



PTT PUBLIC COMPANY LIMITED

GAS SEPARATION PLANT RAYONG

QUALITY REQUIREMENT FOR
PRESSURE VESSEL

ES-20.02



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1.0 SCOPE

The instructions specified in this standard are the basic, minimum require, and general quality requirements for the design, fabrication, testing and inspection of pressure vessels columns.

Any conflicting requirements shall be referred to PTT for clarification before proceeding with fabrication of the affected parts.

2.0 APPLICABLE CODES AND STANDARDS.

2.1 The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME Code)

ASME Section II	Part A, ferrous Materials
	Part C. Welding Rods, Electrode and Filler Metal
	Part D, Propertied
ASME Section V	Non-Destructive Examination
ASME Section VIII Div. 1	Unfired Pressure Vessel
ASME Section VIII Div .2	Alternative rule
ASME Section IX	Welding and Brazing Qualifications

2.2 American Society of Mechanical Engineers (ASME)/ American National Standard Institute (ANSI)

ASME B16.5	Pipe Flanges and Flange Fitting
ASME B16.9	Factory made Wrought Steel Butt-welding Fitting
ASME B16.47	Large Diameter Steel Flange
ASME B36.10	Welded and Seamless Wrought Steel Pipe
ASME RTP-1 Resistant	Reinforced Thermoset Plastic (RTP) Corrosion Equipment

2.3 American Society for Testing Materials (ASTM)

2.4 Research Report

2.4.1 Stresses in Large Horizontal Pressure Vessel on Two Saddled Support- by LP Zick



2.4.2 Welding Research Council (WRC) Bulletin No 107

2.5 National Association of Corrosion Engineers

NACE MR 0175 Sulphide Stress Cracking Resistant-Metallic
Materials for oilfield Equipment

3.0 PTT SPECIFICATIONS, STANDARD DRAWINGS

ES-20.01	Vessel Standard
ES-20.03	Marking for Vessel and Heat Exchanger.
ES-20.04	Column Tray
ES-92.01	Hot Insulation
ES-92.02	Cold Insulation
ES-92.05	External Fireproofing of equipment Supports and Structures
ES-92.06	Painting
ES-92.07	Cathodic Protection of Onshore and Buried Pipe work
ES-99.01	Numbering System
ES-99.04	Final Documentation

4.0 DRAWINGS AND RELATED DOCUMENTS

- 4.1 The term of "Drawings and Related Documents" shall mean to include, and not be limited to, workshop drawings and design calculations as well as all other relevant documents in detail related to fabrication, testing and inspection.
- 4.2 All drawings and related documents shall comply with engineering standard ES-99.001 Numbering system and ES-99.04 Final Document.
- 4.3 All Drawings and related documents are subject to review and comment by PTT /CONSULTANT. However, such review and comment by PTT /CONSULTANT does not in any way relieve CONTRACTOR of his responsibility to meet all requirements of the CONTRACT. Fabrication shall commence only after the drawings and related documents have been approved by the Third Party Inspector and comment received from PTT /CONSULTANT. In case of subcontracted items, approval by CONTRACTOR is required before submission of the documents to PTT/ CONSULTANT.
- 4.4 CONTRACTOR shall ensure a clear and unequivocal correlation between the equipment drawings and the welding procedure specifications to be used for the manufacture of the single equipment items, when issuing the technical documents for approval.
- 4.5 Welding symbols and other terms and definitions shall be in accordance with standard and sound engineering practice (like AWS Standards).
- 4.6 For vessels fabricated and/or assembled at SITE. CONTRACTOR shall submit for such fabrications and assemblies the instructions, specification



and sketches.

- 4.7 Pressure vessels shall be designed and fabricated in accordance with ASME Boiler and Pressure Vessel Code section VIII, Division 2. The Division 1 may be selected if all other additional requirements as specified by Owner and/or indicated on datasheet.

- 4.8 The ASME Code symbol stamp shall be applied when required by Local Regulation or at the OWNER's request.

5.0 MATERIALS

- 5.1 All materials shall be new and meet the requirement of Code and applicable fabrication standard.

- 5.2 All pressure retaining materials and materials welded on to pressure-retaining part shall have Carbon 0.22% maximum in case of carbon steel and 0.19% in case of C-Mo and C-Cr-Mo steels.

In exceptional cases carbon steels with carbon above 0.22% Carbon content may be up to 0.25 % provided % Carbon plus one sixth of %Manganese does not exceed 0.40% for all cases, except SA105, for which % Carbon plus one sixth of %Manganese may be up to 0.45%.

