International Association of Oil & Gas Producers

SPECIFICATION

IOGP S-619

April 2022

Version 2.0

Specification for Unfired, Fusion Welded Pressure Vessels

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
2.0	April 2022	Second Edition
1.0	December 2018	First Edition

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

This second edition cancels and replaces the first edition published in December 2018.

Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of unfired, fusion welded pressure vessels for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Technical Specification

This specification is to be applied in conjunction with the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows.

IOGP S-619: Specification for Unfired, Fusion Welded Pressure Vessels

This specification defines the technical requirements for the supply of the equipment.

IOGP S-619D: Procurement Data Sheet for Unfired, Fusion Welded Pressure Vessels

The procurement data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The procurement data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional purchaser supplied documents may also be incorporated or referenced in the procurement data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-619L: Information Requirements for Unfired, Fusion Welded Pressure Vessels

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

IOGP S-619Q: Quality Requirements for Unfired, Fusion Welded Pressure Vessels

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS is in accordance with ISO/IEC Directives, Part 2.

The procurement data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser defined requirements (procurement data sheet, IRS, QRS);

d) this specification.

1 Scope

This specification defines the minimum requirements for the design, materials, fabrication, inspection, testing and preparation for shipment of unfired, fusion welded pressure vessels.

Vessels fabricated in accordance with this specification are intended for use in the typical services associated with oil and gas production facilities, mid-stream or pipeline facilities, gas plants, LNG facilities, oil refineries or petrochemical facilities.

The requirements in this specification are selected based upon the following boundary conditions.

a) The vessel is manufactured from one of the following materials:

   1) carbon steel;

   2) austenitic stainless steel;

   3) 22 Cr Duplex, 25 Cr Super Duplex; or

   4) carbon steel base integrally clad or weld overlaid with austenitic stainless steel, alloy 276, alloy 625 and alloy 825.

b) The design temperature is less than or equal to 425 °C (800 °F).

c) The design pressure is less than or equal to 20 MPag (3000 psig).

d) The nominal thickness of the vessel shell or heads is less than or equal to 100 mm (4 in).

e) The vessel is designed, fabricated, inspected and tested in accordance with a recognized industry standard (e.g. ASME *BPVC*, Section VIII, Division 1, ASME *BPVC,* Section VIII, Division 2, EN 13445 and PD 5500).

The use of this specification for fabrication of vessels with one or more parameters that are outside the boundary conditions defined above may be an acceptable practice. However, as is provided by the base requirements in this specification, it is the purchaser responsibility to:

— determine which requirements, if any, need to be modified;

— specify additional requirements as necessary to ensure an equivalent level of safety and reliability.

Requirements under Section 2 to Section 10, Annex E, Annex F and Annex J are common for all pressure vessels.

For a typical facility covered by the scope of this specification, it is expected that approximately 60 % to 80 % of the vessels required for an average project can be purchased using this specification. This is one of the key premises against which requirements were tested when deciding whether a requirement is or is not to be included in this specification. In addition, this specification is focused on the identification of fabrication requirements where the vessel vendor is the primary audience, rather than the creation of a design guideline intended for the purchaser.

2 Normative references

The following publications are referred to in this document, the procurement data sheet (IOGP S-619D) or the IRS (IOGP S-619L) in such a way that some or all of their content constitutes requirements of this specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 578, *Guidelines for a Material Verification Program (MVP) for New and Existing Assets*

API Standard 579-1/ASME FFS-1, *Fitness-For-Service*

API Standard 660, *Shell-and-Tube Heat Exchangers*

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard*

ASME B16.9, *Factory-Made Wrought Buttwelding Fittings*

ASME B16.47, *Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard*

ASME *BPVC*, Section VIII, Division 1, *Rules for construction of Pressure Vessels*

ASME *BPVC*, Section VIII, Division 2, *Rules for Construction of Pressure Vessels - Alternative Rules*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Joint Assembly*

ASTM A263, *Standard Specification for Stainless Chromium Steel-Clad Plate*

ASTM A264, *Standard Specification for Stainless Chromium-Nickel Steel-Clad Plate*

ASTM A265, *Standard Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate*

ASTM A388, *Standard Practice for Ultrasonic Examination of Steel Forgings*

ASTM A578, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

AWS A4.2, *Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Austenitic-Ferritic Stainless Steel Weld Metal*

EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*

EN 13445, *Unfired pressure vessels*

IOGP S-705, *Supplementary Specification to API Recommended Practice 582 for Welding of Pressure Containing Equipment and Piping*

ISO 8249, *Welding — Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 15156-1/NACE MR0175 (all parts), *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production*

ISO 17782, *Petroleum, petrochemical and natural gas industries — Scheme for conformity assessment of manufacturers of special materials*

ISO 17945/NACE MR01030, *Petroleum, petrochemical and natural gas industries — Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments*

NACE TM 0284, *Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking*

NORSOK M-601, *Welding and inspection of piping*

NORSOK M-650, *Qualification of manufacturers of special materials*

PD 5500, *Specification for unfired fusion welded pressure vessels*

TEMA, *Standards of the Tubular Exchanger Manufacturers Association*

3 Terms, definitions, acronyms, abbreviations and symbols

3.1 Terms and definitions

3.1.1
custom designed flange
flange (e.g. girth flange, flanged head, nozzle flange, companion flange) designed in accordance with the rules of the specified design code

3.1.2
effective diameter
outside diameter of the insulated vessel plus the additional diameter for any externally attached piping, ladders and platforms

3.1.3
fitting
fitting dimensioned and manufactured in conformance with ASME B16.9 or equivalent standard

3.1.4
hydrogen charging service
service in which the diffusion of atomic hydrogen can occur in the steel

Note 1 to entry: Hydrogen charging services include wet hydrogen sulphide, sour service, hydrofluoric acid service or hydrogen service where the operating temperature is greater than 205 °C (400 °F).

3.1.5
standard flange
flange dimensioned and manufactured in accordance with ASME B16.5, ASME B16.47 or equivalent standard

3.1.6
design corrosion allowance
minimum corrosion allowance as specified on the vessel data sheet

3.1.7
maximum allowable working pressure
MAWP
maximum internal gauge pressure permissible at the top of the completed vessel in its normal operating position at the designated coincident design temperature using the entire new (non-corroded) thickness minus the full corrosion allowance

3.1.8
maximum allowable external pressure
MAEP
pressure acting on the completed vessel in its normal operating position, excluding the effect of the static head, at the designated coincident design temperature using the entire new (non-corroded) thickness minus the full corrosion allowance

3.1.9
maximum allowable pressure
MAP

calculated allowable pressure using the entire new (non-corroded) thickness at ambient temperature (sometimes referred to as MAP new and cold)

3.2 Abbreviated terms and symbols

3.2.1 Abbreviated terms

ACCP ASNT Central Certification Program

BHN Brinell hardness number

CE carbon equivalent

CLR crack length ratio

CSR crack sensitivity ratio

CTR crack thickness ratio

DN nominal diameter

FN ferrite number

HIC hydrogen-induced cracking

LNG liquefied natural gas

MACA maximum allowable corrosion allowance

MAEP maximum allowable external pressure

MAP maximum allowable pressure

MAWP maximum allowable working pressure

MT magnetic particle testing

NPS nominal pipe size

NPT national pipe thread

PSA pressure swing absorber

PT liquid penetrant testing

PWHT post weld heat treatment

WFMT wet fluorescent magnetic particle

WRC Welding Research Council

3.2.2 Symbols

d average outside diameter of the vessel

D outside diameter of nozzle

h distance from the base of the support to the top tangent line of the vessel

4 Design

4.1 General

4.1.1

The vessel shall be designed, fabricated, inspected and tested in accordance with the specified design code.

4.1.2

The minimum thickness *t* of the vessel wall shall not be less than the thickness calculated in accordance with Equation (1).

$$t = \frac{d_i}{1\,000} + c\alpha + x \qquad (1)$$

where

t is the minimum thickness of the vessel wall in mm (in);

$c\alpha$ is the corrosion allowance in mm (in);

x is 2,5 mm (0,1 in);

d_i is the inside diameter of shell or head in mm (in).

NOTE For formed heads, the minimum thickness *t* is after forming.

4.1.3

The use of ASME code cases shall not be permitted.

4.1.4

The MAWP, MAP or MACA of the vessel shall not be limited by fittings, nozzle reinforcement, nozzle neck thickness, flange bolting or custom designed flanges.

NOTE Flanges specified using an industry standard (e.g. ASME B16.5) are permitted to limit the MAWP, MAP or MACA.

4.1.5

During the hydrotest, the general primary membrane stress in any pressure part shall not exceed 95 % of the material minimum specified yield strength.

4.1.6

Pressure components shall be designed for the most severe combination of pressure and coincident temperature.

4.1.7

The effects of one or more loads not acting shall be considered.

4.1.8

Elements common to two or more pressure chambers (e.g. jacketed vessels, internal heads, tubesheets) shall be designed to accommodate the most severe combination of pressures that may include the effects of coincident vacuum in an adjacent chamber.

4.1.9

Butt welds on the primary pressure boundary shall be full penetration type.

4.1.10

Design by analysis methodology shall not be used to justify a thinner thickness for a pressure component where design by rule thickness requirements are specified (e.g. ASME *BPVC*, Section VIII, Division 1 and ASME *BPVC*, Section VIII, Division 2, Part 4).

4.1.11

Each vessel support shall have an earthing lug.

4.1.12

Attachments intended to be removed prior to commissioning shall be identified on the vessel drawing.

4.2 Corrosion allowance

4.2.1

The corrosion allowance for internal parts shall be applied as detailed in Figure 1.

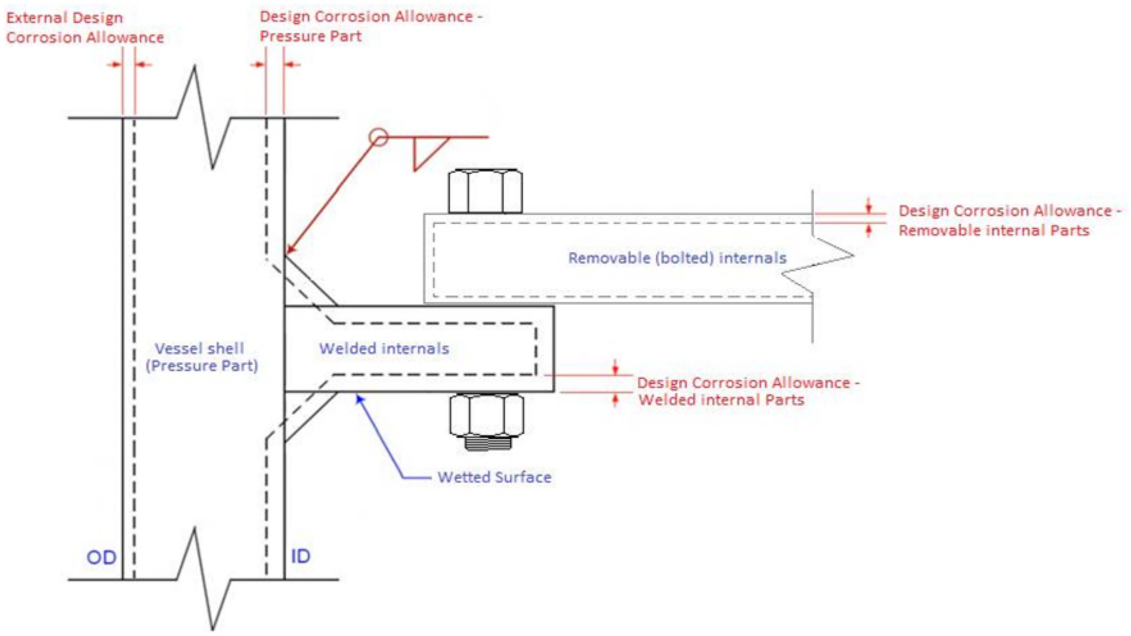


Figure 1 — Design corrosion allowance

4.2.2

Corrosion allowance shall not be considered on the gasket seating surface of flanges.

4.3 Wind, seismic and snow loads

4.3.1

Wind, seismic and snow loads shall be calculated in accordance with the applicable code and any additional requirements specified in the data sheet.

4.3.2

Vibration analysis for wind induced vortex-excited resonance shall be performed on:

a) vertical vessels with $5 \leq h/d \leq 15$ and natural frequency of vessel less than 2 Hz;

b) vertical vessels with $h/d > 15$, irrespective of natural frequency.

4.3.3

Deflection at the top of vertical vessels shall not exceed $h/200$.

4.3.4

The effective diameter of the vessel shall be used when determining the projected area in the wind load calculations.

4.4 Design loads and load combinations

Design loads and load combinations shall be in accordance with Table 1 and Table 2.

Table 1 — Design load combinations

Design load combination	Description
L2 + L10 + L12 + L14	Erected or (as installed) condition with full wind load and full snow load
L3 + L10 + L12 + L13 + L14 + L16	Operating condition (corroded), no pressure, with full wind load and full snow load
L3 + L11 + L12 + L13 + L14 + L16	Operating condition (corroded), no pressure, with full seismic load and full snow load
L3 + L6 + L10 + L12 + L13 + L14 + L16	Operating condition (corroded and uncorroded) with full pressure, full wind load and full snow load
L3 + L6 + L11 + L12 + L13 + L14 + L16	Operating condition (corroded and un-corroded) with full pressure, full seismic load and full snow load
L4 + L8 + (0,25)L10 + L12	Shop (or initial) hydrostatic test condition (uncorroded)
L4 + L9 + (0,25)L10 + L12 + L14	Field (or future) hydrostatic test condition (corroded)
L5 + L12 + L17	Transport condition
L3 + L7 + L12 + L13 + L14 + L15	Blast load condition

Table 2 — Design load combination definitions

Design load	Description
L1 – Fabricated weight	Total weight of the vessel as fabricated in the shop
L2 – Empty weight	Total weight of the vessel sitting on the foundation, fully dressed, waiting for operating liquid
L3 – Operating weight	Empty weight plus any operating fluid weight
L4 – Hydrotest weight [a]	Weight of the vessel under hydrostatic test condition including the weight of the test fluid
L5 – Shipping weight	Fabricated weight of the vessel plus any weight added for shipping purposes (e.g. shipping saddle)
L6	Internal (including static head) or external design pressure and internal or external design temperature
L7	Normal operating pressure and temperature
L8	Shop (or initial) hydro test pressure and temperature
L9	Field (or future) hydro test pressure and temperature
L10	Wind load (not wind speed)
L11	Seismic load
L12	Snow load
L13	Static reactions from the load of attached equipment, such as motors, machinery, other vessels and piping
L14 – Motion induced load	Hull/floating unit movement effect, towing out motion whenever applicable
L15	Blast load
L16 – Thermal load	Steady state or transient effect of fluid flow (e.g. icing, chilling, thermal shock)
L17	Transportation load (transportation acceleration forces)
[a] The removable internals that are not included in field hydrotest weight shall be identified in the vessel data sheet.	

4.5 Lifting loads

4.5.1

For vessels lifted in conditions expected to be stable, lifting attachments shall be designed using a factor of 1,5 on the weight of the vessel during lifting.

4.5.2

For vessels lifted in conditions expected to be dynamic (e.g. lifting from a barge subject to wave action), lifting attachments shall be designed using a factor of 2,0 on the weight of the vessel during lifting.

4.5.3

Skirt supported vertical vessels with a total height *h* greater than or equal to 20 m (65 ft) or an empty weight greater than or equal to 20 000 kg (44 000 lb) shall be provided with tailing devices.

4.5.4

Vertical vessels including the lifting attachments shall be designed for erection from a horizontal to a vertical position.

4.5.5

The design shall be evaluated at 5° increments when lifting the vessel from a horizontal to a vertical position.

4.6 Local loads

4.6.1

Localized stress resulting from concentrated loads on nozzles or structural attachments shall be evaluated using a recognized industry standard or method (e.g. WRC bulletin, finite element analysis).

4.6.2

Geometrical limits specified in the selected method (e.g. WRC) used for local load analysis shall be followed.

4.6.3

Extrapolation beyond the stated geometrical limits in the method selected for local load analysis shall not be permitted.

4.6.4

Nozzles shall be designed for the external loads specified in API Standard 660, Annex K or the loads determined by a pipe stress analysis (when available).

NOTE Where the default nozzle loads lead to an increase in local shell and head thickness, a reduction in the default loads based on the piping layout and/or nozzle flexibility can be considered.

4.6.5

Nozzles where external piping is not connected (e.g. manways, inspection openings, nozzles for thermowells and other similar instruments, packing withdrawal, ventilation) and where the total weight supported by the nozzle is less than four blind flanges that match the size and pressure class of the nozzle shall be excluded from the evaluation required by 4.6.1.

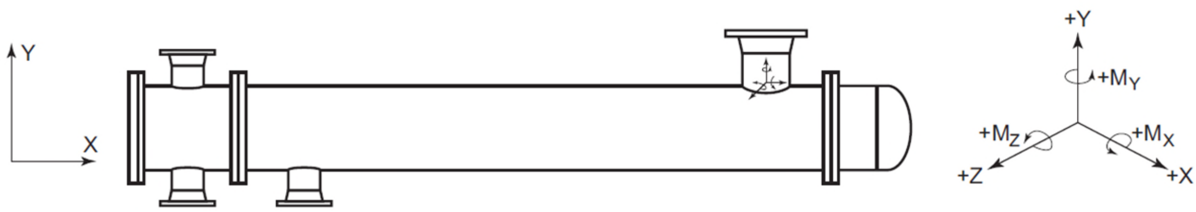


Figure 2 — Directions of moments and forces on nozzles

4.7 Nozzles, manways and reinforcements

4.7.1 Set-on nozzles

4.7.1.1

Set-on nozzle connections may be used if one of the following applies:

a) The nozzle is attached to the header box of an air-cooled heat exchanger.

b) All of the following apply:

1) the vessel shell or head thickness is greater than 50 mm (2 in);

2) the nozzle thickness is less than half of the shell thickness; and

3) when set-in nozzles are not required based on service (e.g. sour service or hydrogen charging service).

4.7.1.2

Prior to fit-up of set-on type nozzles, the surface of the through wall cut (see Figure 3) shall be examined using the liquid penetrant or magnetic particle method with zero defects allowed on this surface.

4.7.1.3

Prior to the fit-up of set-on type nozzles, the entire area of the plate adjacent to the nozzle opening shall be examined using the ultrasonic method to a distance of 100 mm (4 in) around the opening, with indications graded to Acceptance Level C in accordance with ASTM A578.

4.7.1.4

For set-on nozzles attached to plate with a thickness greater than 19 mm ($^{3}/_{4}$ in), 100 % UT examination shall be performed on the attachment weld from the back side of the plate (when accessible) subjected to through-thickness shrinkage stresses.

4.7.2

The minimum nozzle size shall be DN 40 (NPS 1½).

4.7.3

Nozzle connections shall be weld neck flange, long weld neck flange or stub-end (butt weld).

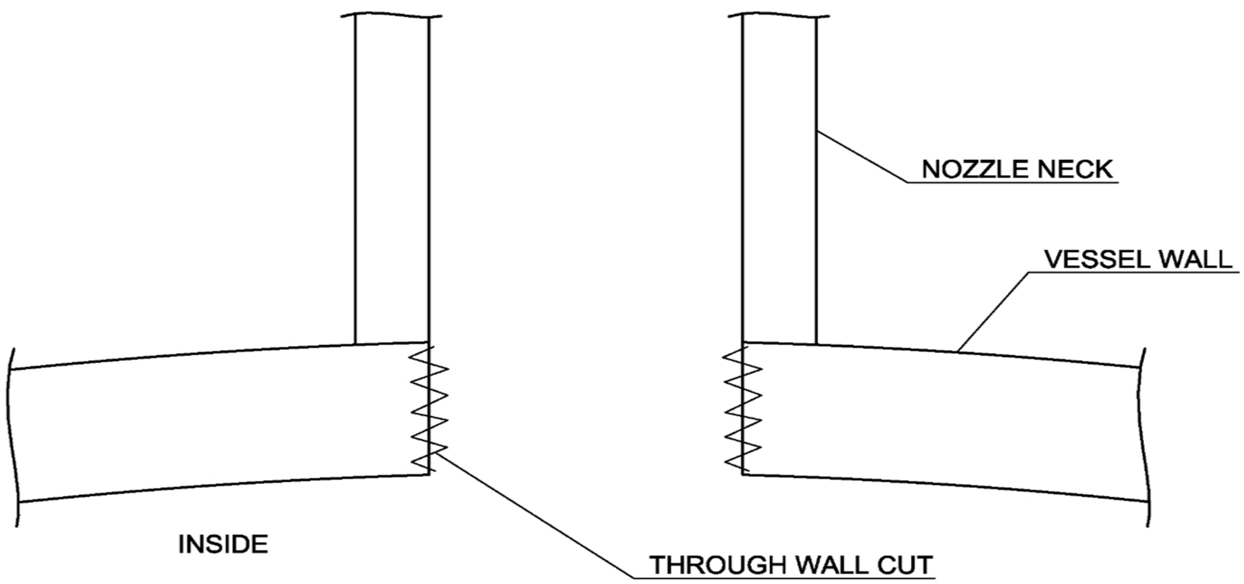


Figure 3 — Through-wall-cut

4.7.4

Flanged nozzles DN 40 (NPS 1½) and DN 50 (NPS 2) shall be long weld neck flanges or fabricated from seamless pipe with a minimum nominal wall thickness of schedule 160 or schedule 80S as applicable.

