned to him to ensure all production welds are traceable to the welder, WPS and NDE report. The welder shall permanently mark each pressure weld with this identification symbol. If more than one welder welds a joint, each shall apply his symbol in such a manner as to indicate the part of the joint he welded. Alternatively, subject to CONSULTANT written approval, an accurate record keeping system shall be established and maintained to identify welds and the welders that fabricate them.

14.0 DOCUMENTATION

All CONTRACTOR/SUPPLIER as built data reports for new construction, alteration, and repairs shall be furnished to CONSULTANT upon completion of the fabrication. Such documentation may include, but not be limited to, the following elements: assembly and spool drawings, welding procedures, heat treating charts, inspection records, and appropriate code documents. For details on as built documentation requirements, refer to specific equipment guides and Contract requirements. Sub CONTRACTOR/SUPPLIER shall provide a typical as built documentation index to CONSULTANT prior to work commencing.

Appendix – A - Explanation of Abbreviations

FCAW	Flux Cored Arc Welding
FIN	Ferrite Index Number
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
HAZ	Heat Affected Zone
HB	Brinnell Hardness
HSLA	High Strength, Low Alloy
HV	Vickers Hardness
NDE	Non-Destructive Examination
PWHT	Post Weld Heat Treatment
SAW	Submerged Arc Welding
SMAW	Shielded Metal Arc Welding
WRC	Welding Research Council

ATTACHMENT A: Inspection and Testing Requirements Sheet

Facility Name:	**Purchase Order No.:**
Location:	**Requisition No.:**
Item Name: Pressure Containing Equipment	**Project No.:**
Item No.:	

	INSPECTION or TESTING	Supplier Inspection and Testing	Contractor Witness	Documented Results of Inspection or Test	ADDITIONAL COMMENTS
1	**Fabrication and manufacturing procedures**				
2	WPS	X	X	X	**Review and Approval**
3	Welding (Each Operator)	X		X	
4	PMI	X		X	**Review and Approval**
5	Welder or Welding Operator Qualification Record	X		X	
5	Quality Assurance / Control Manual	X	X	X	**Review and Approval**
6	NDE Operator Records	X		X	
7	PWHT Procedures	X	X	X	**Review and Approve procedure and PWHT charts**
8	Standard manufacturing checks and tests	X		X	**Inspections/tests as per approved ITP**
9	**Other Examination**				
10	Radiographic Examination	X	X	X	**Review of radiographs**
11	Ultrasonic Examination	X		X	**As built records**
12	Magnetic Particle Examination	X		X	**As built records**
13	Liquid Penetrant Examination	X		X	**As built records**
14	**Leak Testing**				
15	Hydrostatic Leak Test	X	X	X	**As built records / test charts**
16	Pneumatic Leak Test	X		X	**As built records / test charts**
17	Special Leak Test	X		X	**As built records / test charts**
18	**Hardness Testing**				
19	Welds	X		X	**If PWHT is required by Code**
20	Heat Affected Zone	X		X	**If PWHT is required by Code**
21	**Impact Testing**				
22	Welds and HAZ	X		X	**As required to qualify WPS or materials**
23	Forged fittings	X		X	**As required to qualify WPS or materials**
24	**Prior to shipment**				
25	Packaging and preservation				**In accordance with shipping spec**
26	Fabrication/manufacturing record book	X	X	X	**Review and sign off prior to shipping**
27	**Issue of IRN**	X	X	X	**To release item (to include any OWL)**

Detailed Inspection and Testing Requirements:

All CONTRACTOR/SUPPLIER HOLD inspection and test points will be identified during pre-construction meetings and formal mark up of the Inspection and Test Plan for the WORK.

Notes:

CONTRACTOR/SUPPLIER inspection/hold points shall be confirmed during prefabrication meeting.

COMPANY at its option and with prior notification, shall be permitted free access to the CONTRACTOR/SUPPLIER facilities during all phases of the work for performing visual inspections and for routine checking of documentation and work progress.

Revision Log

Rev	Date	Aprvl	Description	Rev	Date	Aprvl	Description