- 5.3 Sour service (SG) or Amine service requirement
For equipment specified as in Sour service or Amine service, the following requirement shall apply.

- 5.3.1 Pressure parts of carbon steel equipment shall be manufactured from fine-grained and normalized condition

- 5.3.2 Carbon content shall not exceed 0.22%, except forgings which shall be limited to 0.25 % maximum

Carbon equivalent (CE) shall not exceed 0.40 as formula below ;

% Carbon plus one sixth of %Manganese does not exceed 0.40%

The chemical composition, product analysis shall be limited as follows.

% Manganese	=	1.30 maximum
% Phosphorus	=	0.025 maximum
% Sulphur	=	0.003 maximum
% V+Nb	=	0.03 maximum

- 5.3.3 Hardness of weld metal, parent metal and heat-affected zone shall be 225 (average) max and 240 (single location) max.

Above-mentioned hardness values shall be based on HV 10 measurement on a machined and ground cross-section of procedure qualification test plates and shall be BHN hardness values in case of production welds or production materials.



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- 5.3.4 Pressure parts, welded attachments, internal (including bolting) shall fully comply with the requirement of NACE MR 0175.
- 5.3.5 Plate furnished by the supplier shall meet the requirement to SA 516. In addition, HIC resistant material requirements shall be met.
- 5.4 For non-pressure-retaining parts to be welded directly to the pressure-retaining parts and shall be same as the material for the pressure-retaining parts and shall meet the requirement of paragraph 5.2, 5.3 above, as applicable. This is also valid for fixtures and auxiliary supports.
- 5.5 The skirt support of pressure vessels with design temperature above 343°C or below -10°C, 1000 mm length from the attached pressure-retaining part for the vertical vessels shall be of the same material as the attached pressure-retaining part.
- 5.6 For pressure vessels with design temperature -10°C and above up to and including 343°C the saddle parts and the bracket parts other than those covered under para 5.4 above and the skirt plates other than those covered under para 5.4 above and beyond 500 mm away from the attached pressure part shall be SA 285 Gr C.
- 5.7 Alternative material specification to those may be proposed but require written approval from PTT / CONTRACTOR. The alternative must provide equal or better chemistry, mechanical properties, weldability and notch toughness.
- 5.8 All pressure flanges including blind flanges shall be of forged material. Flanges made from plate are not acceptable.
- 5.9 All clad materials shall be welding overlay type. Cladding in accordance with ASME SA 263 / SA 264 / SA265 is not permitted.
- 5.10 In case of clad materials, which during and/or after fabrication need post-weld heat treatment and which have clad material of 18 Cr/8 Ni type stainless steel, the clad material shall have a maximum carbon content of 0.03% or shall be stabilized grade (with Ti or Nb) and the PWHT temperature shall be limited to 550°C.
- 5.11 In case of clad materials, which during and/or after fabrication need post-weld heat treatment and which have clad material of 13Cr type stainless steel, the material shall be properly heated and cooled to avoid embattlement in clad material.
- 5.12 Roll cladding or explosion cladding is not permitted.
- 5.13 No credit is to be given for the cladding thickness in the design calculations.
- 5.14 For clad materials, minimum thickness of cladding is the thickness of cladding as measured from the surface exposed to the service medium, over which



the cladding material shall possess all the physical and chemical properties as specified for the cladding material or for the weld metal as the case may be. Depending on the cladding technique, the actual thickness of the cladding is to be more than the specified minimum thickness (eg. Weld overlay).

- 5.15 ASTM A 285 Gr. C may be used for drums up to 15 mm new thickness.
- 5.16 Asbestos in any form shall not be used.
- 5.17 Carbon and C-Mn steel shall be supplied in the as-rolled condition. For sour and amine service all carbon steel and C-Mn steel shall be supplied in normalized condition.
- 5.18 Austenitic stainless steel bolts, if not in contact with the operating fluid, shall be solutionized and strain-hardened to class 2 requirements of SA 193.
- 5.19 In case of ring joint gaskets, the Brinell hardness of the ring joint shall be at least 30 points lower than the flange groove hardness.
- 5.20 Mill certificates with all test results therein shall be furnished by contractor for main pressure-retaining parts and for such other loaded parts which have been dimensioned to specific loading conditions, eg. Skirt of a column.
- 5.21 Mechanical tests on material for equipment which is to be subject to PWHT shall be carried out using coupons in the as-supplied and simulated PWHT conditions. Simulated heat treatment times shall include contingency for in-situ heat treatments for future repair or modifications to the equipment by PTT.