4.7.5

No threaded connection shall be screwed directly into any pressure part of the vessel.

4.7.6

For vessels with removable internals, access shall be provided for maintenance or replacement.

4.7.7

For vessels with an internal diameter less than 1 000 mm (40 in), the use of bolted heads or body flanges for access shall be acceptable.

4.7.8

Inspection openings shall not be less than DN 100 (NPS 4).

4.7.9

Nozzle-to-vessel wall and reinforcement pad to nozzle neck weld joint shall be full penetration welds.

4.7.10

Internal reinforcing pads shall not be used for nozzles.

4.7.11

The minimum manway inside diameter shall be 546 mm (21,5 in).

4.7.12 Set-in nozzles

4.7.12.1

Set-in nozzles shall be ground to match the contour of the vessel inside diameter.

4.7.12.2

Inside edges of nozzles wall shall be rounded off to a radius of at least 3 mm ($^1/_8$ in).

4.7.13

Flanges on nozzles including manways and access openings shall be raised face.

4.7.14

Reinforcing pads for nozzles shall be limited to two pieces.

4.7.15

The thickness of the reinforcing element for non-integrally reinforced nozzles shall not exceed the smaller of 50 mm (2 in) or of the nominal thickness of the vessel wall minus the total corrosion allowance at the location of the opening unless limited further by the code of construction.

4.7.16

Removable internals shall pass through vessel manways.

4.7.17

For vessels in cryogenic service, manway covers shall be hinged (see Annex J, Drawing S619 J.12).

4.8 Custom designed flanges

4.8.1

Minimum bolt spacing shall be in accordance with TEMA.

4.8.2

If hydraulic bolt tensioning is required, spacing shall be provided between bolts.

4.8.3

The flange design shall account for the design pressure and other applicable loads (e.g. externally applied bending moment, axial thrust loadings).

4.8.4

If not specified in the design code, the gasket seating surface finish and flatness tolerance for custom designed flanges shall be in accordance with ASME PCC-1.

4.8.5

The flatness of gasket contact surfaces for custom designed flanges shall be measured after heat treatment and final machining.

4.9 Flange bolting

4.9.1

Bolts shall be studs, threaded full length, with heavy hex nuts.

4.9.2

Stud bolts shall be installed flush with the nut at one end of the stud.

4.9.3

When bolt tensioning is used, studs shall have the additional threaded length equivalent to one stud diameter, extending from the nut at one end.

4.9.4

When the stud bolt length is increased as required for bolt tensioning, the exposed length of the stud bolts shall be protected with a second heavy hex nut.

4.10 Skirt support

4.10.1

The skirt thickness shall be less than or equal to 6 mm (¼ in) inclusive of any skirt corrosion allowance or the nominal thickness of the vessel component to which it is attached.

4.10.2

Skirts shall be provided with an access opening (see Figure J.3).

4.10.3

Piping shall not be routed through skirt access openings.

4.10.4

Flanged connection shall not be installed inside the skirt.

4.10.5

Skirt openings shall be provided with rings or collars sized for the structural stability.

4.10.6

Skirt vents and drains shall be provided in accordance with Figure J.3.

4.11 Leg supports

4.11.1

The use of leg supports on vertical vessels shall be permitted if the following conditions are met:

a) vessel internal diameter no greater than 1 500 mm (60 in);

b) design temperature no greater than 230 °C (450 °F);

c) vessel height (*h*) to internal diameter ratio no greater than 5;

d) vessel not in cyclic service.

4.11.2

If a vessel is supported with legs, base plates drilled with anchor bolt holes shall be welded to each leg support.

4.12 Saddles

4.12.1

Horizontal vessels shall be supported on two saddles, one fixed and one sliding.

4.12.2

Vessels shall be evaluated for stresses imposed by all applicable loading on the saddles.

4.13

Vessels designed for internal pressure only shall be stamped for the calculated MAEPs at the internal pressure design temperature.

4.14 Name plate brackets

4.14.1

The nameplate bracket shall be a "C" shape.

4.14.2

The nameplate bracket shall be welded externally to the vessel shell or vessel support along the two edges.

4.14.3

Welds between the nameplate bracket and to vessel wall shall be full fillets on one side.

4.14.4

The nameplate bracket material thickness shall be greater or equal to 5 mm (¼ in).

5 Materials

5.1

Castings shall not be used.

5.2 Permanent attachments

5.2.1

Permanent attachments including vessel supports welded directly to pressure parts shall be of the same nominal chemistry as the pressure part.

5.2.2

Permanent attachments shall be suitable for the minimum design metal temperature of the vessel.

5.2.3

The structural shape of stiffening rings or insulation support rings shall not hold water.

5.3

The skirt support material shall be the same nominal chemistry as the vessel wall base material for a minimum distance below the vessel-to-skirt connection line in accordance with Equation (2) or 300 mm (12 in), whichever is larger.

$$\text{Minimum length of skirt support with matching nominal chemistry} = 1{,}8 \times \sqrt{Ds \times Ts} \quad (2)$$

where

Ds is the skirt outside diameter;

Ts is the skirt nominal thickness.

5.4

Achieving the specified minimum design metal temperature without impact testing by using a reduced stress ratio method shall not be permitted.

5.5

Use of non-impact tested materials as allowed by ASME *BPVC*, Section VIII, Division 1, UG-20 (f) shall not be permitted.

5.6

The proposed repair of defects in the as-received base metal of pressure components shall be approved.

5.7

Positive material identification of alloy steel pressure containing parts, weldments, cladding and weld overlay shall be performed in accordance with API Recommended Practice 578 or NORSOK M-601.

6 Fabrication

6.1 General

6.1.1

Continuously welded external attachments (e.g. wrapper plate for saddles, wear plates) shall be provided with one 6 mm (1/4 in) diameter vent hole in each segment at the lowest practical point of the pad or attachment.

6.1.2

The vent hole in the nozzle reinforcement pad shall be tapped DN 8 (¼ NPT).

6.1.3

Non-circular attachment pads shall have a corner radius of at least five times the pad thickness or 50 mm (2 in), whichever is smaller.

6.1.4

Production test plates shall be welded and heat treated in accordance with the procedures used for production welds in the shell and head.

6.1.5

The distance between main seam welds (longitudinal and circumferential joints) and nozzles, reinforcement or other welded attachments shall be at least 50 mm (2 in), measured weld toe to weld toe (see Figure 4).

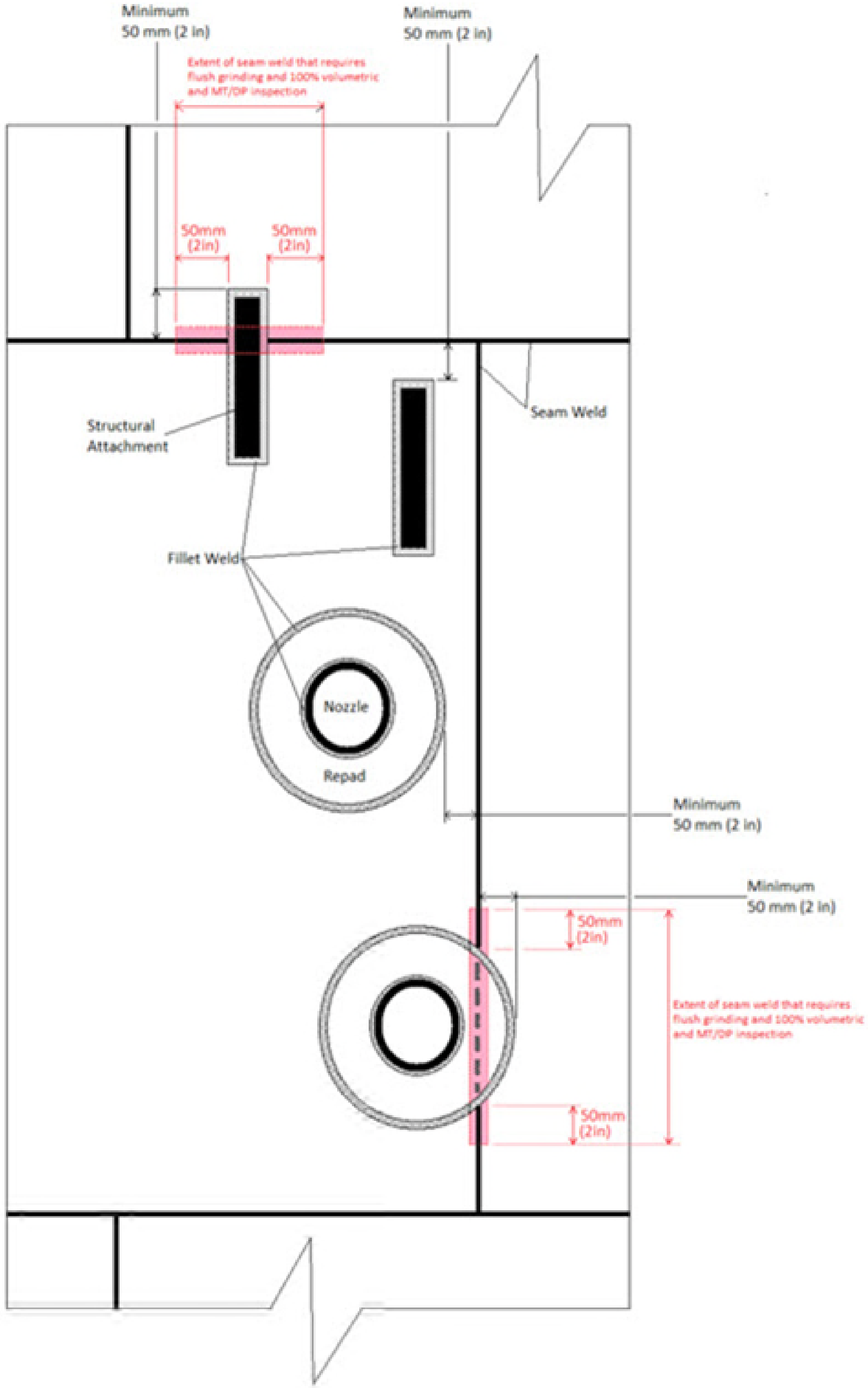


Figure 4 — Weld seams clearance and Overlapping

6.1.6

Where attachments cover main seam welds, the length of the main seam weld covered by the attachment and projecting at least 50 mm (2 in) beyond each side of the attachment shall be ground flush (see Figure 4).

6.1.7

Where attachments cover main seam welds, the length of the main seam weld covered by the attachment and projecting at least 50 mm (2 in) beyond each side of the attachment shall be inspected with 100 % volumetric examination and magnetic particle or liquid penetrant examination (see Figure 4).

6.1.8

The thickness of all formed pressure parts shall be measured and recorded after forming.

6.1.9 Permanent marking

6.1.9.1

Permanent marking on the pressure boundary shall be applied with low-stress stamps on the outside of the vessel wall.

6.1.9.2

Permanent marking shall be applied before PWHT.

6.1.10

Local thin areas, as defined in accordance with the design code, that fall below the nominal thickness of the vessel wall (including consideration of the specified tolerance) shall be repaired or replaced.

6.1.11

Fitness for service calculation shall not be used as justification for accepting identified defects without repair.

6.1.12

Longitudinal weld seams of horizontal vessels shall be located on or above the horizontal plane through the centreline of the vessel.

6.2 Welding

6.2.1

Pressure part welding requirements shall be in accordance with IOGP S-705.

6.2.2

Welds between a saddle, skirt, stiffening ring or similar external attachment and a pressure part shall be continuous (intermittent welds are not allowed).

7 Heat treatment

When additional simulated PWHT cycles are required for weld procedure qualification, mechanical tests shall be performed after the first and final PWHT cycles.

8 Non-destructive examination

8.1 General

8.1.1

Non-destructive examination of welded joints and weld overlay for final acceptance of the vessel shall be performed after the completion of welding, weld repairs and PWHT, and prior to pressure testing.

8.1.2

The person responsible for the non-destructive examination shall be qualified to ISO 9712 level III, ACCP level III or equivalent.

8.1.3

Non-destructive examination operators shall be qualified in accordance with ISO 9712 level II or ACCP level II or equivalent.

8.2 Radiographic and ultrasonic examination

8.2.1

Where allowed by the design code, ultrasonic examination shall be acceptable in lieu of radiographic examination.

8.2.2

Where 100 % volumetric examination is specified, the complete length of butt welds, nozzle-to-vessel wall joints, nozzle neck weld seams, nozzle to flange joints and skirt to vessel wall welds shall be examined.

8.2.3

The welds of heads constructed from two or more pieces shall be subjected to 100 % volumetric examination after forming.

8.2.4

When spot radiography is specified, the purchaser or the purchaser's representative shall designate the locations at which the spot radiographs shall be taken.

8.2.5

All plates with a nominal thickness greater than or equal to 50 mm (2 in), excluding any thickness of cladding or weld overlay, shall be inspected in accordance with the requirements of ASTM A578, including supplementary requirement S1 or EN 10160, as specified in the data sheet.

8.2.6

All forgings with a nominal thickness greater than or equal to 50 mm (2 in), excluding any cladding or weld overlay, shall be in accordance with the requirements of ASTM A388.

8.3 Magnetic particle or liquid penetrant examination

8.3.1

If not specified by the design code, the minimum extent of MT or PT examination shall be as per ASME *BPVC,* Section VIII, Division 2, Table 7.2.

8.3.2

Cold formed heads shall have the inside and outside surfaces of the knuckle region examined by magnetic particle or liquid penetrant examination after completion of forming and material heat treatment.

8.3.3

MT or PT examination shall be performed for all lifting attachment welds.

9 Pressure testing

9.1

Vessels shall be hydrostatically tested using potable water or water filtered through a 10 micrometre (1 250 openings per inch mesh).

9.2

The more stringent water quality requirements of Annex B, Annex C or Annex D shall apply when applicable.

9.3

The hold time at hydrotest pressure shall not be less than 1 h.

9.4

Vertical vessels hydrotested in a horizontal position shall be supported to prevent overstress during testing.

9.5

Each reinforcing pad segment shall be tested at a pressure of 100 kPag (15 psig) with dry air or nitrogen and a bubble forming solution.

9.6

Gaskets and bolting used during pressure testing shall be identical in geometry, dimensions, bolt strength and gasket m and y factors to those required for service.

NOTE If the bolted joint is not disassembled after completion of hydrostatic pressure testing, these gaskets can be service gaskets.

9.7

Surface preparation and painting shall not be applied to the vessel prior to hydrostatic testing.

10 Preparation for shipment

10.1 General

10.1.1

Vent holes shall be plugged after testing.

10.1.2

The material used to plug vent holes shall not be capable of sustaining pressure between the reinforcing plate and the vessel wall.

10.1.3

The vessel shall be shipped with service gaskets and bolting in place for body flanges, custom designed flanges and permanently blinded connections.

10.1.4

A barrier material shall be provided between shipping saddles and the vessel to prevent damages to the surface of the vessel or contamination of the vessel material.

10.2 Protection

10.2.1

Liquids used for cleaning or testing shall be drained from the vessel and any residues dried prior to shipment.

10.2.2

The vessel shall be free of any foreign matter prior to shipment.

10.2.3

Removable internal and external parts assembled with the vessel prior to shipment shall be tied or braced with temporary supports.

10.2.4

Temporary supports shall be painted with a fluorescent colour paint.

10.2.5

Exposed machined and threaded surfaces on the vessel and parts to be shipped loose shall be protected with rust preventive.

10.2.6

Flanges shall be blanked with oil-resistant rubber gaskets or self-adhesive flange protectors and steel or water resistant plywood blanks with a minimum of four bolts.

10.2.7 Vessel purging

10.2.7.1

When an inert gas purge is specified, the pressure shall be maintained at a minimum of 35 kPag (5 psig) indicated by a pressure gauge during transportation and storage.

10.2.7.2

Gauges shall be protected from damage during transportation.

10.2.7.3

When the vessel is purged with dry air and desiccant bags are placed in the vessel, the quantity and location of the desiccant bags shall be recorded.

10.3 Identification

10.3.1

The exterior of the vessel shall be marked with the vessel tag number, shipping weight and purchase order number with a minimum of 75 mm (3 in) high letters of contrasting colour against the background.

NOTE Other markings may have 25 mm (1 in) high letters.

10.3.2

The centre of gravity shall be marked on each side of the exterior of the vessel.

10.3.3

Vessels that have received PWHT shall be labelled or painted with the text "POST WELD HEAT TREATED – DO NOT BURN OR WELD".

10.3.4

Equipment protected by an inert gas fill shall display the warning "DANGER - NON-LIFE SUPPORTING ATMOSPHERE" in the immediate vicinity of any manway and other point of access to the interior of the vessel.

Annex A
(normative)
Additional requirements for sour service vessels

A.1

The requirements specified by this annex are minimum requirements. If more stringent requirements such as butt-welded type nozzles, forged ring type skirt to head joints and full penetration groove welds for welded attachments are required based on severity of the service, these shall be agreed between the purchaser and the vendor.

A.2

The requirements of ISO 15156/NACE MR0175 (all parts) or ISO 17945/NACE MR0103 shall be satisfied.

A.3

Nozzles shall be set-in type, integrally reinforced and fitted flush with the shell or head.

A.4

Butt welds shall be subjected to 100 % volumetric examination.

A.5

Nozzle-to-vessel wall joints shall be 100 % ultrasonically tested.

A.6

Welds directly to the internal surfaces of the pressure part shall be subjected to 100 % surface inspection by WFMT or liquid penetrant examination.

A.7

When HIC testing is specified, one plate per lot shall be HIC tested in accordance with NACE TM0284, using test solution A.

A.8

The acceptance criteria for HIC testing for sour service shall be in accordance with the following:

a) CLR lesser than or equal to 15 % per specimen;

b) CTR lesser than or equal to 5 % per specimen;

c) CSR lesser than or equal to 2 % per specimen;

d) 5 mm (0,2 in) maximum individual crack length;

e) ultrasonically tested as per ASTM A578 S1, S2.1 or EN 10160 quality classes S2 (plate) E3 (edge).

A.9

PWHT shall be performed for all vessels in sour service.

A.10

Unless they are vented in accordance with 6.1.1, external attachments shall be welded to the pressure boundary with full penetration welds.

A.11

Internal attachments shall be welded to the pressure boundary with full penetration welds.

Annex B
(normative)
Additional requirements for integrally clad and weld overlay vessels

This annex covers the requirements for integrally clad and weld overlaid carbon steel with austenitic stainless steel, alloy 276, alloy 625 or alloy 825.

B.1 General

B.1.1

The method of cladding shall be integral cladding by hot rolling, explosion bonding or weld overlay.

B.1.2

The base metal nominal thickness shall not be less than 10 mm (⅜ in).

B.1.3

The minimum thickness of cladding or overlay welding shall be 3 mm (⅛ in) after machining.

B.1.4

Design calculations shall be based on the base material thickness after clad restoration, excluding the machining allowance for clad restoration (see Annex J, Drawing S619 J.6).

B.1.5

The chloride content of the hydrostatic test water shall not exceed 50 mg/kg (50 parts per million by mass).

B.2 Nozzles

B.2.1

The minimum nozzle size for nozzles in cladded sections shall be DN 50 (NPS 2).

B.2.2

Nozzles shall be clad, either integrally or by weld overlay.

NOTE Nozzles DN 100 (NPS 4) and smaller and girth flanges may be of solid alloy subject to the purchaser's approval.

B.2.3

When nozzles are rolled from integrally clad plate, the longitudinal and circumferential welds in the nozzle section shall be subjected to 100 % volumetric examination.

B.2.4

Radius or profiling at nozzle connections shall not reduce the clad thickness below the specified minimum value.

B.3 Integral cladding

B.3.1

Integrally clad plates shall comply with the requirements of ASTM A263, ASTM A264 or ASTM A265 including supplementary requirement S12 with a bond quality level of Class 1.

B.3.2

Formed heads or sections shall be ultrasonically tested after forming in accordance with the requirements specified under B.3.1.

B.3.3

Shear strength tests shall be performed on all integrally clad steel plates in accordance with the provisions of the applicable material specification.

B.3.4 Internal attachments

B.3.4.1

When the induced weld stress due to thermal and mechanical loads on the attachment exceeds 25 % of the allowable shear stress or 50 % of the allowable tensile stress for the weld, welding of internal attachments to integrally clad plates shall not be permitted.

B.3.4.2

Internal welded attachments that do not meet the requirements in B.3.4.1 shall be welded directly to the base metal after stripping back the cladding locally.

B.3.4.3

When an integrally clad plate has regions that are locally stripped back, the stripped back areas shall be restored by weld overlay.

B.4 Weld overlay

B.4.1

Internal attachments in weld overlaid sections shall be welded to the overlay.