6.0 FABRICATION

6.1 General

- 6.1.1 Unless otherwise specified by Owner, all connections shall be flanged with through studs. All nozzle attachment welds (category "D") shall be full-penetration welds.

Flanges used for nozzle shall be in accordance with ASME B16.5 for nozzle size through NPS24 and ASME B16.47 Series B or ASME Section VII design for nozzle size through NPS26 through NPS 60, as specified by OWNER. Series A is permitted when required to flange to equipment supplied with Series A flange.

Flanges facing used for nozzle shall be in accordance with ASME B16.5. Flange shall have raised face unless otherwise.

- 6.1.2 If shell courses have different thickness, the inside diameter shall be constant unless otherwise specified by OWNER.

The minimum distance between two longitudinal seams in one course shall be 200 mm or five times the wall thickness, whichever is the larger, as measured between the toe of each weld. The minimum distance between the staggered



longitudinal seams of two adjacent courses shall be 200 mm or five time wall thickness, whichever is the grater. However, where this cannot be achieved, the last 300 mm of the adjacent longitudinal seams shall be subjected to 100% examination in accordance with the NDE specified for a construction category 1 vessel in ASME sec VIII Div I

Longitudinal and circumferential welded seams shall be kept out of the internal welds in so far as practical, and shall be so located that they can easily be inspected with internals in place.

- 6.1.3 No openings such as nozzles shall be located to pass through a weld. Such openings shall have their boundaries at least one OD away from the adjacent welds.

No weld shall be covered/ concealed by external attachments like pads.

- 6.1.4 Unless otherwise specified by OWNER, head shall be ellipsoidal. A formed head shall be made of single plate. CONTRACTOR shall submit forming procedure of clad steel to PTT/CONSULTANT for approval.

- 6.1.5 Dished ends formed from blanks made out of welded seam shall be 100 % radiographed.

- 6.1.6 When temporary attachments are required during the forming work, they shall be welded to the shell plate using the same welding procedures as for the main seams. After removing these attachments, the surface shall be ground flush and examined by either magnetic particle or liquid penetrant method.

- 6.1.7 Fabrication temporary attachment shall not be welded to knuckles of head and conical section.

- 6.1.8 If reinforcement pads for nozzles are made out of two segments, the segments shall be welded at a location away from the vessel shell and the weld shall not run parallel to vessel axis.

- 6.1.9 Using of flame cutting instead of drilling for nozzle including anchor bolt holes is not permitted.

- 6.1.10 The gasket seating surfaces on girth flanges of equipment shall be machined to final smoothness and dimensions after PWHT of the equipment.

- 6.1.11 Unless otherwise noted, gasket surface shall have a finish of 125 ~250 RMS.

- 6.1.12 All permanently attached backing rings on aluminum welds shall be seal-welded (not only tack-welded) on the upstream side in order to provide against the danger of amalgamating due to mercury residues in the fluid.



6.1.13 Loading

External loading shall be specified on the data/requisition sheets.

All vertical vessels shall be provided with lifting trunnions, attached by full penetration welds, or lifting lugs as specified on the data/requisition sheets. The tail end vertical vessels that have a mass greater than 20 tonnes shall be provided with tailing lug (or lugs.)

Lifting lugs and trunnions shall be designed for a total load of 1.5 times the lifted weight of the equipment to allow for dynamic effects etc., except lifting lugs and trunnions on vessels liable to be lifted from an offshore barge, etc., which shall be designed for a total load of 3 times the lifted weight.

If davits are to be provided for servicing components having a mass greater than 25 kg, mounted at the top or attached to the sides of columns higher than 20 m, this shall be specified on the data/requisition sheets.

- 6.1.14** The minimum distance between the edge of any attachment of a pressure part (e.g. a nozzle) to the edge of another pressure weld of the vessel shall be 50 mm or twice the thickness of the pressure part, whichever is the greater. Similarly, the minimum distance between the edge of a non-pressure attached weld to the edge of a pressure weld of the vessel shall also be 50 mm or twice the thickness of the pressure part, whichever is the greater.

However, if this is not possible the attachment weld shall cross the pressure weld completely by length of at least 50 mm or twice the wall thickness (whichever is the greater) in order to avoid stress concentration. Prior to making the attachment weld, the adjacent pressure weld shall in the area where the attachment weld will cross, be subjected to the NDE specified for a construction category 1 vessel in ASME section VIII Div I

- 6.1.15.** Reinforcement pad thickness shall not exceed 40 mm or the as-built shell thickness, whichever is the lesser.

The required thickness of an integrally reinforced branch shall not be greater than twice the vessel wall thickness at the location of the attachment.