B.4.2

For transition areas at nozzles and flanges, a fabrication procedure shall be provided.

B.4.3

The fabrication procedure shall include as a minimum all of the following.

a) Detailed arrangement drawing showing:

   1) functionality of the nozzle or flange;

   2) set in or set on;

   3) preparation of the nozzle or flange;

4) tapering;

5) line up and measurement prior to overlay welding.

b) Details of overlay welding including:

1) reference to the applicable welding procedure;

2) number of layers.

c) Method of preparation after overlay welding.

d) Examination after overlay welding including:

1) thickness;

2) liquid penetrant;

3) ferrite testing.

B.4.4

Where there is change in geometry for highly stressed areas (e.g. nozzle or manway welds in shells or heads, internal beam support weld build-ups), the weld overlay shall be provided with a smooth contour finish and a minimum radius of 6 mm (¼ in).

B.4.5

Weld overlay, clad restoration welds and internal attachment welds shall be subjected to 100 % liquid penetrant examination.

B.4.6

Weld overlaid surfaces shall be examined with the liquid penetrant method after final machining.

B.4.7

The test acceptance criteria for liquid penetrant inspection of weld overlay shall be zero cracks or crack-like indications and zero open defects of any size.

B.4.8

Any linear indication in the weld overlay as identified by the liquid penetrant test shall be repaired.

B.4.9

When partial removal of the final weld overlay or clad layer is performed by grinding, machining or another method, a copper sulphate test shall be performed on all surfaces that were subjected to metal removal during the grinding or machining process.

Annex C
(normative)
Additional requirements for carbon steel vessels

C.1

The maximum allowable CE shall be in accordance with Table C.1.

Table C.1 — Maximum allowable CE

Nominal plate thickness	Maximum allowable CE
≤ 50 mm (2 in)	0,43
> 50 mm (2 in) ≤ 100 mm (4 in)	0,45
> 100 mm (4 in)	0,48

C.2

The maximum carbon content of carbon steel material shall not exceed 0,23 %.

C.3

Cold formed heads shall be normalized after forming.

C.4

Hot formed heads not formed in the normalizing range shall be normalized.

C.5

The minimum Charpy impact values, at the minimum design metal temperature or impact testing temperature specified in design code (whichever is lower), shall be 27 J (20 ft-lb) average of three specimens and 20 J (15 ft-lb) minimum for a single specimen, unless the design code contains more stringent requirements.

C.6

Impact testing shall include testing of specimens from the base metal, weld metal and heat affected zone.

C.7

The chloride content of the hydrostatic test water shall not exceed 250 mg/kg (250 parts per million by mass).

Annex D
(normative)
Additional requirements for austenitic stainless steel, 22Cr and 25Cr duplex vessels

D.1 General

D.1.1

Materials shall be supplied in a solution annealed condition.

D.1.2

Cold formed heads and tori-conical transition sections shall be solution annealed after forming and before welding to the shell.

D.1.3

Hot formed heads shall be solution annealed followed by rapid cooling.

D.1.4

Arc-air or oxy-gas methods of cutting and bevelling shall not be permitted.

D.2 Contamination control

D.2.1

Procedures shall be in place to ensure no cross-contamination between ferritic, austenitic or duplex materials.

D.2.2

Exterior surfaces shall be protected from chloride exposure during fabrication, shipping and storage.

D.2.3

Materials for marking, painting or inspection shall not contain halides and heavy metals.

D.2.4

Aluminium and zinc containing paints shall not be used for material identification.

D.2.5

The chloride content of the hydrostatic test water shall not exceed 50 mg/kg (50 parts per million by mass).

D.3 Ferrite measurement

D.3.1

The FN shall be measured during procedure qualification and production welding prior to any post weld heat treatment using a ferrite scope calibrated in accordance with ISO 8249 or AWS A4.2.

D.3.2

Ferrite number measurements of production welds shall include all longitudinal and circumferential pressure retaining welds.

D.3.3

A minimum of three separate measurements per weld shall be performed.

D.4 Welding

The minimum preheat temperature shall be 10 °C (50 °F).

D.5 Pickling and passivation

D.5.1

The internal surfaces of vessels with a wall thickness of less than 10 mm (⅜ in) shall be pickled and passivated after completion of all welding activities.

D.5.2

Surfaces contaminated with iron during fabrication shall be pickled and passivated.

D.5.3

Internal and external surfaces of welds shall be pickled and passivated.

D.6 Special requirements for 22Cr duplex and 25Cr duplex

D.6.1

Pressure retaining components shall be supplied by manufacturers qualified in accordance with the requirements of ISO 17782 or NORSOK M-650.

D.6.2

The maximum number of repairs of the same defective area shall not exceed the values listed in Table D.1.

Table D.1 — Repair limits

Material	Repairs allowed
22Cr Duplex	2
25Cr Duplex	1

D.6.3

22Cr duplex and 25Cr duplex shall not be post weld heat treated.

Annex E
(normative)
Vessel tolerances

E.1

Tolerances shall be in accordance with the design code, and Figure E.1 or Figure E.2.

E.2

Where tolerances for horizontal vessels are not shown, vertical vessel tolerances shall be applied.

E.3

Tangent lines, principal axis centre lines and orientation shall be punch marked externally.

E.4

Out of roundness tolerance for skirts shall be in accordance with the design code for shell under external pressure.

E.5

Flatness tolerances for vessel support base plates (e.g. skirts, legs, lugs and saddles) shall be ±6 mm (¼ in).

E.6

For nozzles supplied with an agitator mounting, the maximum out of plane tolerance shall be ±0,25°.

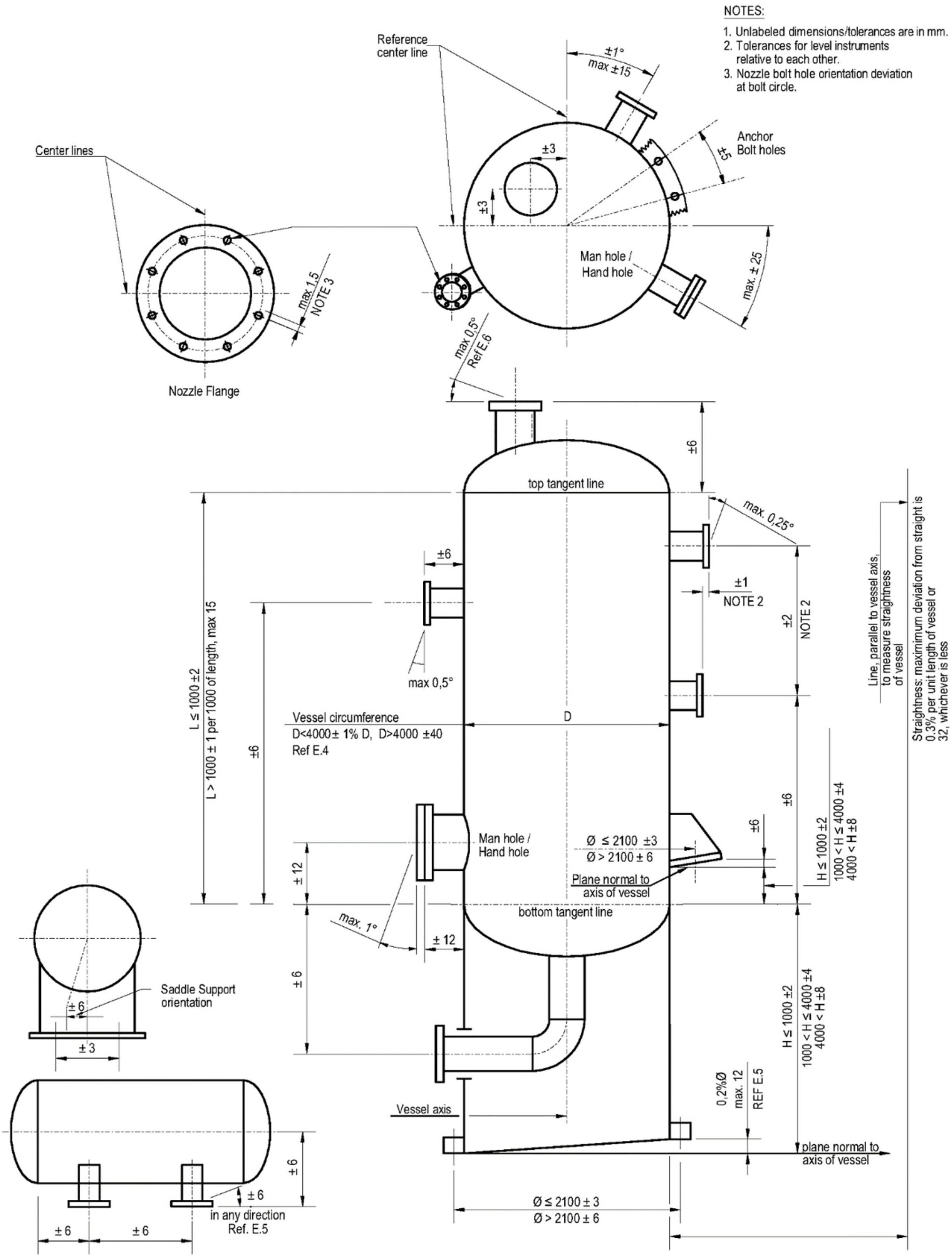


Figure E.1 — Vessel tolerances (SI units)

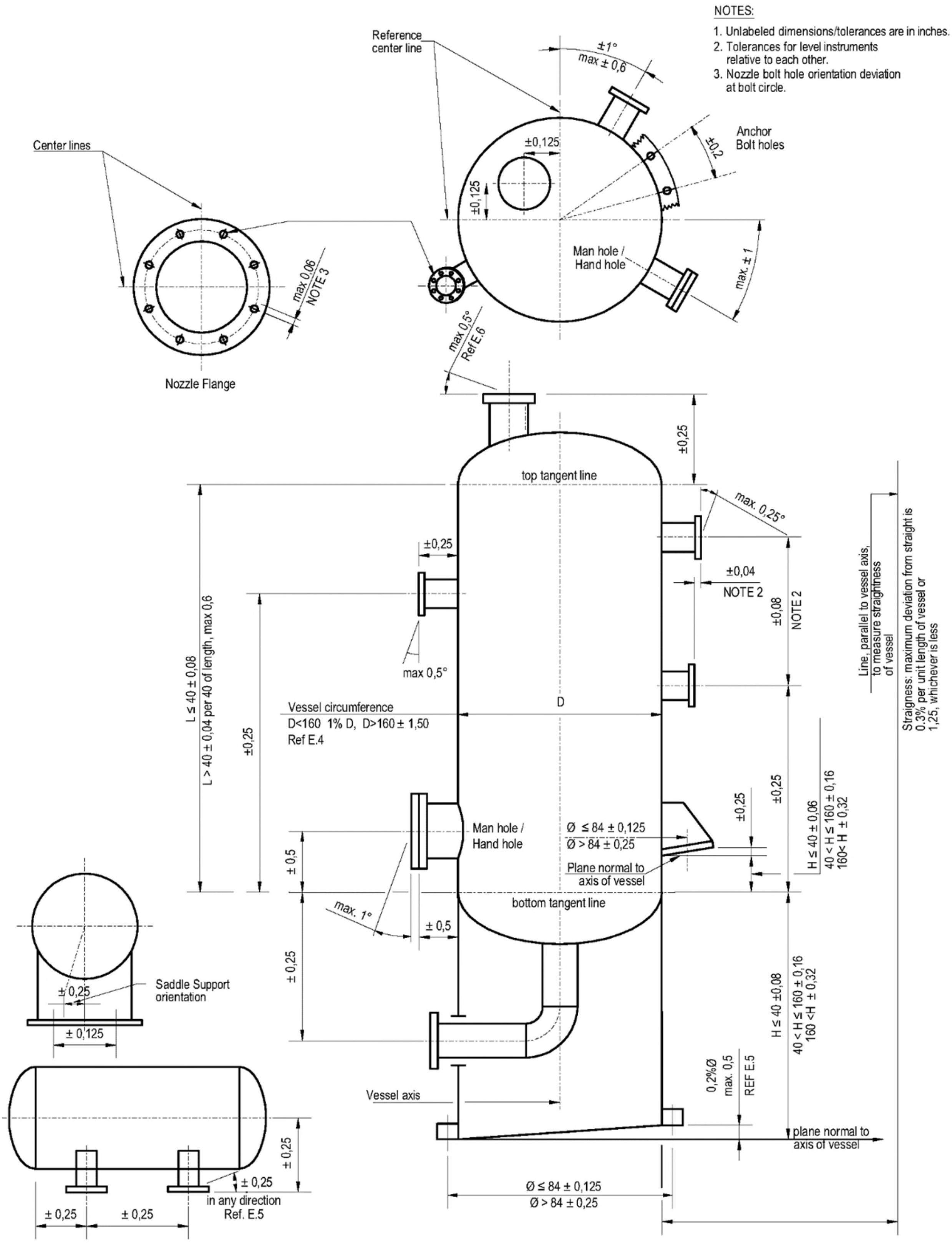


Figure E.2 — Vessel tolerances (US customary units)

Annex F
(normative)
Requirements for maximum allowable corrosion allowance (MACA)

The MACA for pressure components is the difference between the nominal thickness and the calculated required (retirement) thickness in accordance with the design code. The MACA is the sum of the design minimum corrosion allowance (internal, external or both) plus the thickness added (“round up thickness”) to obtain a commercially available nominal thickness.

The MACA methodology is used to optimize the design for the CA. The CA is not required to be displayed on the nameplate by the ASME code or by this specification.

Calculation of the MAWP is not required for vessels build to ASME *BPVC*, Section VIII, Division 1; the design pressure may be substituted for the MAWP. However, this specification allows for the MAWP to be calculated as an option after the MACA has been determined. This calculated MAWP may be slightly higher than the design pressure.

F.1

The MACA shall be determined individually for each of the cylindrical, straight conical or flat major components first.

F.2

The MACA shall be calculated regardless of whether the CA is internal or external.

NOTE Where the as-built head and minor component (typically a nozzle) configuration allows, it is preferable for the minor component to inherit the MACA of its parent major component.

F.3

The reinforcement requirements of openings shall be calculated after the MACA for the parent component has been determined.

F.4

Thickness added to the component for additional reinforcement or for meeting the supplemental minimum thickness requirements of other standards is not required to be counted towards the MACA.

EXAMPLE 1 (SI) A shell course may be designed with a required thickness of 5,7 mm plus a design CA of 3,0 mm at 8,7 mm. This is rounded up to 10 mm as the next commonly available thickness. If the fabricator chooses or is required by TEMA to use 12 700 mm plate, the MACA is calculated based on 10 mm, thus MACA is 4,3 mm. Accounting for the slight increase in ID with a larger CA as well as roundoff error, it is likely that the actual MACA will drop to 4,2 mm. The excess 3 mm can be allocated to opening reinforcement, external nozzle loads, etc. or at the fabricator’s option added to the MACA.

EXAMPLE 2 (US Customary) A shell course may be designed with a required thickness of 0,225 in plus a design CA of 0,125 in at 0,350 in. This is rounded to 0,375 in as the next commonly available thickness. If the fabricator chooses or is required by TEMA to use 0,500 in plate, the MACA is calculated based on 0,375 in, thus MACA is 0,15 in. Accounting for the slight increase in ID with a larger CA as well as roundoff error, it is likely that the actual MACA will drop to 0,14 in. The excess 0,250 in can be allocated to opening reinforcement, external nozzle loads, etc. or at the fabricator’s option added to the MACA.

F.5

The MACA of the pressure component need not exceed twice the design CA for that component.

F.6

When attached to a formed head or formed transition component, the CA of minor components may be designed using 150 % of the vessel design corrosion allowance instead of a calculated MACA.

F.7

The MACA for each major component shall be calculated to the nearest 0,2 mm (0.01 in).

F.8

For vessels with more than one shell course, the MACA shall be calculated separately for each course.

F.9

When attached to cylindrical shell components, straight conical transitions or flat heads, the CA of minor components (e.g. nozzle neck, nozzle flange) shall inherit the MACA of the cylindrical shell or flat head component that it is attached to.

F.10

The thickness of formed heads and formed knuckles for conical transition components shall be measured after forming.

F.11

The as-built MACA shall be calculated based on the as-received thickness.

F.12

Calculations shall clearly state the minimum required thickness for all major components of the vessel.

F.13

The minimum required thickness for all major components shall be included in a table on the general arrangement drawing.

F.14

The MACA of each major component shall be listed on the manufacturer’s data report.

F.15

The manufacturer's draft data report shall be submitted to the purchaser for review and approval.

Annex G
(normative)
Additional requirements for vessels in cyclic service

There is a range of operating conditions that may be considered fatigue service based upon the cyclic loading screening requirements in the selected code of construction. However, some vessels may be designed for a relatively small number of operating cycles (e.g. the range of 100 to 1 000 cycles) and may therefore be operating in a lower severity cyclic service application. In other cases, a vessel may be designed for a large number of cycles (e.g. 100 000 or more cycles) and/or experience extreme stress cycles associated pressure and thermal stress, and are as such in a more severe cyclic service application. Examples of this category include PSA vessels, molecular sieve dryer vessels, or coke drums.

Appropriate mechanical details for vessels in these two broad categories may be quite different. For vessels that are designed for a small number of operating cycles, the mechanical details specified in Section 4 to Section 10 may prove to be sufficient provided the local stress at critical locations is accurately accounted for in the fatigue design calculations.

For vessels designed for a larger number of operating cycles, experience has shown that the mechanical details similar to those included in Section 4 to Section 10 of this specification may not be sufficient to ensure reliable, predictable operation. This is due to the following difficulties:

a) accurately predicting the local stress at a discontinuity;

b) assuring a defect free vessel for some detail types during initial fabrication;

c) inspecting certain detail types for fatigue cracks after the vessel has experienced a number of operating cycles.

The mechanical design requirements in Annex G have been selected assuming that a vessel is designed for a cyclic operating condition that is more likely to result in unreliable, unpredictable fatigue life if the Annex G requirements are not followed.

The mechanical design of vessels intended for less severe cyclic service applications is outside the scope of this annex. However, the mechanical design of the vessels shall be evaluated for cyclic service in accordance with the code of construction and either found to be exempt or analyzed in order to demonstrate compliance to the code. Vessels intended to be stamped as compliant with ASME *BPVC*, Section VIII, Division 1 can either be demonstrated to be exempt from fatigue analysis basis and the ASME cyclic loading screening criteria or to pass a fatigue analysis in accordance with ASME *BPVC,* Section VIII, Division 2, Part 5.

G.1

If the selected design code is ASME *BPVC*, Section VIII, Division 1, the screening and evaluation method for fatigue analysis shall be in accordance with ASME *BPVC*, Section VIII, Division 2.

G.2

If other than ASME *BPVC*, Section VIII, Division 1, the selected design code does not include a screening and evaluation method for fatigue analysis, ASME *BPVC*, Section VIII, Division 2, EN 13445, PD 5500 or API Standard 579-1/ASME FFS-1 shall be used.

G.3

Fatigue analysis shall include attachments welded to the pressure envelope and the following locations:

a) head-to-shell;

b) support-to-vessel;

c) nozzle-to-vessel wall, considering external piping loads.

G.4

Integrally reinforced nozzles shall be used.

G.5

Internal and external attachments welds shall be full penetration type excluding welds attaching saddle wear pads to a vessel wall.

G.6

The cap of all butt welds shall be ground smooth with the parent material.

G.7

Fillet welds caps on a full penetration weld shall be ground to form a smooth transition with the parent metal.

G.8

Butt welds shall be subjected to 100 % volumetric examination and surface examination by MT or PT.

G.9

Nozzle-to-vessel wall welds shall be subjected to 100 % volumetric examination and surface examination by MT or PT.

G.10

Welds between attachments and the pressure envelope shall be subjected to 100 % surface examination by WFMT or PT.

G.11

Conical transitions shall be made with a knuckle at both ends.

G.12

Lifting attachments on a pressure part shall be designed for removal prior to commissioning.

G.13

The weld toe to weld toe distance between a nozzle and an adjacent structural discontinuity shall be a minimum of 1,8 x $(D \times t_{min})^{0,5}$ or 50 mm (2 in), whichever is greater.

G.14

Permanent attachments or openings in the knuckle region of a formed head shall be prohibited.

G.15

If not specified in the code of construction, the requirements of ASME *BPVC,* Section VIII, Division 2 for "Peaking of Welds in Shells and Heads for Internal Pressure" shall be satisfied.

NOTE See ASME *BPVC*, Section VIII, Division 2, 6.1.6.3.

G.16

The back of the root pass, if applicable, shall be examined by MT or PT after preparation for welding.

Annex H
(normative)
Additional requirements for carbon steel vessels in caustic and lean amine service vessels

H.1

All welds in contact with the process fluid shall be inspected with the WFMT method after PWHT (if performed).

H.2

If crack-like indications are identified via the WFMT inspection (regardless of the code of construction acceptance criteria) and the indications are not removed, a dimensional map shall be provided with sizing and information allowing location of indication during the inspections.

Annex I
(normative)
Additional requirements for vessels in hydrogen charging service

I.1

Nozzle-to-vessel wall connections shall be set-in type.

I.2

Integrally reinforced nozzles shall be used.

I.3

Butt welds shall be subjected to 100 % volumetric examination.

I.4

Butt welds shall be subjected to MT or PT examination of all weld surfaces exposed to the process fluid, including a 25 mm (1 in) wide band on either side of the weld.

I.5

Nozzle-to-vessel wall welds shall be subjected to 100 % volumetric examination.

I.6

Nozzle-to-vessel wall welds shall be subjected to MT or PT examination of all weld surfaces exposed to the process fluid, including a 25 mm (1 in) wide band on either side of the weld.

I.7

Welds between attachments and the pressure envelope shall be subjected to 100 % surface examination by WFMT or PT method.

I.8

External attachments shall be welded to the pressure boundary with full penetration welds unless they are vented in accordance with 6.1.1.

I.9

Internal attachments shall be welded to the pressure boundary with full penetration welds.

I.10

Wetted surfaces of pressure boundary and attachment welds shall be hardness tested.

I.11

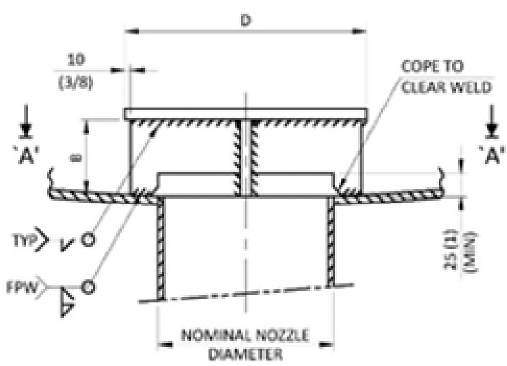
The hardness of attachment welds shall not exceed 200 BHN.

I.12

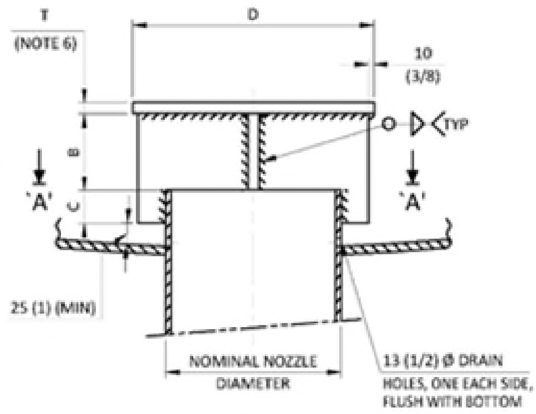
PWHT shall be performed for all vessels in hydrogen charging service.

Annex J
(normative)
Standard drawings

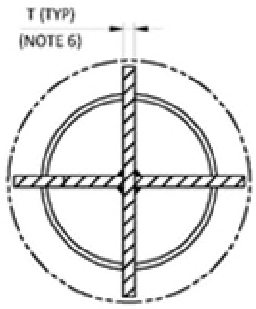
J.1 Vortex breaker – cross type



SET IN OR SET ON CONNECTION



SET THROUGH CONNECTION



SECTION A-A

NOMINAL DIAMETER	B	C	D
DN 40 (1 1/2)	50 (2)	25 (1)	80 (3)
DN 50 (2)			100 (4)
DN 80 (3)			125 (5)
DN 100 (4)			160 (6 1/2)
DN 150 (6)	75 (3)		225 (9)
DN 200 (8)	100 (4)		300 (12)
DN 250 (10)	125 (5)	40 (1 1/2)	375 (15)
DN 300 (12)	150 (6)		450 (18)
DN 350 (14)	175 (7)		525 (21)
DN 400 (16)	200 (8)		600 (24)
DN 450 (18)	225 (9)	50 (2)	700 (28)
DN 500 (20)	250 (10)		750 (30)
DN 600 (24)	300 (12)		900 (36)

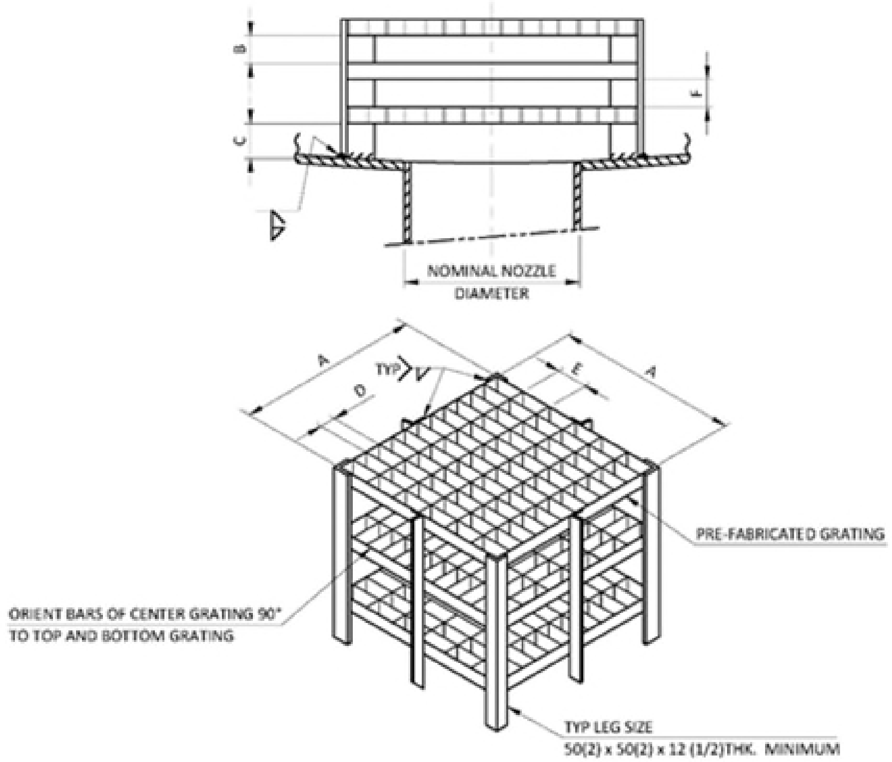
NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. IN CASE OF CLADDED VESSEL, USE MATERIAL SAME AS ALLOY CLADDING OR WELD OVERLAY MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD)
5. ROUND OFF ALL SHARP EDGES.
6. T (THICKNESS) = 5MM (3/16 INCH) EXCLUDING CORROSION ALLOWANCE.
7. WHERE WELD DIMENSIONS ARE NOT SHOWN, WELDS ARE INTENDED TO BE AS STRONG AS POSSIBLE FOR A GIVEN WELD JOINT. FOR EXAMPLE, AN UNDIMENSIONED GROOVE WELD SHALL HAVE A FULL THICKNESS GROOVE; AN UNDIMENSIONED FILLET WELD SHALL HAVE A LEG SIZE EQUAL TO THE THICKNESS OF THE THINNER OF THE TWO COMPONENTS BEING JOINED.

IOGP International Association of Oil & Gas Producers	VORTEX BREAKER–CROSS TYPE	S619 J.1
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.2 Vortex breaker – grid type

SOURCE: EXXON MOBIL



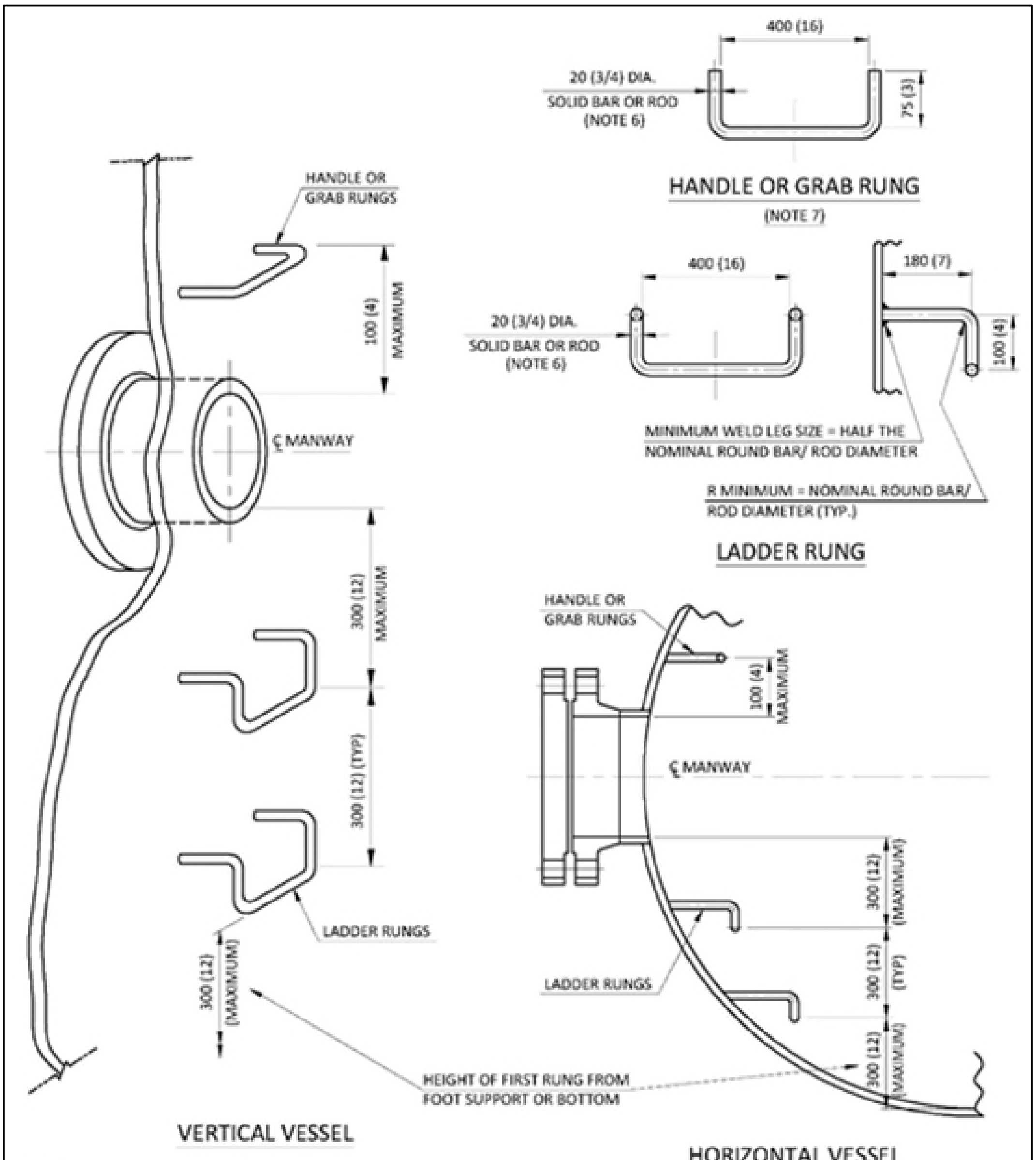
	FOR VERTICAL VESSELS	FOR HORIZONTAL VESSELS
GRATING COUNT	3	2
GRATING HEIGHT	25 (1)	25 (1)
GRATING THICKNESS	3 (1/8)	3 (1/8)
A	3D OR 0.5 x VESSEL I.D., WHICHEVER IS SMALLER	3D OR 0.5 x VESSEL I.D., WHICHEVER IS SMALLER
B	50 (2)	50 (2)
C	50 (2) FROM VESSEL SURFACE FOR NOZZLE WITH INTERNAL PROJECTION, THE LOWER GRATING SHALL BE STAND OFF 50 (2) FROM THE END OF THE NOZZLE	50 (2) FROM VESSEL SURFACE FOR NOZZLE WITH INTERNAL PROJECTION, THE LOWER GRATING SHALL BE STAND OFF 50 (2) FROM THE END OF THE NOZZLE
D	25 (1)	25 (1)
E	100 (4)	100 (4)
F	50 (2)	25 (1)

NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. IN CASE OF CLADDED VESSEL, USE MATERIAL SAME AS ALLOY CLADDING OR WELD OVERLAY MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD)
5. ROUND OFF ALL SHARP EDGES.
6. WHERE WELD DIMENSIONS ARE NOT SHOWN, WELDS ARE INTENDED TO BE AS STRONG AS POSSIBLE FOR A GIVEN WELD JOINT. FOR EXAMPLE, AN UNDIMENSIONED GROOVE WELD SHALL HAVE A FULL THICKNESS GROOVE; AN UNDIMENSIONED FILLET WELD SHALL HAVE A LEG SIZE EQUAL TO THE THICKNESS OF THE THINNER OF THE TWO COMPONENTS BEING JOINED.

International Association of Oil & Gas Producers	VORTEX BREAKER–GRID TYPE	S619 J.2
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.3 Internal ladder rungs

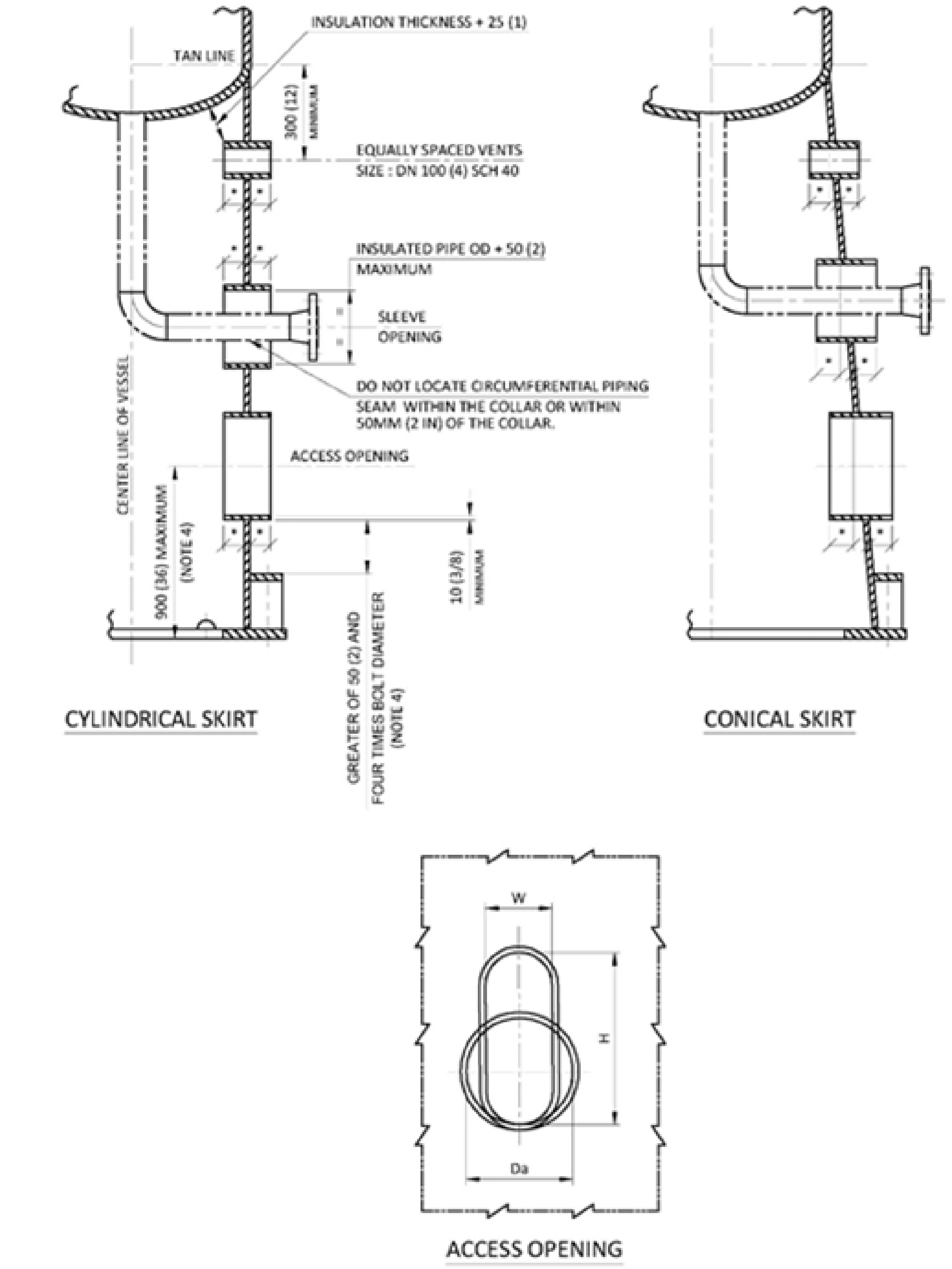


NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. ROUND OFF ALL SHARP EDGES.
5. NO RUNGS ARE REQUIRED WHEN FOOT SUPPORT IS LESS THAN 1 METER (3 FEET) FROM MANWAY CENTER LINE.
6. ADD TWO TIMES THE DESIGN CORROSION ALLOWANCE ON THE SPECIFIED DIAMETER OF ROUND BAR / ROD.
7. LADDER RUNG TYPE (FOUR BENDS) DETAIL CAN BE USED ALTERNATIVELY FOR HANDLE (OR GRAB RUNG) ABOVE MANWAY. IN THIS CASE MAINTAIN GRIP AREA AT THE SAME LOCATION AND SHIFT THE WELD TO SHELL ACCORDINGLY.

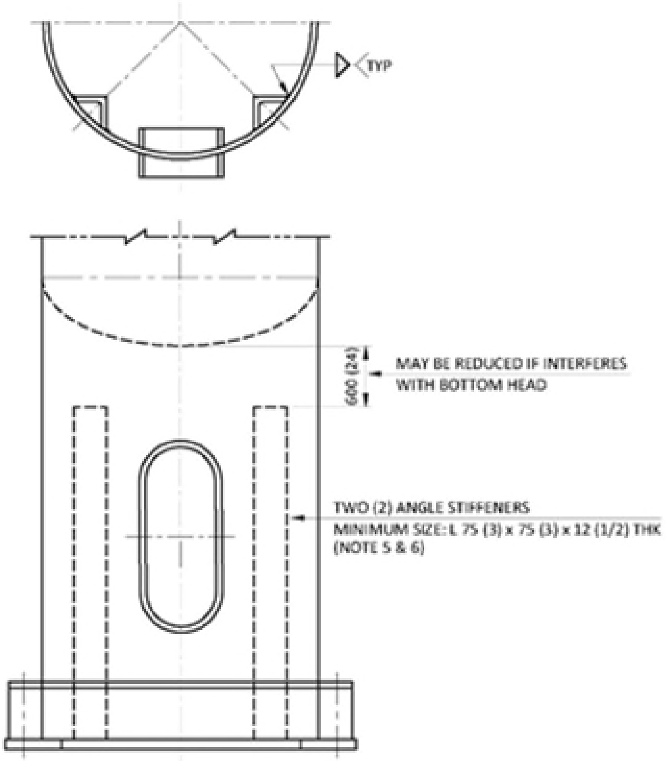
International Association of Oil & Gas Producers	INTERNAL LADDER RUNGS	S619 J.3
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.4 Skirt openings



* = GREATER OF 50 (2) AND FIREPROOFING / INSULATION THICKNESS + 25 (1)

International Association of Oil & Gas Producers	SKIRT OPENINGS	S619 J.4
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 2



ANGLE STIFFENERS FOR OBROUND TYPE ACCESS OPENING

VESSEL INSIDE DIAMETER	ACCESS OPENING				VENT QUANTITY
	QUANTITY	TYPE	Da	W x H	
< 750 (30)	1	CIRCULAR	250 (10)	-	3
750 (30) < 1200 (48)	1	OBROUND	-	400 (16) x 900 (36)	
1200 (48) < 2400 (96)	1	CIRCULAR / OBROUND	600 (24)	450 (18) x 1200 (48)	
2400 (96) < 4000 (156)	2	CIRCULAR / OBROUND	600 (24)	450 (18) x 1200 (48)	4
4000 (156) < 6000 (240)					6
> 6000 (240)					8

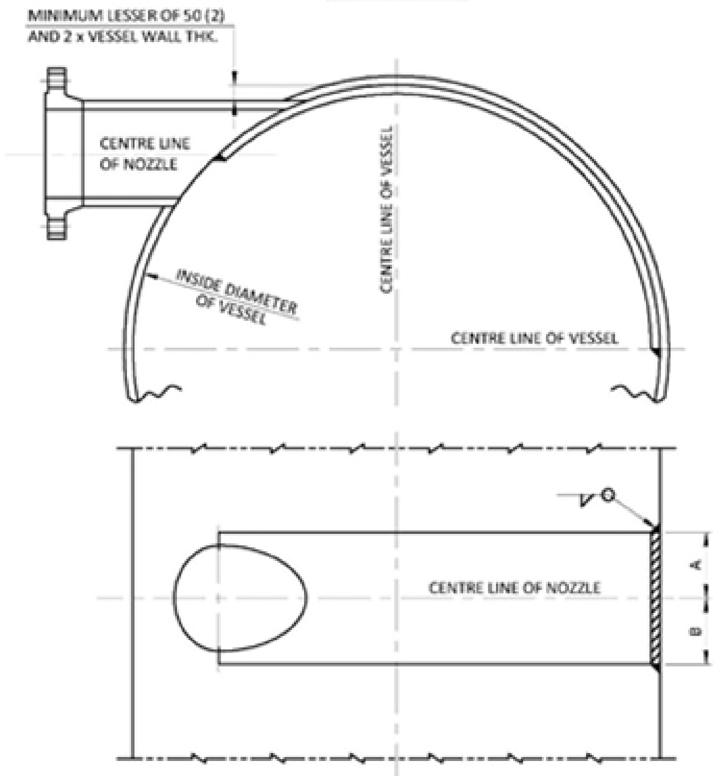
NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. ROUND OFF ALL SHARP EDGES.
4. LOCATE ACCESS OPENING AS LOW AS POSSIBLE FROM BASE RING BOTTOM. PROVIDE SUFFICIENT DISTANCE BETWEEN ACCESS OPENING BOTTOM AND TOP OF COMPRESSION RING OR CHAIR PLATE IN ORDER TO TIGHTEN OR REMOVE THE NUT ON TOP OF AN ANCHOR BOLT
5. MANWAY REINFORCEMENT SHOWN IN THE DRAWING IS A MINIMUM REQUIREMENT. A CHECK OF ADEQUATE AREA REINFORCEMENT IN THE HORIZONTAL PLANE SHALL BE COMPLETED, AND ADDITIONAL REINFORCEMENT SHALL BE ADDED IF NECESSARY. VERTICAL ANGLE IRON CONTRIBUTES TO REINFORCEMENT.
6. ADEQUATE OPENING REINFORCEMENT USING THE AREA REPLACEMENT METHOD MUST BE PROVIDED IN THE SKIRT HORIZONTAL PLANE. CIRCULAR OPENING SLEEVE REINFORCEMENT LENGTH SHALL NOT EXCEED THE DIAMETER OF THE OPENING. ADDITIONAL REINFORCEMENT VIA OTHER MEANS TO SUPPLEMENT THE SLEEVE (I. E. VERTICAL ANGEL IRON IN CLOSE PROXIMITY) IS ACCEPTABLE.