- 6.1.16** Flanges shall comply with ASME B16.5 or ASME B16.47 series B, facing finish shall comply with ASME B16.5. Unless otherwise approved by Principal, only raised-face (narrow-faced) flanges shall be used.

Welding neck flanges shall be used for vessels.

- 6.1.17** Davit or hinge shall provide for all inspection/maintenance openings 12" up to and including 30".
- 6.1.18** The nominal minimum diameter for inspection opening (handholes) is 6"
- 6.1.19** All vessel supports shall be provided with at least earthing lug in accordance with ES-20.01.
- 6.1.20** Continuous liquid outlets on column and vessels shall be provided with a vortex breaker, and in the following cases internally extended vortex breakers shall be used:
- in fouling service;
 - for hydrocarbon liquid outlet of separators where the liquid is separated



from water or aqueous solutions, except where this would give rise to corrosion problems in the bottom.

6.2 Welding

- 6.2.1 All Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) shall be submitted to PTT / CONSULTANT for review prior to commencement of production weld. PQR shall include the additional tests results when these tests are specified by Codes and this specification. Impact tests for welding procedure qualification shall be witnessed by the authorized third-party inspection agency.
- 6.2.2 Welders shall be initially qualified by bend tests in addition to radiography. Welder's performance qualification shall be in form QW-484 of ASME section IX (see also para 7.7.2).
- 6.2.3 Fusion arc process SAW (submerged arc welding), SMAW (shielded metal arc welding), and GTAW (gas tungsten arc welding) are permitted. Electro-slag welding is permitted only for welds which will be subject to a normalizing heat treatment and 100% radiography.
- 6.2.4 Pressure-holding seams shall normally be full-penetration, double-welded butt joints. Single side welded butt joints which ensure full penetration may be used, where double sided weld butt joints are impractical.
- 6.2.5 Welding procedures shall be selected to minimize the residual stress insofar as practical.
- 6.2.6 All welds shall be immediately stamp after completion of welding provided with the welder's identification. For such cases where stamping will be deleterious to the parent material (thin materials, notch-sensitive material, etc.) engraving shall be done. In order to avoid possibility of forgotten stampings, it is recommended that the welder provide his identification marking near the weld just before commencing welding work.
- 6.2.7 No more peening than is necessary to clean slag from the weld shall be permissible.
- 6.2.8 Permanent backing strips are not permitted. Temporary backing strips shall have the same chemical composition as the base metal.
- 6.2.9 In all cases, filler materials shall have a similar analysis and properties as the parent materials. Any deviation from this requirement needs the written consent of PTT /CONSULTANT. This requirement holds good for tack welds, too.
- 6.2.10 Fillers used in production welds shall be the same used for welding procedure qualification. For submerged arc welding the wire-flux combination used for production welds shall be the same as the one



employed for the welding procedure qualification.

- 6.2.11 Welding materials like electrodes, fillers and fluxes shall be properly stored and shall be properly heated/dried before use.
- 6.2.12 Welds that are produced under violation of para 6.2.9 above or by using unapproved procedures shall be subject to complete removal.
- 6.2.13 Unacceptable discontinuities shall be completely removed by chipping, gauging, grinding, or other methods (suitable for the type of material being repaired) to clean, sound metal, and the excavated area shall be examined by magnetic particle or liquid penetrant methods to assure complete removal of defects.
- 6.2.14 Repairs to correct weld defects shall be made using the same welding procedure specification used for the original weld or any other previously approved welding procedure specifications.
- 6.2.15 The repaired areas shall be re-examined using the same inspection procedures by which the defect was originally detected.
- 6.2.16 Any weld repairs of solid material (plate, forging, pipe etc.) is not permitted.
- 6.2.17 All site-welding activities shall be done under proper protection against weather conditions.
- 6.2.18 Continuous fillet welds shall be used for all internal structures, supports and fittings to welded to the vessel wall.

6.3 Post weld Heat Treatment(PWHT)

- 6.3.1 PWHT shall not be commenced unless and until all non-destructive testing has been successfully completed. PWHT shall be performed prior final examination.
- 6.3.2 No welding is permissible on the equipment after completion of post weld heat treatment.
- 6.3.3 All carbon steel and C- Mn steels shall be subject to PHWT where "Sour service" or "Amine service" is indicated.
- 6.3.4 A continuous record of temperature shall be made on recorder charts.
- 6.3.5 The holding temperature for post weld heat treatment or stress relief temperature shall be :

Material type	Holding temp(°c) Minimum	Time at temperature (Minutes)
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Carbon steel	600+/-20	60
1.25Cr-0.5Mo	660+/-20	120
2.25Cr-0.5Mo	715+/-25	120
5Cr-0.5Mo or 9Cr-1Mo	730+/-30	120
3.5Ni	615+/-15	60

- 6.3.6 When clad steel or dissimilar welded parts are heat-treated, the heat-treating procedure shall be submitted for PTT /CONSULTANT approval.

Austenitic stainless steel shall not be subject to PWHT or stabilization Heat treatment without approval from PTT / CONSULTANT.

- 6.3.8 Thermocouples shall be attached every 4.6 meters both longitudinally and circumferentially at the top, bottom and centre of the vessel and at each head.

- 6.3.9 Plates, seamless heads, parts of built-up heads, and similar pressure-holding parts subject to cold or hot bending or forming or forging shall be heat-treated as required by table 1. Annealing, normalizing, and tempering required by table 1 shall be performed in accordance with table 2.



Table 1 Heat Treatment and Test Requirement of Dished End

Forming *6	Material	Heat Treatment			Test Requirement
		Due to Forming	Due to Thickness	Due to Service	
Cold *7	CS CS Temp < -10 °C*8 3 1/2 Ni	As per *1 UCS-79	As per *1 UCS-56	Required for - alkaline *1 temp >80 °C - SG, BWN >245 - Amine service	No extra test Charpy impact test Charpy impact test
	C-Mo *8	As per *1 UCS-79	as per *1 UCS-56	-	1 per each plate *2
	SS	Solutionizing When BHN >230 After forming			1 per each plate per heat treatment lot *3 *5
Hot Forming temp 900 – 1,050 °C	SS	Not required			1 per each dished end
Forming temp <900 °C	SS	solutionizing			1 per each plate per heat treatment lot *3
Forming temp 850 – 1,050 °C	CS, CS temp <-10 °C 3 1/2 Ni C-Mo	Not required *4			1 per each dished end
Forming temp <850 °C	CS, CS temp <-10 °C 3 1/2 Ni C-Mo	Normalizing or, if required, Normalizing and tempering			1 per each plate per heat treatment lot *3



Remarks

- *1: PWHT can be performed on the dished end after vessel assembly.
- *2: Simulation by mill can be representative of test.
- *3: When the dished ends from a plate are heat-treated in different lots and the records (charts) show good conformity with each other with regard to cooling rate (± 15 °C) and to soaking temperature (± 15 °C), such heat treatments can be deemed as one lot.
- *4: When normalizing and tempering are required to the base material, tempering shall be performed.
- *5: No test is required when dished ends are not heat-treated after forming.
- *6: Bending and forming are defined for ferritic materials as cold when the temperature is below the maximum temperature permitted by para 6.3.5, and hot when above 870°C; and for austenitic materials as cold when the temperature is 593°C or below, and as hot when over 593°C. Bending and forming shall not be performed on ferritic materials at temperatures between the maximum cold temperature and 870°C.
- *7: Pressure vessel formed parts having a ratio of thickness to local radius greater than 5% shall be stress-relieved prior to any subsequent operations.
- *8: See para 5.3 and 7.5.4 as regards hardness for "Sour Service.(SG)"



Table 2 Heat-Treating Requirements

Heat Treatment	Type of Material	Soaking Temp (°C)	Holding Time (hour)	Method of Cooling
Anneal	AISI Types 304, 316, 321, and 347	1,040 – 1,100	1 per 25 mm of thickness but not less than 1/2	Water Quench or Air blast
	Incoloy	1,150 (1)	1 per 25 mm of thickness but not less than 1	
	AISI Type 310			
Normalize	C steel C ½ % Mo steel ½ to 9 % CrMo steel	900 - 950	1 per 25 mm of thickness but not less than ½	Still air
	2 to 6 % Ni steel	820 - 845		
Temper	½ to 9 % CrMo steel	700 - 760	1 per 25 mm of thickness but not less than 1	In furnace (2)
	2 to 6 % Ni steel	593 - 650		Still air

Notes :

(1) The temperature range during heat treatments shall be + 0, + 30 °C.

(2) After attaining the soaking temperature and maintaining the required holding time, the cooling time to 430°C shall not be less than 1 h.



7.0 TESTING AND INSPECTION

7.1 General

7.1.1 PTT/ CONSULTANT reserves the right to inspect, to approve or reject the CONTRACTOR or SUB-CONTRACTOR's facilities, materials or workmanship at any time.

7.1.2 CONTRACTOR shall take full responsibility for examination in accordance with the requirement of ASME Code section VIII and this engineering standard and qualified personnel shall perform all examination.