International Association of Oil & Gas Producers	SKIRT OPENINGS	S619 J.4
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 2 OF 2

J.5 Tangential nozzle anti-erosion plate

SOURCE : ENI



NOZZLE SIZE DN (NPS)	A	B
80 (3)	90 (3 1/2)	160 (6)
100 (4)	115 (4 1/2)	200 (8)
150 (6)	170 (7)	300 (12)
200 (8)	220 (9)	385 (15)
250 (10)	275 (11)	480 (20)
300 (12)	325 (13)	570 (24)
350 (14)	355 (14)	620 (24)

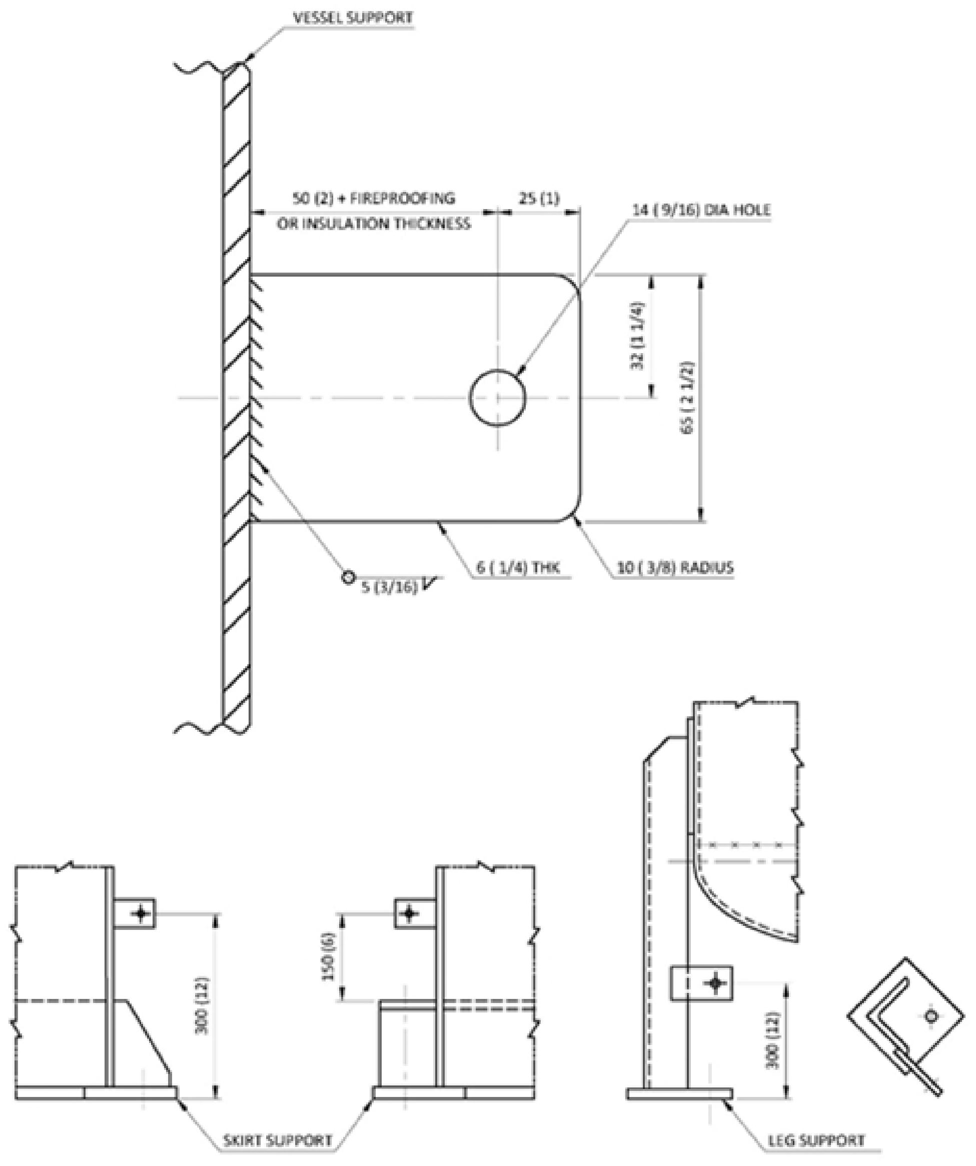
NOZZLE SIZE DN (NPS)	A	B
400 (16)	405 (16)	710 (28)
450 (18)	460 (18)	810 (32)
500 (20)	510 (20)	890 (35)
550 (22)	560 (22)	990 (39)
600 (24)	610 (24)	1090 (43)
650 (26)	660 (26)	1170 (46)
750 (30)	760 (30)	1345 (53)

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. ROUND OFF ALL SHARP EDGES.
5. WHERE A FILLET WELD IS SHOWN WITHOUT A DIMENSION, THE INTENT IS THAT IT BE A "FULL" FILLET. THIS MEANS THAT THE LEG SIZE SHALL BE THE THICKNESS OF THE THINNER OF THE PLATES BEING JOINED
6. SPECIFY REQUIREMENT OF WEAR PLATE AND THICKNESS OF WEAR PLATE ON THE DATASHEET SKETCH OR NOZZLE OPENING NOTE.
7. AN ALTERNATE DESIGN UTILIZING WELD OVERLAY OR BUILDUP MAY BE SUBSTITUTED FOR THE PLATE DESIGN WHICH IS SHOWN.

International Association of Oil & Gas Producers	TANGENTIAL NOZZLE WITH ANTI-EROSION PLATE	S619 J.5
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.6 Earthing (grounding) lug

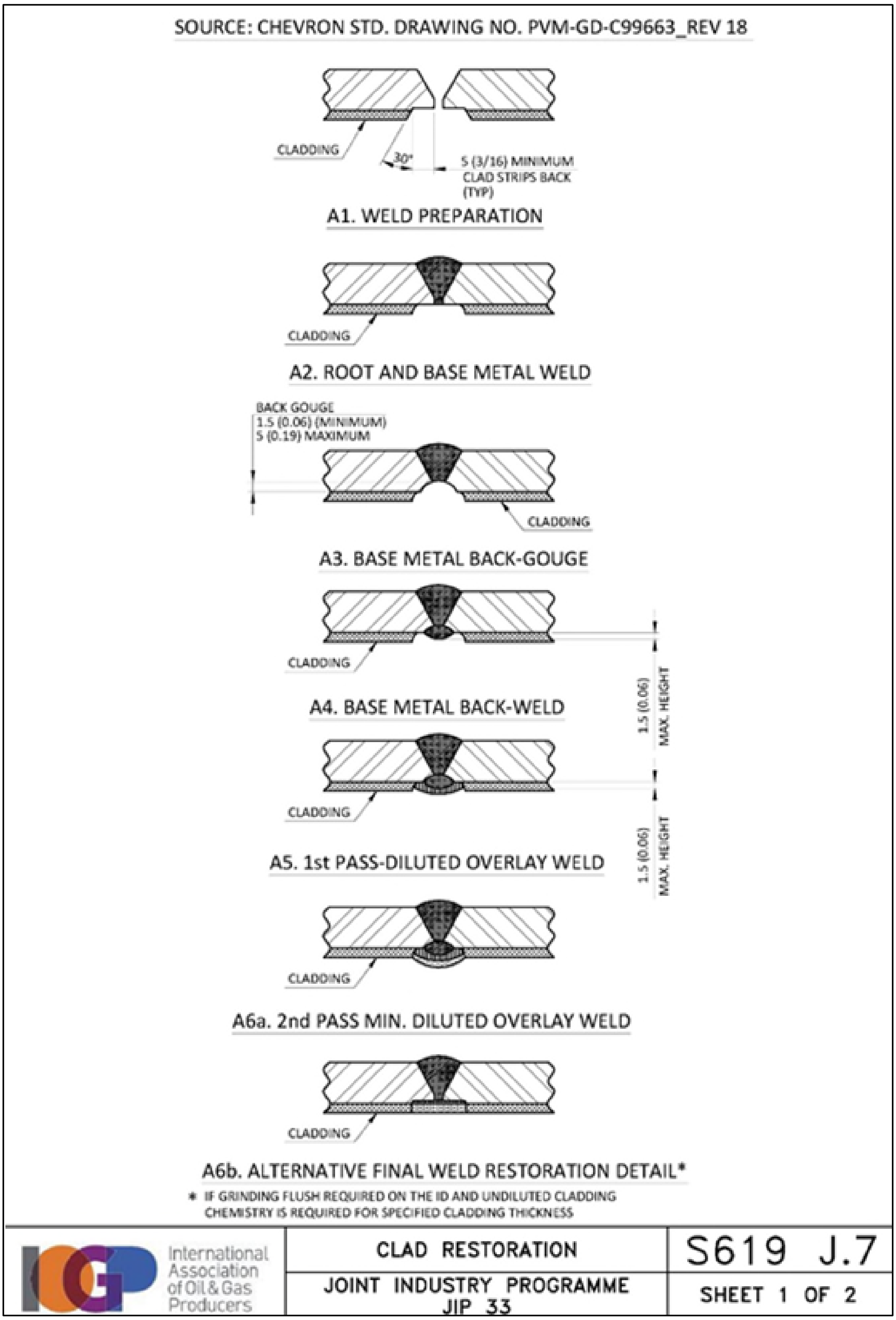


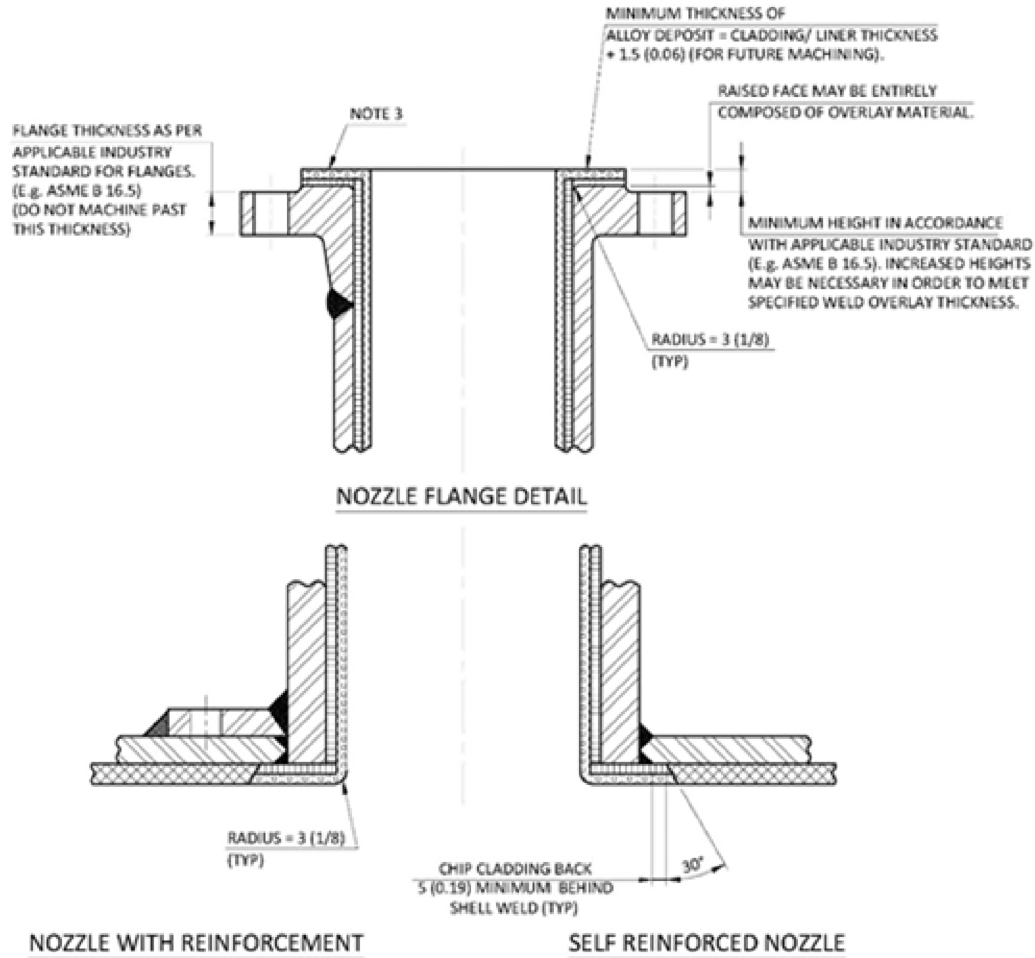
NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. LUG MATERIAL AUSTENITIC STAINLESS STEEL.
3. NO PAINTING ON EARTHING (GROUNDING) LUG.
4. FOR EARTHING LUG LOCATIONS ON SADDLE AND LUG TYPE SUPPORT, REFER STANDARD DRAWING NO. S619 J.10 AND S619 J.11 RESPECTIVELY.
5. DO NOT WELD EARTHING (GROUNDING) LUGS TO PRESSURE PARTS.
6. LOCATE EARTHING (GROUNDING) LUGS ON SKIRT IN BETWEEN ANCHOR BOLTS.

International Association of Oil & Gas Producers	EARTHING (GROUNDING) LUG	S619 J.6
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.7 Clad restoration





NOZZLE CONNECTION TO SHELL DETAILS

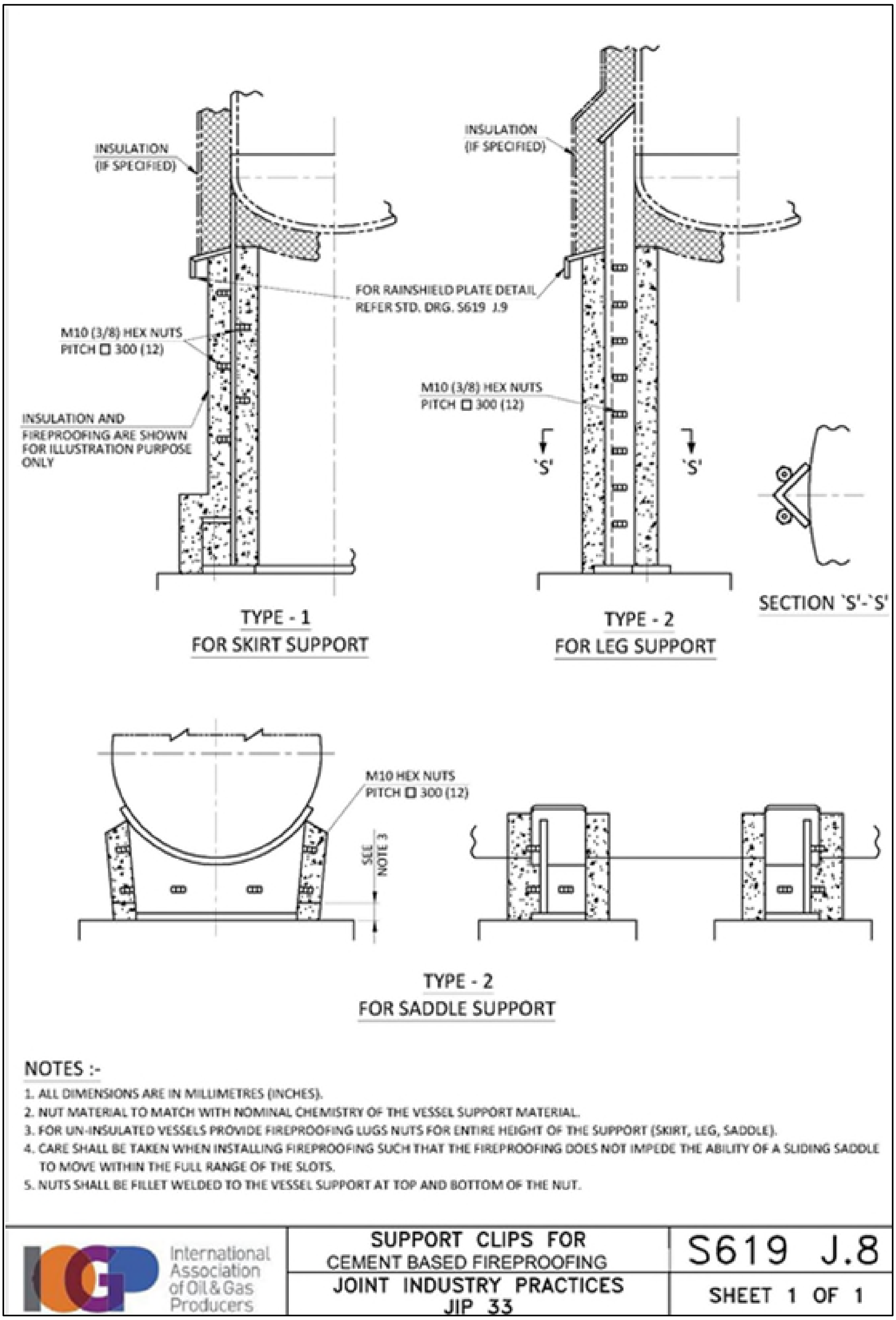
LEGEND
BASE METAL
ALLOY CLAD
BASE METAL WELD
INTER MEDIATE ALLOY WELD
ALLOY WELD

NOTES :-

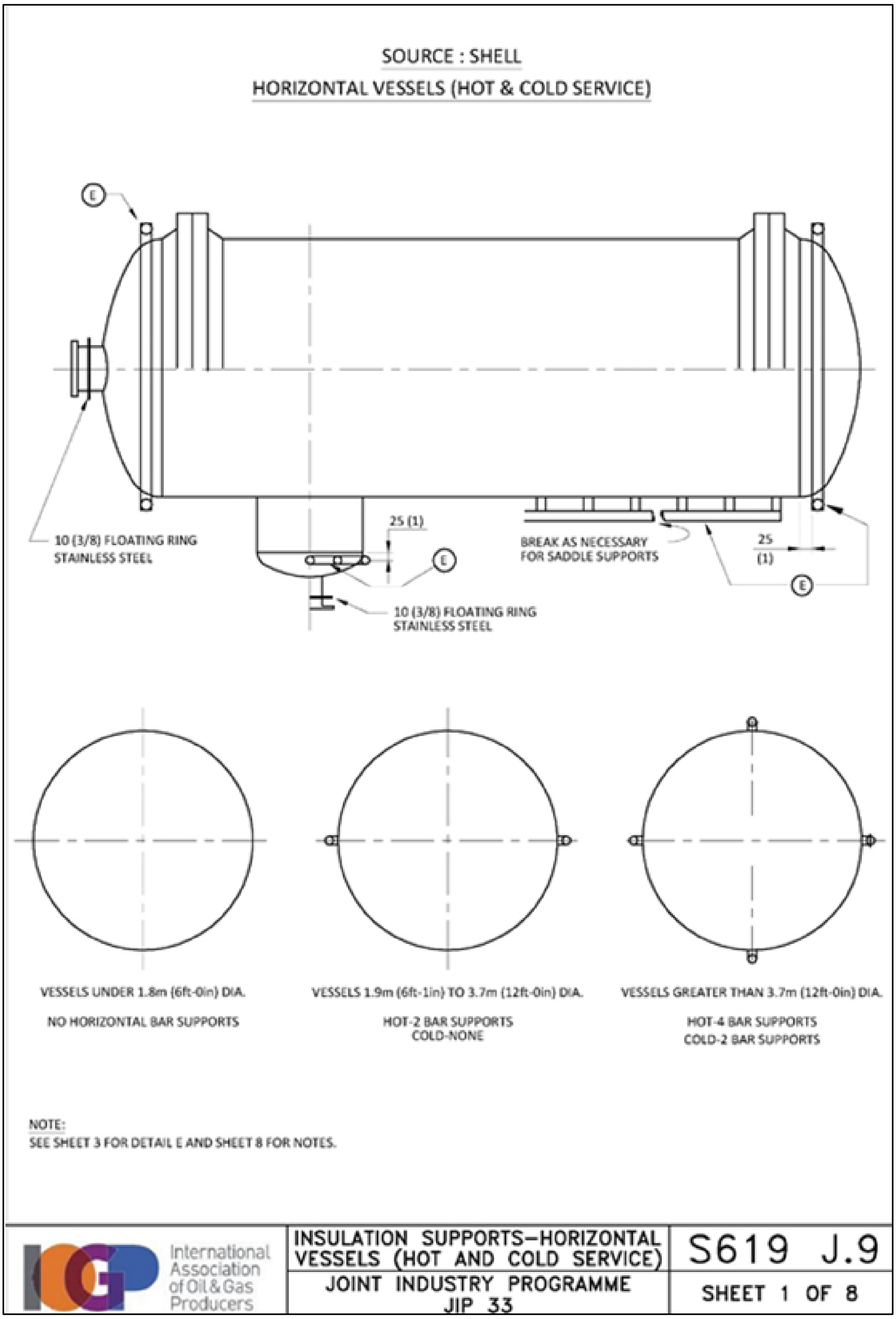
1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. DEBURR ALL SHARP EDGES AFTER FINAL MACHINING.
3. AFTER OVERLAY IS COMPLETE FLANGE GASKET SURFACE FACING SHALL BE RESTORED TO SURFACE FINISH REQUIREMENTS IN ACCORDANCE WITH THE APPLICABLE FLANGE STANDARD (e.g. ASME B16.5).

IOGP International Association of Oil & Gas Producers	CLAD RESTORATION	S619 J.7
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 2 OF 2

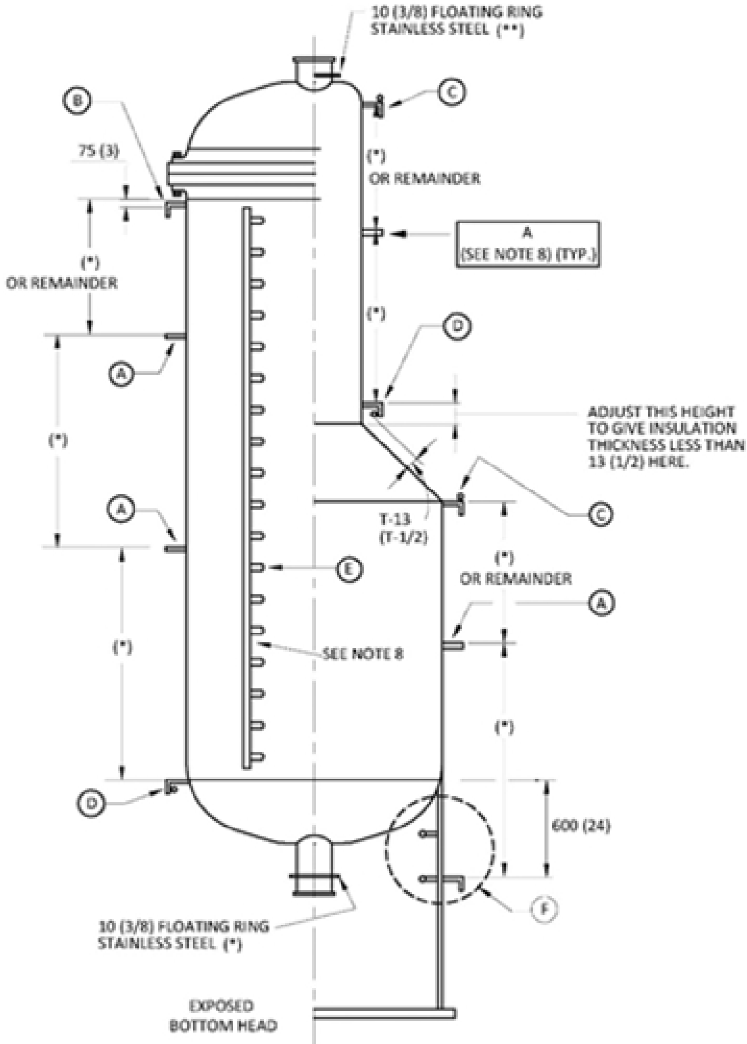
J.8 Support clips for fireproofing



J.9 Insulation supports (hot and cold)



VERTICAL VESSELS (HOT SERVICE)

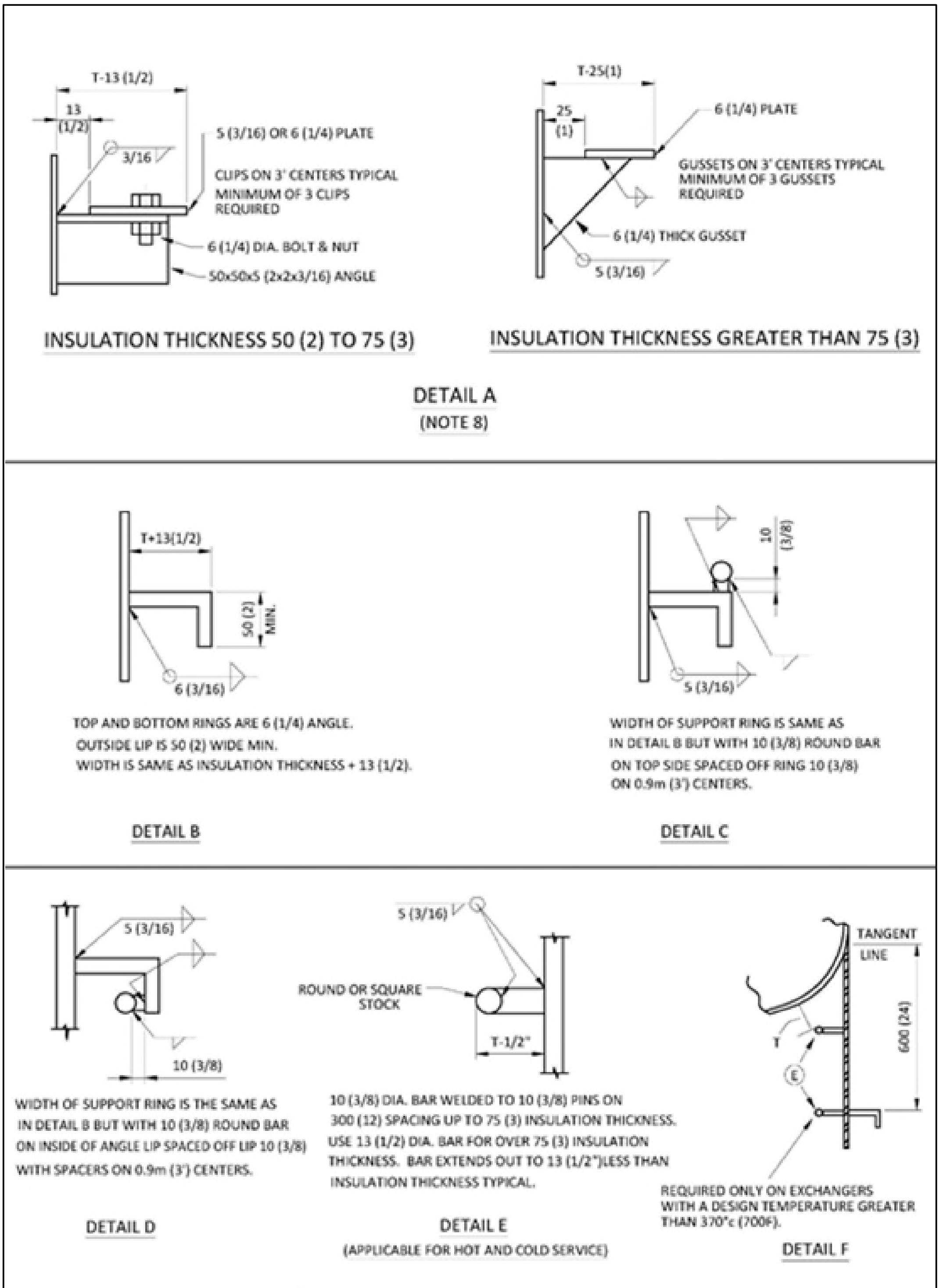


(*) MAXIMUM DISTANCE BETWEEN SUPPORT RINGS IS 3660 MM (12 ft).

(**) LOCATE FLOATING RINGS ON THE CENTER NOZZLE ON EACH HEAD

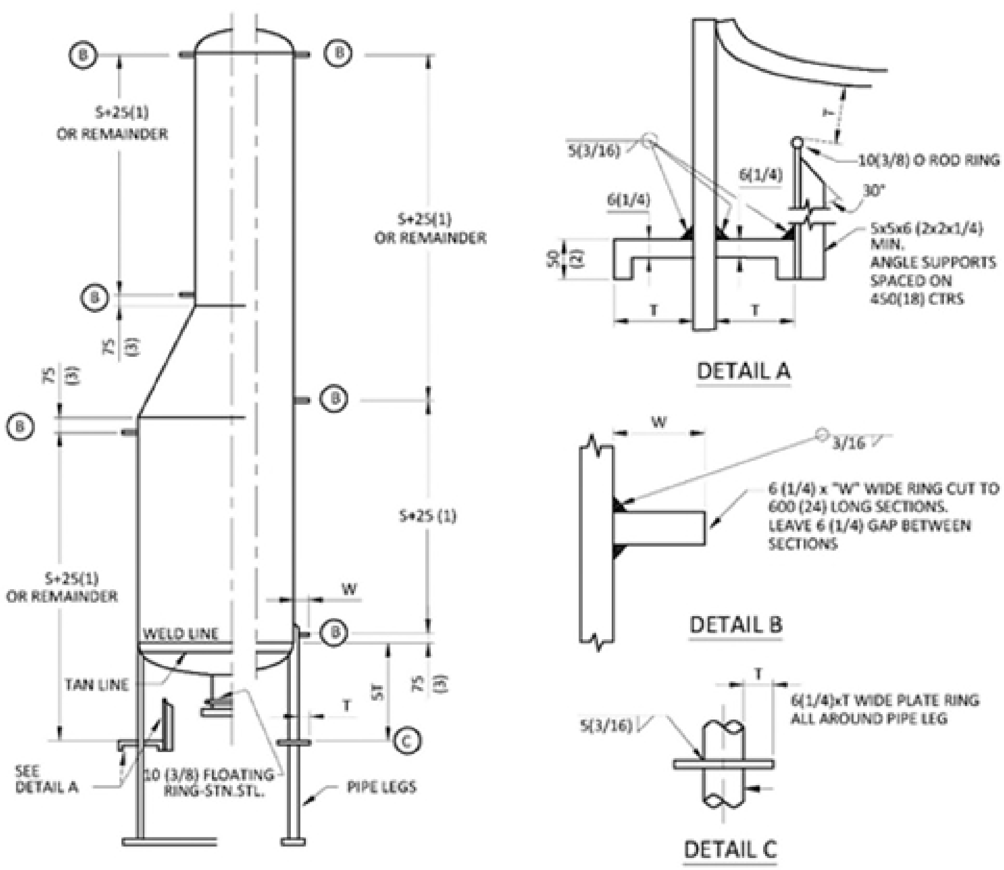
NOTE:
SEE SHEETS 3 FOR DETAILS A, B, C, D, & E AND SHEET 8 FOR NOTES.

International Association of Oil & Gas Producers	INSULATION SUPPORTS–VERTICAL VESSELS (HOT SERVICE)	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 2 OF 8



International Association of Oil & Gas Producers	INSULATION SUPPORTS–VERTICAL VESSELS (HOT SERVICE)	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 3 OF 8

VERTICAL VESSELS (COLD SERVICE)

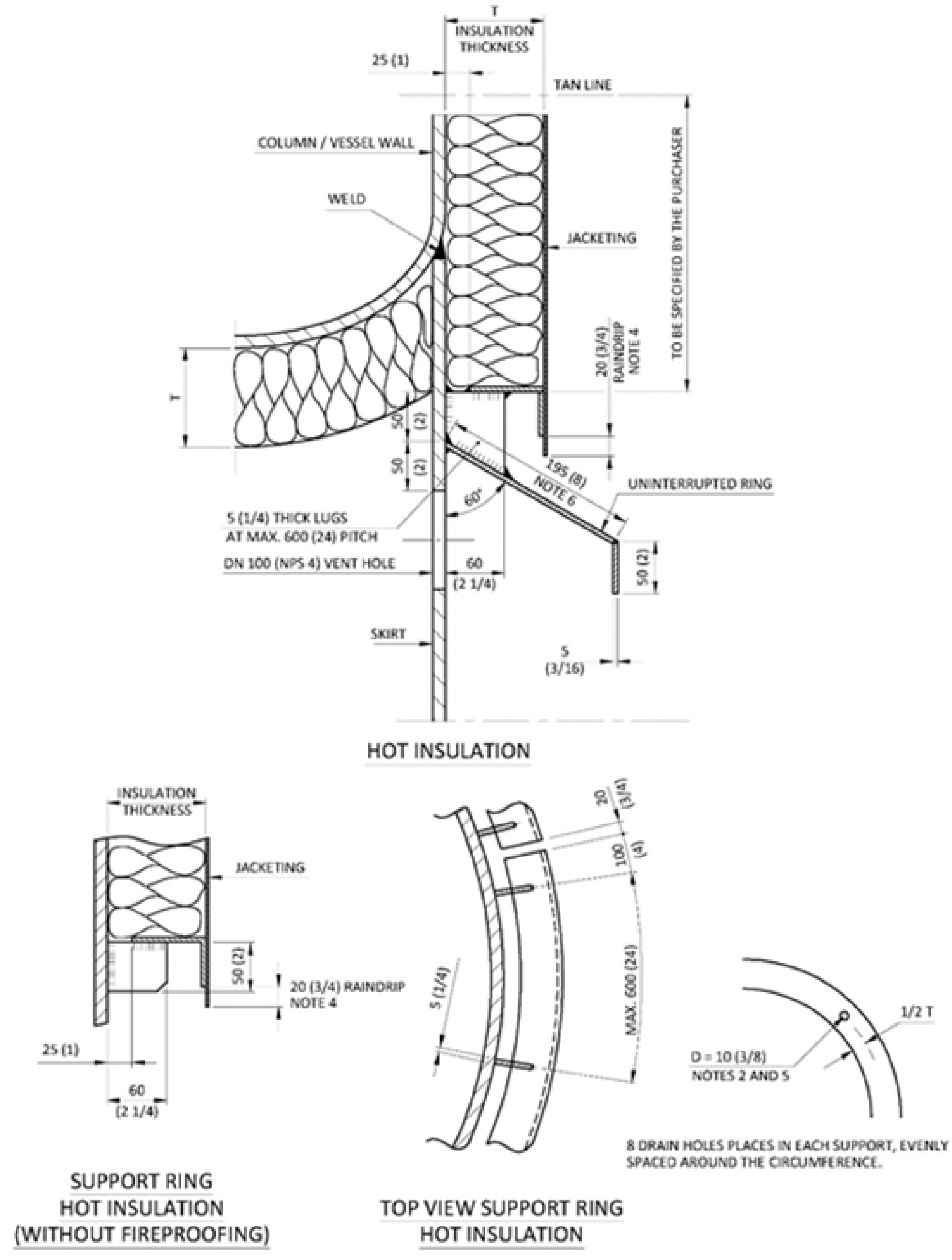


COLD INSULATION			
OPERATING TEMPERATURE °C (°F)	S SUPPORT SPACING (FT)		
	STEEL	ST. STEEL	AL
0 (32)	30.5 (100)	24.4 (80)	15.2 (50)
-18 (0)	15.2 (50)	9.1 (30)	6.1 (20)
-45 (-50)	6.1 (20)	6.1 (20)	4.6 (15)
-100 (-150)		4.6 (15)	3.0 (10)
<-100 (<-150)		3.7 (12)	2.44 (8)

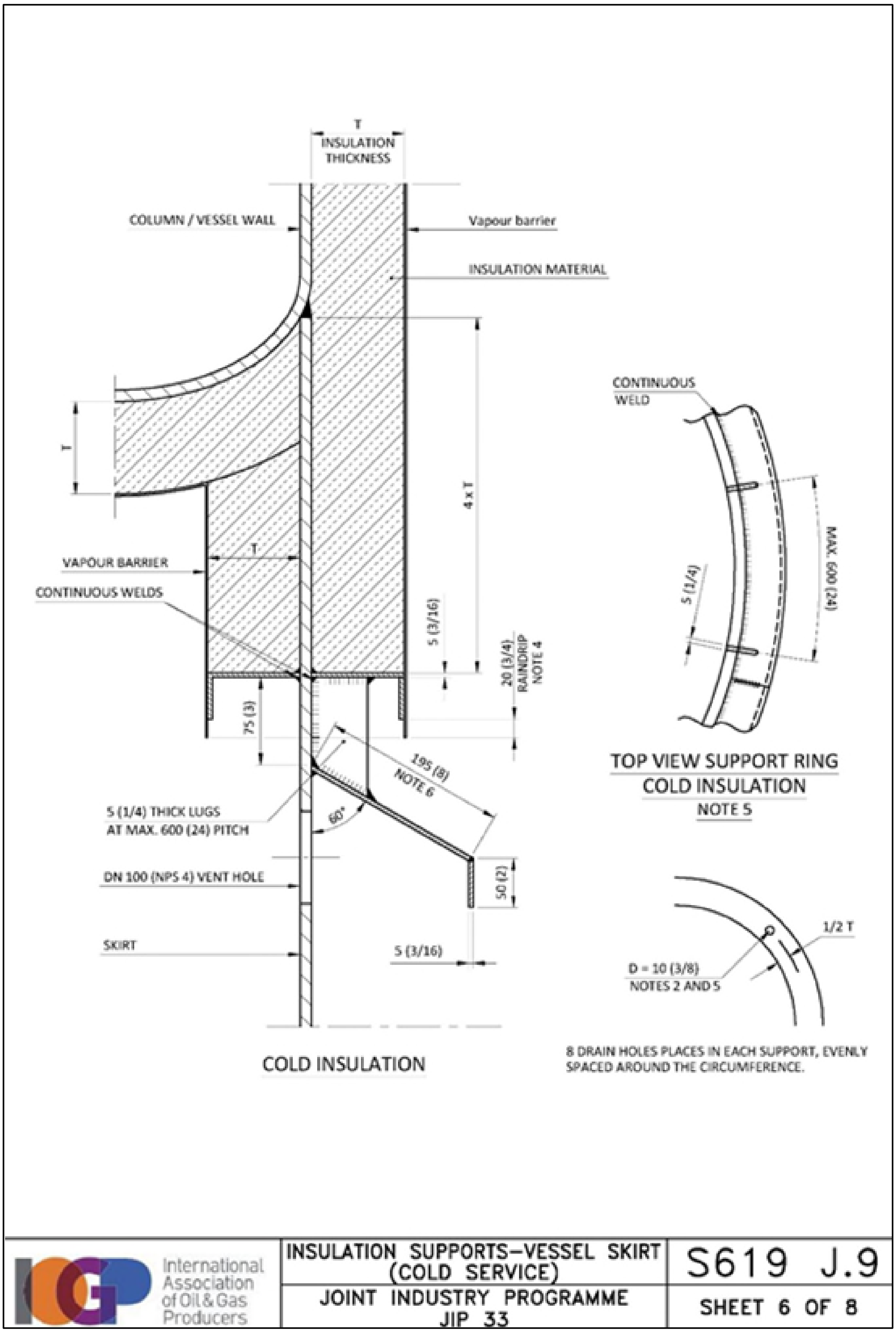
W=1/2 OF INSULATION THICKNESS FOR SINGLE LAYER INSULATION

W=THICKNESS OF 1st LAYER + 1/2 THICKNESS OF SECOND LAYER FOR DOUBLE LAYER INSULATION

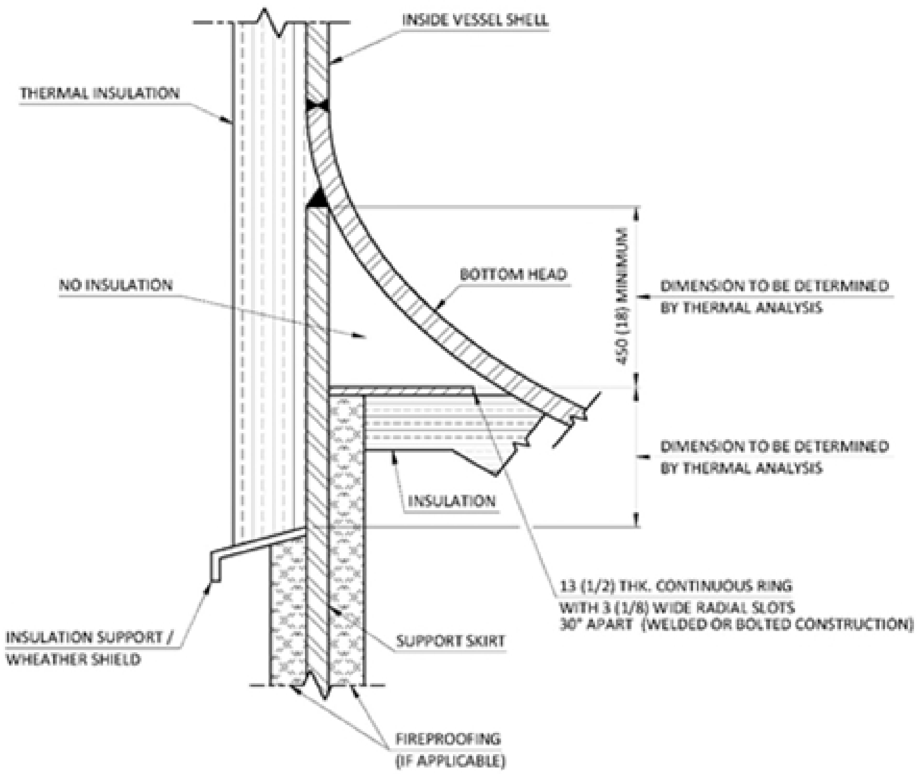
International Association of Oil & Gas Producers	INSULATION SUPPORTS–VERTICAL VESSELS (COLD SERVICE)	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 4 OF 8