7.1.3 All non-destructive testing shall be conducted in accordance with the relevant article (s) of ASME Boiler and pressure vessel code, Section V.

7.2 Radiographic Examination

7.2.1 RT procedures and techniques shall be in accordance with Article 2 of ASME Code section V

7.2.2 Acceptance criteria shall be in accordance with ASME Code section VIII Div 1, UW-51 for full RT and UW-52 for Spot RT.

7.2.3 Spot radiography shall mean at least 10% coverage by total length of each concerned weld. However the welds to be examined by spot RT shall consist of:

- a) All T- junction, At least one spot RT shall be taken from each longitudinal weld seam.
- b) At least one exposure shall be taken of each welding process applied to the welded seams.
- c) All category A and B seam passing under the reinforcing plate or vessel support, shall be fully examined for the entire hidden length plus a 50 mm each side prior attaching the pad plate or support.

7.2.4 For clad equipment, radiography, if required, shall be done after completing the weld fully including weld overlay part.

7.2.5 Radiographic film shall be fine grain, high definition, high contrast film.

7.2.6 A report of RT examined shall be submitted as part of the manufacturer's data book.

7.3 Ultrasonic Test



7.3.1 The procedure, calibration and techniques for UT of weldments shall be in accordance with ASME Code section V , Article 5

7.3.2 The acceptance criteria and report concerning the recording of result shall be in accordance with the requirement of ASME VIII Appendix 12.

7.4 Liquid Penetrant and Magnetic Particle Examination

7.4.1 PT, MT procedure shall be in accordance with the requirement and methods specified in article 6 and 7 of ASME section V respectively.

7.4.2 Evaluation of indication and acceptance criteria shall be in accordance with ASME Code section VIII Appendix 6 and 8

7.4.3 Weld overlay shall be 100% liquid penetrant tested.

7.5 Miscellaneous

7.5.1 After completion of welding, all welds shall be visually inspected. In case of single welded joints, should a visual inspection on the rear side of the root be impossible/not done, radiography shall be adopted. In case of double-welded joints root fusion shall be investigated by liquid penetrant or magnetic particle examination, after back gauging.

7.5.2 All NDE shall be performed and evaluated by qualified personnel according to ASNT recommend practice SNT-TC-1A

7.5.3 PTT /CONSULTANT will accept only the NDE result after vessels have been post weld heat-treated, if required.

7.5.4 Sample of production weld overlay shall be taken to confirm chemical analysis to the required depth.

7.5.5 Surface defects such as arc strikes caused due to welding or magnetic particle examination shall be removed and the locations shall be tested for freedom from defects by liquid penetrate or magnetic particle examination.

Impact tests on production test plates shall be witnessed by the Third-Party Inspector.

7.6 Leakage Test and Pressure Test

7.6.1 All reinforcement pads shall be provided with a ¼" NPT hole and the nozzle attachment weld shall be tested pneumatically at a pressure of a 1 bar(g).

7.6.2 The hydrostatic test temperature shall be a minimum of 15 ° C and not below Code recommendations for all vessels.



- 7.6.3 All vessels shall be hydrostatically tested in accordance with Code. The test pressure shall be shown on the shop drawing
- 7.6.4 If any weld of an equipment remains concealed, a gas leak test at test pressure equal to that for a pneumatic test shall be conducted in lieu of hydrostatic test for the concealed weld.
- 7.6.5 Hydrostatic testing shall be performed using clean potable water with a chloride content of max 50 ppm for stainless steels. In case this requirement cannot be fulfilled the equipment shall be drained completely and flushed with water fulfilling the above requirement of 50 ppm maximum of chlorides.
- 7.6.6 During hydrostatic tests, the test pressure shall be held for at least 1 hour before inspecting the welds for leakage. In case of pneumatic tests, the test pressure shall be maintained for at least ½ hour and then reduced to design pressure at which pressure the soapsuds test shall be done.
- 7.6.7 After final hydrostatic test all equipment shall be dried and cleaned in order to ensure freedom from dirt, oil, grease, etc.
- 7.6.8 Service gaskets and bolting shall be used for hydrotest. New gaskets or ring joints shall be fitted where the joint has been disturbed during hydrotest.

7.7 Special Cases

- 7.7.1 If due to some reason, an equipment cannot be delivered in fully welded condition, the parts to be delivered shall be trial-assembled and hydrostatic tested in the shop. After successful completion of the pressure test in the shop, the trial assembly welds for the test shall be removed. The weld edges shall be re-prepared and tested for freedom from defects by liquid penetrant examination. After completion of the welding at the site, all site welds shall be fully examined by radiography and shall be subjected to a pressure test.
- 7.7.2 For such cases as described under para 7.7.1 above, if the site welding is executed by the same manufacturers as of the delivered parts, separate welding procedure qualification is not required provided the intended procedure had been earlier approved by PTT / CONSULTANT for any other weld of the delivered part. However, welder's performance qualifications shall be done afresh to take care of the site conditions. In case this welding is executed by another fabricator different from the manufacturer of the delivered parts, intended welding procedures shall be invariably qualified afresh on site and all welders shall be qualified on site under the site conditions.
- 7.7.3 Irrespective of the fabricator at the site for the welding of the



equipment delivered in parts vide para 7.7.1 above, production test plates for such equipment that need impact test shall be welded at the site. This test plate requirement is in addition to the required test plates in case the welding procedure used at the site is the same as the one used for any other weld in the delivered part.

7.8 Inspection and Test Records

7.8.1 CONTRACTOR shall take responsibilities to complete the engineering, manufacturing, and inspection record for each equipment.

7.8.2 Approval of the records by the third party inspector shall not be considered as release of inspection.

7.8.3 Content of manufacturing data book shall be in compliance with the requirement of engineering standard ES-99.04

8.0 MARKING

8.1 Marking in ink, oily paint or waterproof color shall be used.

8.2 Marking of vessels made of stainless steel, chloride content in paint or ink shall not exceed 15 ppm.

8.3 Vessels which have been stress relieved shall have warning printed on the outside of shell "HEAT TREATED VESSEL NO WELDING PERMITTED" in letter at least 100 mm high.

8.4 Vertical vessels shall have "0 degree" clearly marked by vertical yellow line 50 mm minimum wide. "Plant North" shall also be indicated in the similar way.

8.5 Bolts and nuts including spare shall be marked with the material symbol with the carved stamp in accordance with table below. Depth of stamp shall not exceed 1 mm.

Material	Marking Symbol	Material	Marking Symbol
SS41	-	A193 GrB5	B5
S25C	25C	A193 GrB6	B6
S35C	35C	A193 GrB7	B7
S45C	45C	A193 GrB16	B16
SCM3	M3	A193 GrB8	B8
A320 L7	L7	A193 GrB8C	B8C
A320 B8	B8L	A193 GrB8m	B8M
TYPE 304 S.S.	S304	A193 GrB8T	B8T
TYPE 304L S.S.	S304L	A194 Gr2, 2H	G2, 2H
TYPE 321 S.S.	S321	A194 Gr3	G3
TYPE 316 S.S.	S316	A194 Gr4	G4
TYPE 316L S.S.	S316L	A194 Gr6	G6
TYPE310S S.S.	S310S	A194 Gr8	G8
TYPE347 S.S.	S347	A194 Gr8C	8C
TYPE 410 S.S.	S410	A194 Gr8M	8M
TYPE 310 S.S.	S310	A194 Gr8T	8T

9.0 Baseline Thickness measurement



- 9.1 After vessel installation at site, contractor shall carried out thickness measurement of the vessel by using Ultrasonic method (UT).

Measurement shall be :

- done at the internal surface of shell, nozzle, bottom, top, head etc.
- basically, at 4 direction 0, 90, 180, 270 degree
- compare with the design thickness, corrosion allowance, selected thickness

The location of measurement and format of report shall be submitted to PTT for prior approval. The report shall be in both hard copy and computer database. Marking of the measurement location on the vessel shall be done so that PTT can use for future reference.



APPENDIX 1

SUPPLEMENTARY REQUIREMENT FOR PRESSURE VESSEL

General:

This requirement shall be applied for the inspection and test of the pressure vessels, which are categorized in ASME Code Section VIII Division 1 and 2. Pressure vessels categorized in Division 2 shall be inspected and tested as per Alternative Rules of the code.

1. CLASSIFICATION OF THE VESSEL

Vessels and their parts are classified as shown in table A:

Table A. Classification of Vessel

Material and Services		Class
Carbon steel for high and intermediate temperature service (Design temp. $\geq -10^{\circ}\text{C}$)	Killed Steel	B
Carbon steel for low temperature service (Design temp. $< -10^{\circ}\text{C}$)	Fine Grained steel	C
Low-alloy steel for low temperature service	2.5Ni 3.5 Ni Killed steel	D
Austenitic stainless steel		S

Remarks:

- 1.0 A vessel may be classified using any combination of the classes provided vessel parts having different materials and/or design condition.
- 2.0 For common elements, the more severe classification shall apply.