IOGP International Association of Oil & Gas Producers	INSULATION SUPPORTS–VERTICAL VESSELS (HOT SERVICE)	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 5 OF 8


T
INSULATION THICKNESS
COLUMN / VESSEL WALL
Vapour barrier
INSULATION MATERIAL
T
4 x T
VAPOUR BARRIER
T
CONTINUOUS WELDS
5 (3/16)
20 (3/4) RAINDRIP NOTE 4
75 (3)
195 (8) NOTE 6
5 (1/4) THICK LUGS AT MAX. 600 (24) PITCH
60°
DN 100 (NPS 4) VENT HOLE
50 (2)
SKIRT
5 (3/16)
COLD INSULATION
CONTINUOUS WELD
5 (1/4)
MAX. 600 (24)
TOP VIEW SUPPORT RING COLD INSULATION NOTE 5
1/2 T
D = 10 (3/8) NOTES 2 AND 5
8 DRAIN HOLES PLACES IN EACH SUPPORT, EVENLY SPACED AROUND THE CIRCUMFERENCE.
International Association of Oil & Gas Producers
INSULATION SUPPORTS–VESSEL SKIRT (COLD SERVICE)
JOINT INDUSTRY PROGRAMME JIP 33
S619 J.9
SHEET 6 OF 8

SOURCE : ExxonMobil



HOT BOX ARRANEGEMENT FOR SKIRT SUPPPORTED VESSELS

International Association of Oil & Gas Producers	INSULATION SUPPORTS–HOT BOX ARRANGEMENT	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 7 OF 8

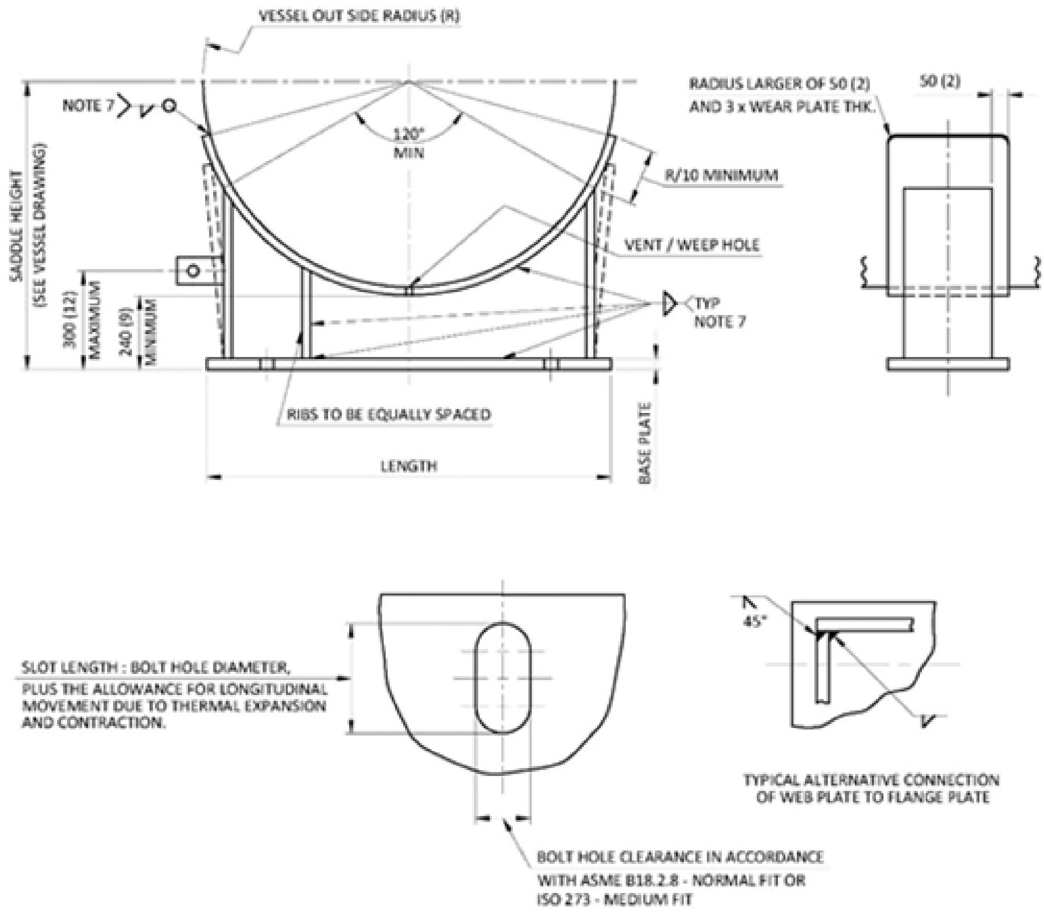
NOTES:

1. ALL DIMENSIONS ARE IN mm (inches) UNLESS STATED OTHERWISE.
2. DRAIN HOLES NOT TO PENETRATE THE PRIMARY VAPOR BARRIER.
3. SUPPORT RING CAN EITHER BE WELDED OR ROLLED ANGLE IRON.
4. RAINDRIP TO BE PROVIDED BY THE INSULATION CONTRACTOR (e.g. BY EXTENSION OF JACKETING). USE OF A JACKET END CAP DETAIL FOR THE TERMINATION OF THE INSULATION OF A COLUMN INSTEAD OF THE INSULATION SUPPORT RING THAT IS SHOWN SHALL BE AGREED WITH PURCHASER.
5. FOR INSULATION SUPPORTS INSTALLED ON VESSELS OPERATING BETWEEN 0 °C (32 °F) AND 175 °C (350 °F), INSTALL A MOISTURE DRAIN.
6. THE WIDTH SHOWN OF THE RAIN CAP IS FOR BRICKWORK AS A FIRE PROTECTION MATERIAL.
7. WHEN USING VACUUM SUPPORT RINGS FOR INSULATION SUPPORTS, THE RING WIDTH IS SELECTED TO MATCH THE REQUIRED WIDTH OF INSULATION SUPPORTS.
8. TYPE A INTERMEDIATE SUPPORTS NOT REQUIRED FOR VESSELS LESS THAN 1.8m (12') TAN TO TAN.
9. WHERE EVER THERE IS A CHANGE IN INSULATION THICKNESS AND THE UPPER PORTION OF THE INSULATION IS THICKER THAN THE LOWER PORTION, A NEW SUPPORT MUST BE ADDED AT THE CHANGE IN THICKNESS AND TYPICAL SPACING CONTINUED.
10. MATERIAL OF SUPPORTS IS THE SAME AS MATERIAL OF THE VESSEL.
11. LOCATE SUPPORTS AWAY FROM NOZZLES AND MANWAYS

T = INSULATION THICKNESS.

International Association of Oil & Gas Producers	INSULATION SUPPORT (HOT AND COLD)	S619 J.9
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 8 OF 8

J.10 Saddles for horizontal vessels



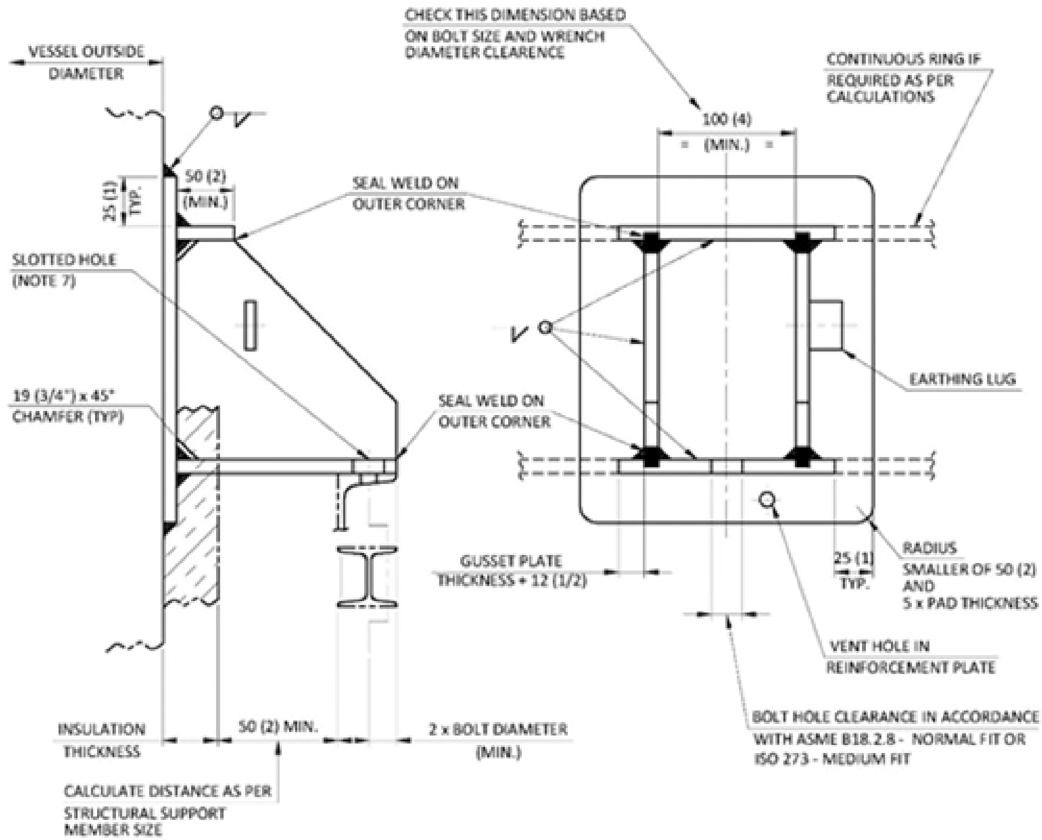
SLOTTED HOLE FOR SLIDING SADDLE

NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. ROUND OFF ALL SHARP EDGES.
5. WHERE WELD DIMENSIONS ARE NOT SHOWN, WELDS ARE INTENDED TO BE AS STRONG AS POSSIBLE FOR A GIVEN WELD JOINT. FOR EXAMPLE, AN UNDIMENSIONED GROOVE WELD SHALL HAVE A FULL THICKNESS GROOVE; AN UNDIMENSIONED FILLET WELD SHALL HAVE A LEG SIZE EQUAL TO THE THICKNESS OF THE THINNER OF THE TWO PLATES BEING JOINED.
6. ALL WELDS SHALL BE CONTINUOUS.
7. SADDLE WELD DETAILS AND CONNECTION TO THE VESSEL SHALL BE SUBJECT TO FATIGUE ASSESSMENT (S619 ANNEX G), WHERE APPLICABLE.

International Association of Oil & Gas Producers	SADDLES FOR HORIZONTAL VESSELS	S619 J.10
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.11 Support lugs and rings

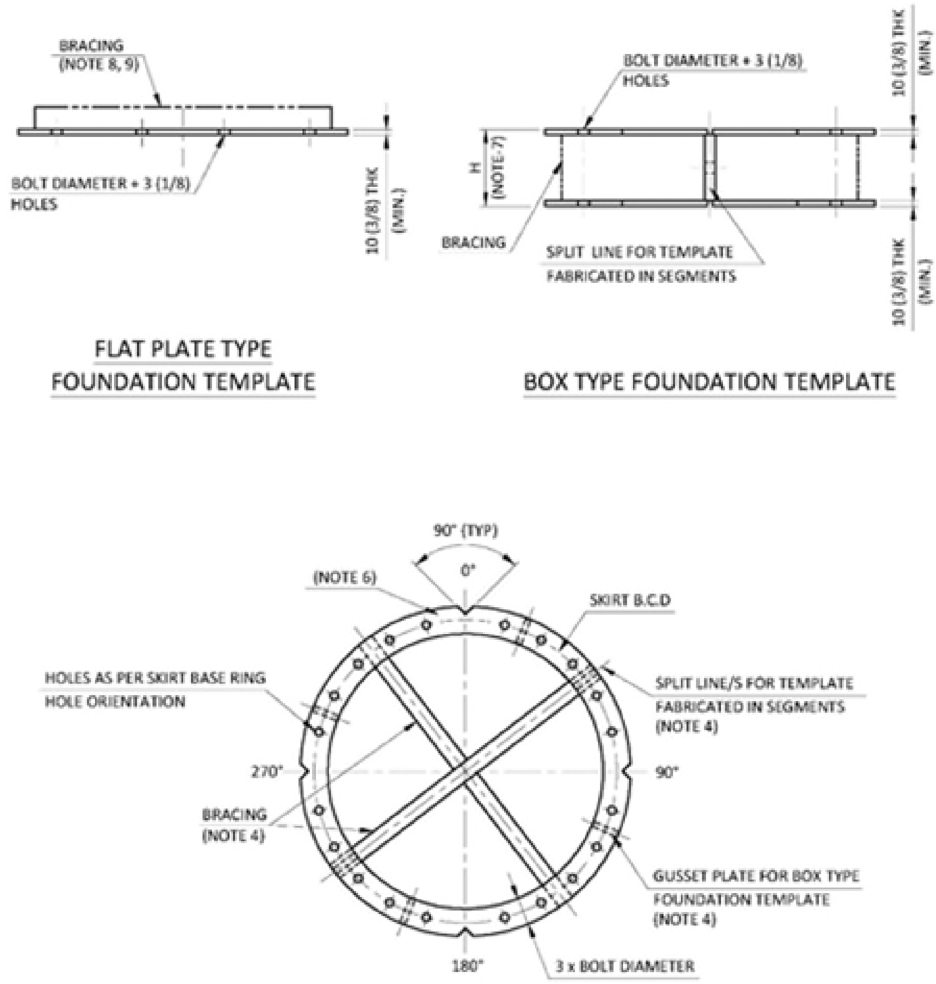


NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. IF MATERIAL IS NOT NOTED ON VESSEL DATA SHEET, USE MATERIAL SAME AS VESSEL MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD).
4. ROUND OFF ALL SHARP EDGES.
5. DIMENSION AND THICKNESS CRITERIA IS FOR THE PURPOSE OF STANDARDIZATION AND IS A STARTING POINT FOR DESIGN. FINAL THICKNESSES AND DIMENSIONS TO BE AS REQUIRED IN ACCORDANCE WITH CALCULATIONS.
6. USE MINIMUM THICKNESS 10 (3/8) FOR ALL LUG COMPONENTS.
7. SLOT LENGTH : BOLT HOLE DIAMETER, PLUS THE ALLOWANCE FOR RADIAL MOVEMENT DUE TO THERMAL EXPANSION AND CONTRACTION.

International Association of Oil & Gas Producers	SUPPORT LUGS AND RINGS	S619 J.11
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.12 Foundation template for skirt supported vessels