2. INSPECTION AND TESTING REQUIREMENTS

Inspection and testing requirements for the individual classification of vessel (Table A) are listed, but not limited to, as follows:

Vessel Class B:

Inspection and Testing Requirements	Refer to ASME Paragraph	Notes
(1) UT is required for all carbon steel plates with a nominal thickness of 75 mm and above (*).	UG-84 UCS-66 UCS-67 QW-140 QW-170 QW-401.3	
(2) UT is required for all forging (except for standard nozzle flanges) with a nominal thickness of 100 mm and above (*).		
(3) Charpy impact tests of materials. Production test plates. Welders performance qualification. With shell thickness 100 mm and above (*).		(iii)
(4) MT or PT is required for welding edges of base materials with shell thickness 50 mm and above (*).		(iv)
(5) MT or PT is required for backside of double welded joints after being prepared for welding with shell thickness 50 mm and above (*).		(iv)
(6) MT is required for weld surface of: (a) Category A & B with shell thickness 38 mm and above (*) (b) Category C & D when full RT required (*). (c) Category E with shell thickness 50 mm and above (*)		(vi)
(7) UT is required for Category A,B & D with shell thickness 75 mm and above (*)		(iv)/(vii)

Note: 1. (*) PTT's requirements



Vessel Class C:

Inspection and Testing Requirements	Refer to ASME Paragraph	Notes
(1) UT is required for all plates with a nominal thickness of 38 mm and above (*).	UCS-66 UG-84 UCS-67 QW-140 QW-170 QW-401.3 UW-13 (f)	
(2) UT is required for all forging (except for standard nozzle flanges) with a nominal thickness of 100 mm and above (*).		
(3) Charpy impact tests of materials. Production test plates. Welders performance qualification.		(iii)
(4) MT or PT is required for welding edges of base materials with shell thickness 38 mm and above (*).		(iv)
(5) MT or PT is required for backside of double welded joints after being prepared for welding with shell thickness 25 mm and above (*).		(iv)
(6) MT is required for weld surface of: (a) Category A & B with shell thickness 25 mm and above (*) (b) Category C, D & E (*).		(v)
(7) UT is required for Category A,B & D with shell thickness 50 mm and above (*)		(iv)/(vii))
(8) Vessel production impact test (*).		(viii)
(9) Tensile test for tube sheet hubs is required.		

Note: 1. (*) PTT's requirements



Vessel Class D:

Inspection and Testing Requirements	Refer to ASME Paragraph	Notes
(1) UT is required for all plates with a nominal thickness of 38 mm and above (*).	UCS-66	
(2) UT is required for all forgings (except for standard nozzle flanges) with a nominal thickness of 100 mm and above (*).		
(3) MT or PT is required for welding edges of base materials with shell thickness 38 mm and above (*).		(iv)
(4) MT or PT is required for backside of double welded joints after being prepared for welding (*).		(iv)
(5) MT of weld surfaces for category A, B, C, D & E (*).		
(6) UT is required for category A,B & D with shell thickness 50 mm and above (*).		(iv) (vii)
(7) Charpy impact test is required for all pressure retaining parts.		

Note: 1. (*) PTT's requirements



Vessel Class S:

Inspection and Testing Requirements	Refer to ASME Paragraph	Notes
(1) PT is required for backside of double welded joints after being prepared for welding with shell thickness 25 mm and above (*).		(iv)
(2) PT is required for weld surfaces of: (a) Category A, B, C, D & E in contact with fluids (*). (b) Category A, B, C, D & E when shell thickness 19 mm and above (*). (c) Category C & D when full RT required (*).		(ix)

Note: 1. (*) PTT's requirements

Notes:

- i) Main components shall cover such parts as shell, heads, girth, flanges, forged nozzles, tube-sheets, channels and channel covers.
- ii) The test temperature shall be the minimum design temperature or 0°C, whichever is lower.
- iii) Charpy impact test shall be according to applicable Codes, Standards and Specifications.
- iv) This requirement shall apply to the pressure retaining welds (Category A, B & D) in the shell and heads.
- v) Category A & B in nozzles that are not subject to RT shall additionally be examined by UT.
- vi) When full RT required, category A & B in nozzles that are not suitable to RT shall be examined by UT.
- vii) UT shall be performed after post weld heat treatment.
- viii) Vessel production impact tests shall be performed for minimum design temperature below -10°C. Impact tests shall be made both in the weld metal and heat affected zones.
- ix) PT shall apply to the interior surfaces of the welds regardless of thickness.



- x) This specification and the Inspection and Testing Requirements shall not be limited to the requirements of the applicable code.
- xi) Materials shall be verified by checking against the material test reports.
- xii) MT may be substituted by PT, if MT is considered impractical.