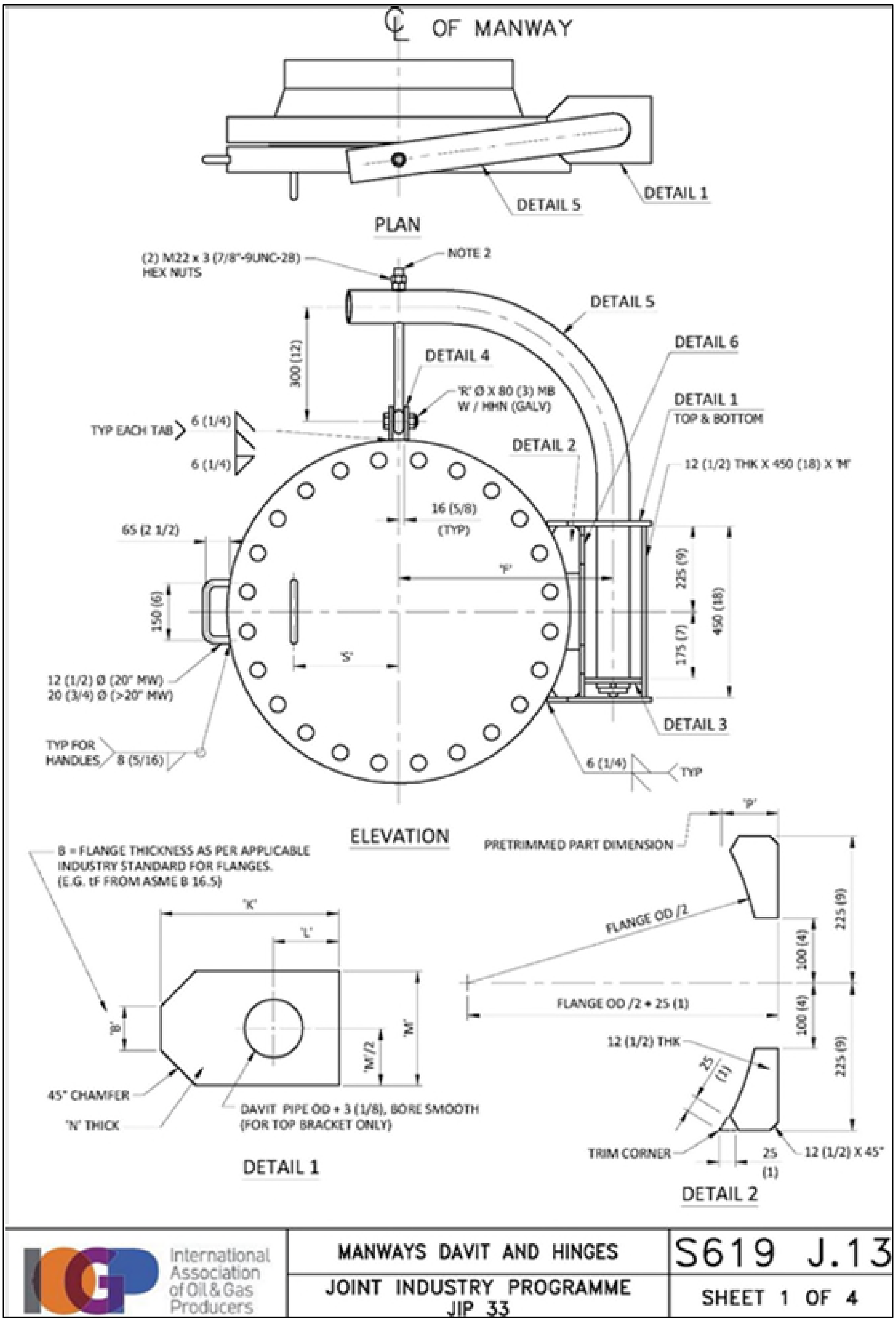


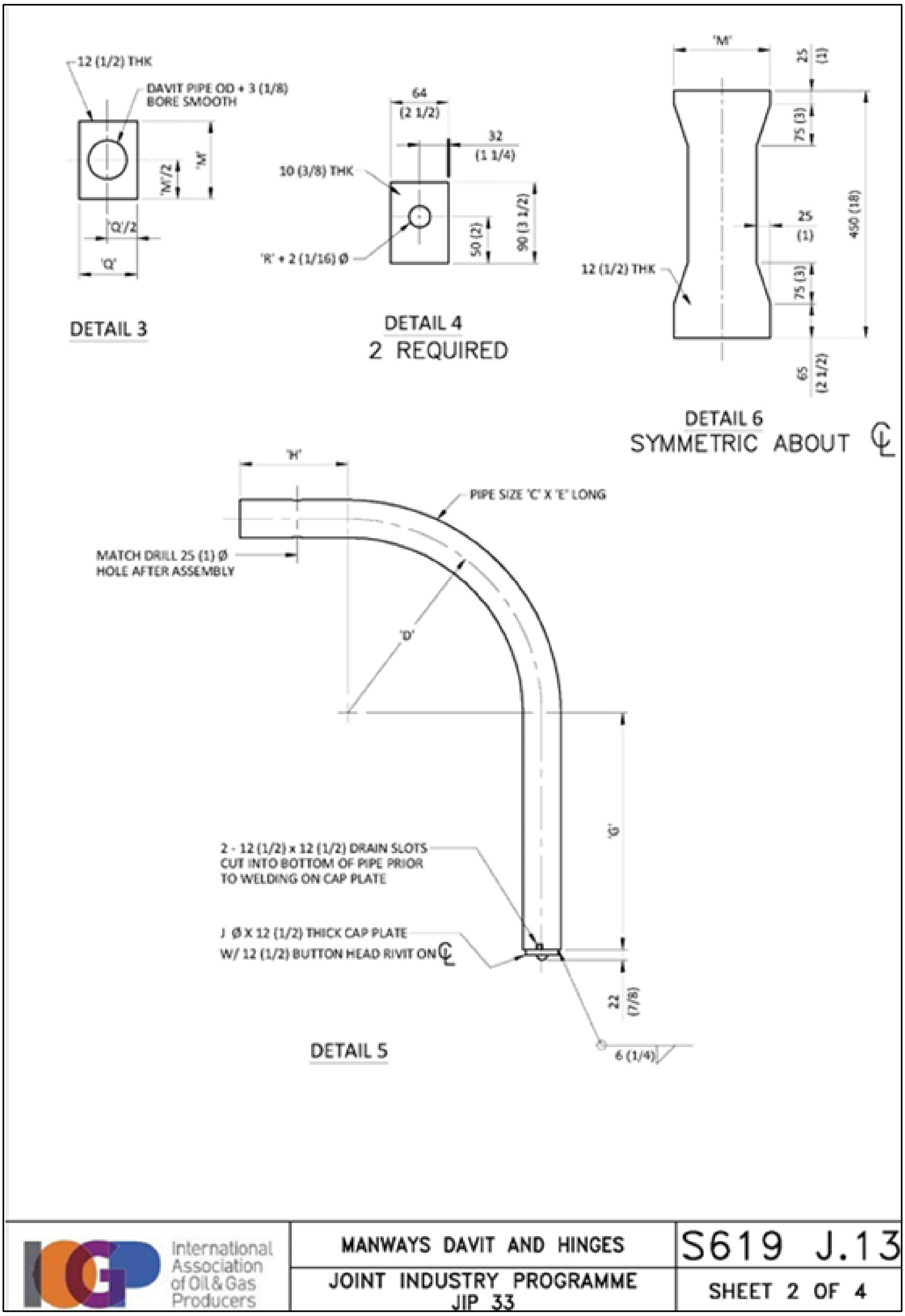
NOTES :-

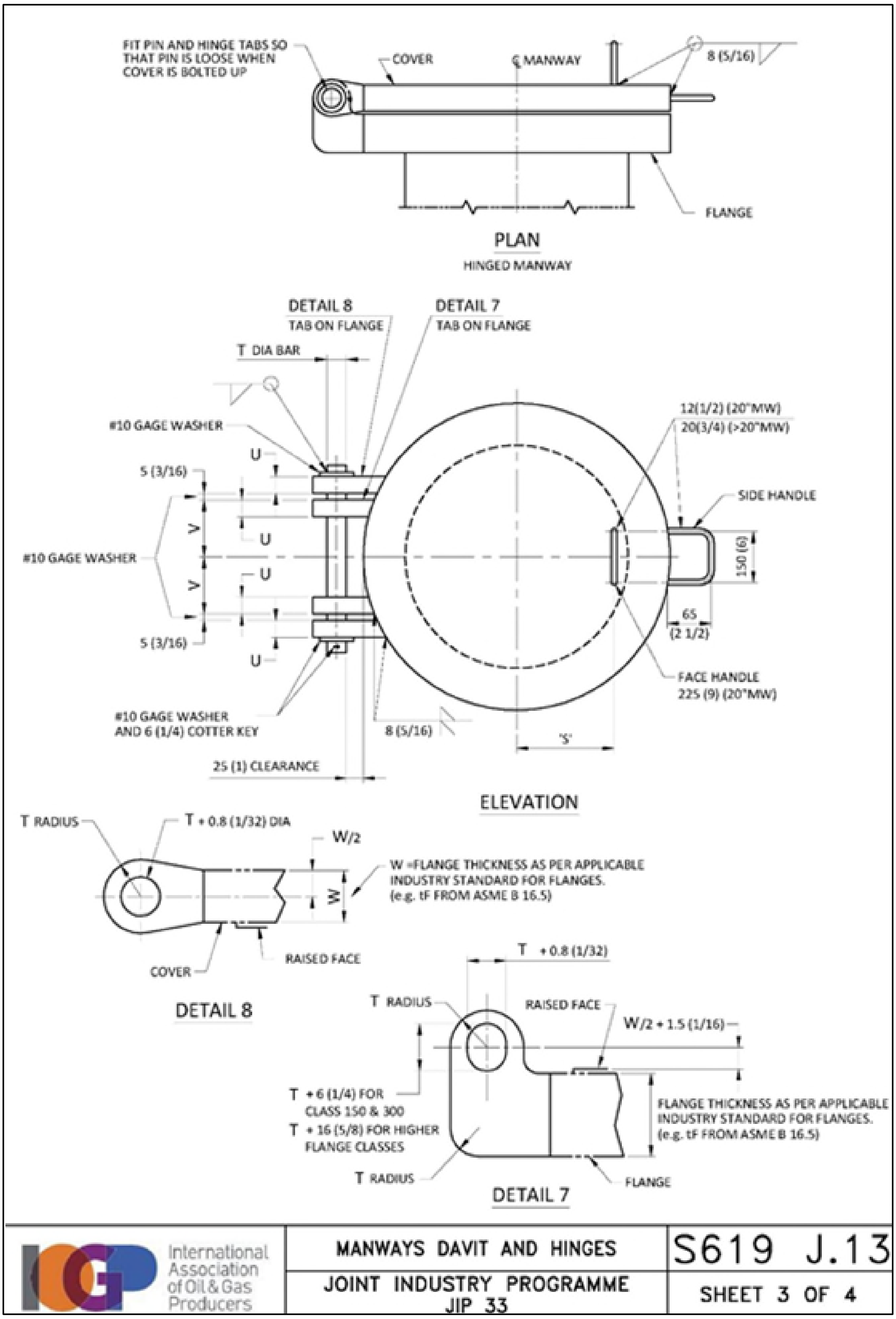
1. ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).
2. USE TEMPLATE FOR VERTICAL VESSEL WITH EIGHT (8) OR MORE ANCHOR BOLTS.
3. DRILL BOLT HOLES IN BASE PLATE AND FOUNDATION TEMPLATE PLATE TOGETHER.
4. DESIGN THE TEMPLATE COMPONENTS (SUCH AS ADDITIONAL BRACING SUPPORTS, NUMBER OF SEGMENTS, REQUIREMENT OF GUSSET PLATES) TO AVOID DEFORMATION DURING TRANSPORTATION AND HANDLING AT SITE. BRACING, SEGMENT SEPARATION AND GUSSET PLATES SHOWN IN DRAWING ARE INDICATIVE.
5. TRIAL FIT / ASSEMBLE ALL SEGMENT PRIOR TO DISPATCH.
6. MARK 0°, 90°, 180°,270°, "NORTH" (SAME AS VESSEL ORIENTATION), VESSEL TAG NUMBER AND WORD "TOP" ON TEMPLATE PLATE WITH WELD BEAD LETTERING NO LESS THAN 25 (1) HIGH.
7. DIMENSION 'H' IS EQUAL TO THE HEIGHT OF THE GUSSET PLATE PLUS THICKNESS OF SKIRT BASE PLATE PLUS THICKNESS OF COMPRESSION RING PLUS WASHER THICKNESS.
8. BRACING SHOULD BE ON THE TOP OF THE TEMPLATE.
9. BOTTOM OF TEMPLATE SHOULD BE FLUSH.

International Association of Oil & Gas Producers	FOUNDATION TEMPLATE FOR SKIRT SUPPORTED VESSELS	S619 J.12
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 1 OF 1

J.13 Manway davit




12 (1/2) THK
DAVIT PIPE OD + 3 (1/8)
BORE SMOOTH
'M'/2
'M'
'Q'/2
'Q'
DETAIL 3
64
(2 1/2)
32
(1 1/4)
10 (3/8) THK
'R' + 2 (1/16) Ø
50 (2)
90 (3 1/2)
DETAIL 4
2 REQUIRED
'M'
25
(1)
75 (3)
450 (18)
12 (1/2) THK
65
(2 1/2)
DETAIL 6
SYMMETRIC ABOUT ℄
'H'
PIPE SIZE 'C' X 'E' LONG
MATCH DRILL 25 (1) Ø
HOLE AFTER ASSEMBLY
'D'
'G'
2 - 12 (1/2) x 12 (1/2) DRAIN SLOTS
CUT INTO BOTTOM OF PIPE PRIOR
TO WELDING ON CAP PLATE
J Ø X 12 (1/2) THICK CAP PLATE
W/ 12 (1/2) BUTTON HEAD RIVIT ON ℄
22
(7/8)
6 (1/4)
DETAIL 5
International Association of Oil & Gas Producers
MANWAYS DAVIT AND HINGES
JOINT INDUSTRY PROGRAMME
JIP 33
S619 J.13
SHEET 2 OF 4


FIT PIN AND HINGE TABS SO THAT PIN IS LOOSE WHEN COVER IS BOLTED UP
COVER
℄ MANWAY
8 (5/16)
FLANGE
PLAN
HINGED MANWAY
DETAIL 8
TAB ON FLANGE
DETAIL 7
TAB ON FLANGE
T DIA BAR
#10 GAGE WASHER
U
5 (3/16)
V
#10 GAGE WASHER
#10 GAGE WASHER AND 6 (1/4) COTTER KEY
8 (5/16)
25 (1) CLEARANCE
12(1/2) (20"MW)
20(3/4) (>20"MW)
SIDE HANDLE
150 (6)
65 (2 1/2)
FACE HANDLE 225 (9) (20"MW)
'S'
ELEVATION
T RADIUS
T + 0.8 (1/32) DIA
W/2
W
W =FLANGE THICKNESS AS PER APPLICABLE INDUSTRY STANDARD FOR FLANGES. (e.g. tF FROM ASME B 16.5)
COVER
RAISED FACE
DETAIL 8
T + 0.8 (1/32)
T RADIUS
RAISED FACE
W/2 + 1.5 (1/16)
T + 6 (1/4) FOR CLASS 150 & 300
T + 16 (5/8) FOR HIGHER FLANGE CLASSES
FLANGE THICKNESS AS PER APPLICABLE INDUSTRY STANDARD FOR FLANGES. (e.g. tF FROM ASME B 16.5)
T RADIUS
FLANGE
DETAIL 7
International Association of Oil & Gas Producers
MANWAYS DAVIT AND HINGES
JOINT INDUSTRY PROGRAMME JIP 33
S619 J.13
SHEET 3 OF 4

MANWAY		DAVIT PIPE						
DIAMETER DN (NPS)	CLASS RATING	NOMINAL SIZE	BEND	LENGTH	OFFSET	VERT LEN	HORIZ LEN	CAP DIA
		C	D	E	F	G	H	J
500 (20)	150	DN 50 (NPS 2) SCH 160	380 (15)	1305.8 (51.41)	438.2 (17.25)	529.6 (20.85)	175 (7)	48 (1.875)
500 (20)	300	DN 50 (NPS 2) SCH 160	405 (16)	1383.8 (54.48)	476.3 (18.75)	542.3 (21.35)	200 (8)	48 (1.875)
500 (20)	600	DN 80 (NPS 3) SCH 80	405 (16)	1453.6 (57.23)	520.7 (20.5)	561.3 (22.10)	250 (10)	76 (3)
500 (20)	900	DN 80 (NPS 3) SCH 160	460 (18)	1479.6 (58.25)	543 (21.375)	532.9 (20.98)	225 (9)	76 (3)
600 (24)	150	DN 65 (NPS 2 1/2) SCH 160	405 (16)	1453.6 (57.23)	520.7 (20.5)	561.3 (22.10)	250 (10)	60 (2.375)
600 (24)	300	DN 80 (NPS 3) SCH 80	460 (18)	1533.4(60.37)	571.5 (22.5)	561.3 (22.10)	250 (10)	76 (3)
600 (24)	600	DN 100 (NPS 4) SCH 160	460 (18)	1596.9(62.87)	596.9 (23.5)	574 (22.60)	300 (12)	76 (3)
600 (24)	900	DN 100 (NPS 4) SCH 160	530 (21)	1666.0 (65.59)	647.7 (25.5)	548.6 (21.60)	275 (11)	76 (3)
750 (30)	150	DN 80 (NPS 3) SCH 80	460 (18)	1520.0 (59.84)	558 (21.97)	547.9 (21.57)	250 (10)	76 (3)
750 (30)	300	DN 100 (NPS 4) SCH 160	530 (21)	1615.2(63.59)	622.3 (24.5)	523.2 (20.60)	250 (10)	102 (4)
750 (30)	600	DN 100 (NPS 4) SCH 160	530 (21)	1656.3 (65.21)	638.2 (25.125)	539.2 (21.23)	275 (11)	102 (4)
900 (36)	150	DN 100 (NPS 4) SCH 80	530 (21)	1673.9(65.90)	655.6 (25.81)	556.5 (21.91)	275 (11)	102 (4)
900 (36)	300	DN 100 (NPS 4) SCH 160	610 (24)	1749.0(68.86)	712.7 (28.06)	537.5 (21.16)	250 (10)	102 (4)

DETAIL D1			DETAIL D2	DETAIL D3	ELEVATION	
					BOLT DIA	HANDHOLD
K	L	M	P	Q	R	S
250.2 (9.85)	75 (3)	125 (5)	110.5 (4.35)	100 (4)	22 (0.875)	225 (9)
239.8 (9.44)	75 (3)	125 (5)	100.1 (3.94)	100 (4)	22 (0.875)	225 (9)
286.3 (11.27)	100 (4)	150 (6)	95.8 (3.77)	150 (6)	22 (0.875)	225 (9)
282 (11.10)	100 (4)	175 (7)	91.4 (3.60)	150 (6)	22 (0.875)	225 (9)
286.3 (11.27)	100 (4)	150 (6)	95.8 (3.77)	150 (6)	22 (0.875)	275 (11)
277.1 (10.91)	100 (4)	175 (7)	86.6 (3.41)	150 (6)	22 (0.875)	275 (11)
300.8 (11.84)	115 (4.5)	200 (8)	84.8 (3.34)	175 (7)	22 (0.875)	275 (11)
294.1 (11.58)	115 (4.5)	200 (8)	78.2 (3.08)	175 (7)	25 (1)	275 (11)
279.4 (11.00)	100 (4)	162.5 (6.5)	88.9 (3.50)	150 (6)	22 (0.875)	350 (14)
297.2 (11.70)	115 (4.5)	200 (8)	81.3 (3.20)	175 (7)	22 (0.875)	350 (14)
295.1 (11.62)	115 (4.5)	200 (8)	79.2 (3.12)	175 (7)	25 (1)	350 (14)
293.4 (11.55	115 (4.5)	200 (8)	77.5 (3.05)	175 (7)	22 (0.875)	425 (17)
287.8 (11.33)	115 (4.5)	200 (8)	71.9 (2.83)	175 (7)	25 (1)	425 (17)

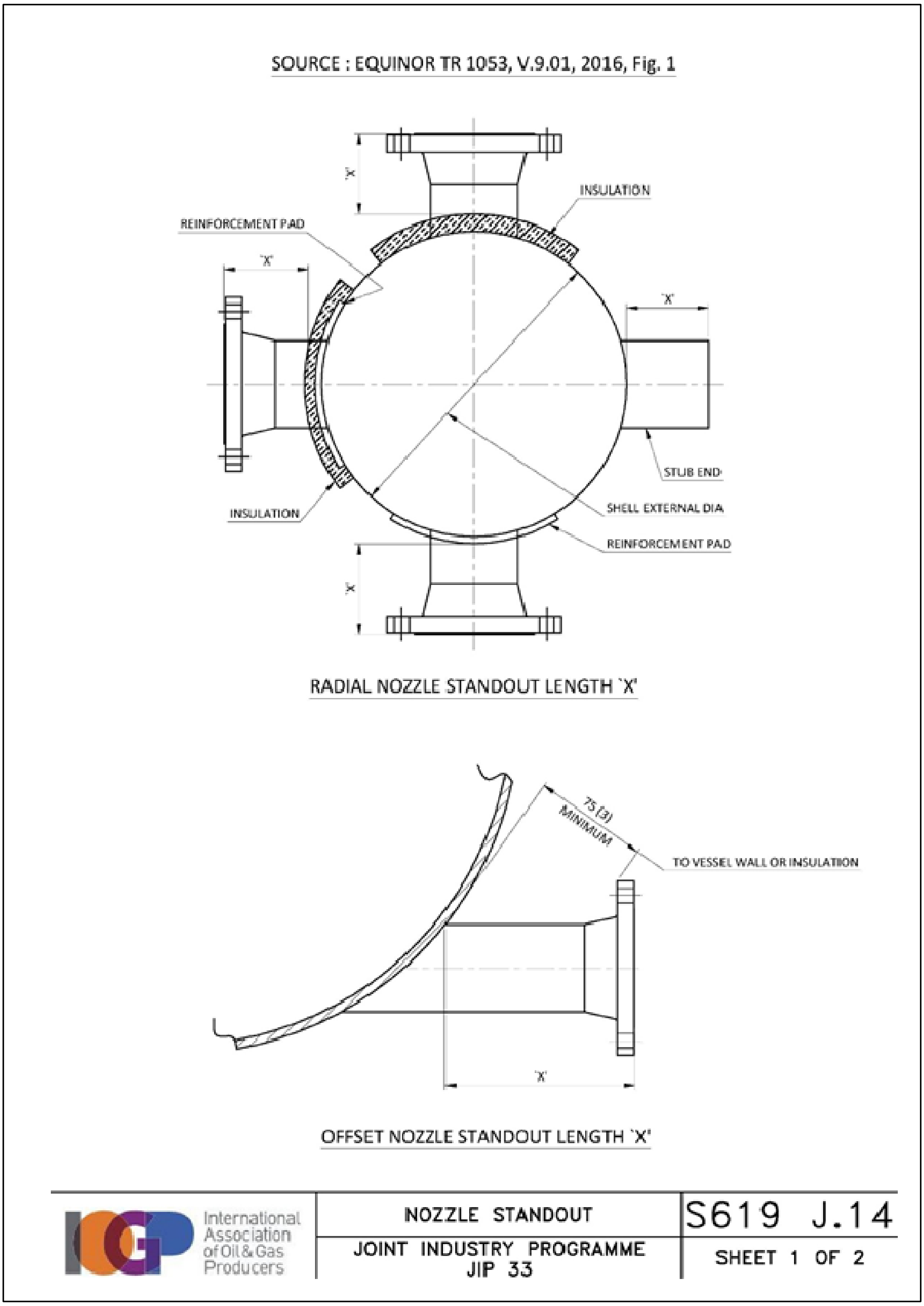
NON-DAVIT DESIGN		
PIN DIA	TAB THK	HINGE DIM
T	U	V
25 (1)	25 (1)	150 (6)
25 (1)	25 (1)	150 (6)
32 (1.25)	25 (1)	150 (6)
38 (1.5)	25 (1)	150 (6)
38 (1.5)	32 (1.25)	190 (7.5)
38 (1.5)	32 (1.25)	190 (7.5)
38 (1.5)	32 (1.25)	190 (7.5)
50 (2)	32 (1.25)	190 (7.5)
38 (1.5)	38 (1.5)	225 (9)
38 (1.5)	38 (1.5)	225 (9)
45 (1.75)	38 (1.5)	225 (9)
38 (1.5)	38 (1.5)	225 (9)
45 (1.75)	38 (1.5)	275 (11)

NOTES :-

1. UNLESS SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETERS (INCHES).
2. VERIFY FUNCTIONALITY OF DAVIT ASSEMBLY IN SHOP
3. PLATE AND BAR TO BE ASTM A36 OR A516 . PIPE TO BE ASTM A53 GRADE B OR A106M PLATE AND BAR TO BE ASTM A36 OR A516.
   PIPE TO BE ASTM A53 GRADE B OR A106M.
4. 22(7/8) DIA. FORGED EYEBOLT FOR APPLICATIONS WARMER THAN 20°F (-7°C) MAT'L SHALL BE ASTM A489.
   FOR APPLICATIONS WARMER THAN -40°F(-40°C) MAT'L SHALL BE ASTM F541. EYEBOLT SHALL BE SUFFICIENTLY LONG TO ALLOW FIVE THREADS TO SHOW ABOVE NUTS WHEN MANWAY COVER IS CLOSED.
5. WELDS TO BE 6(1/4) MINIMUM. DOUBLE FILLET WELDS U.N.O.

International Association of Oil & Gas Producers	MANWAYS DAVIT AND HINGES	S619 J.13
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 4 OF 4

J.14 Nozzle standout



SOURCE : EQUINOR TR 1053, V.9.01, 2016, TABLE 2

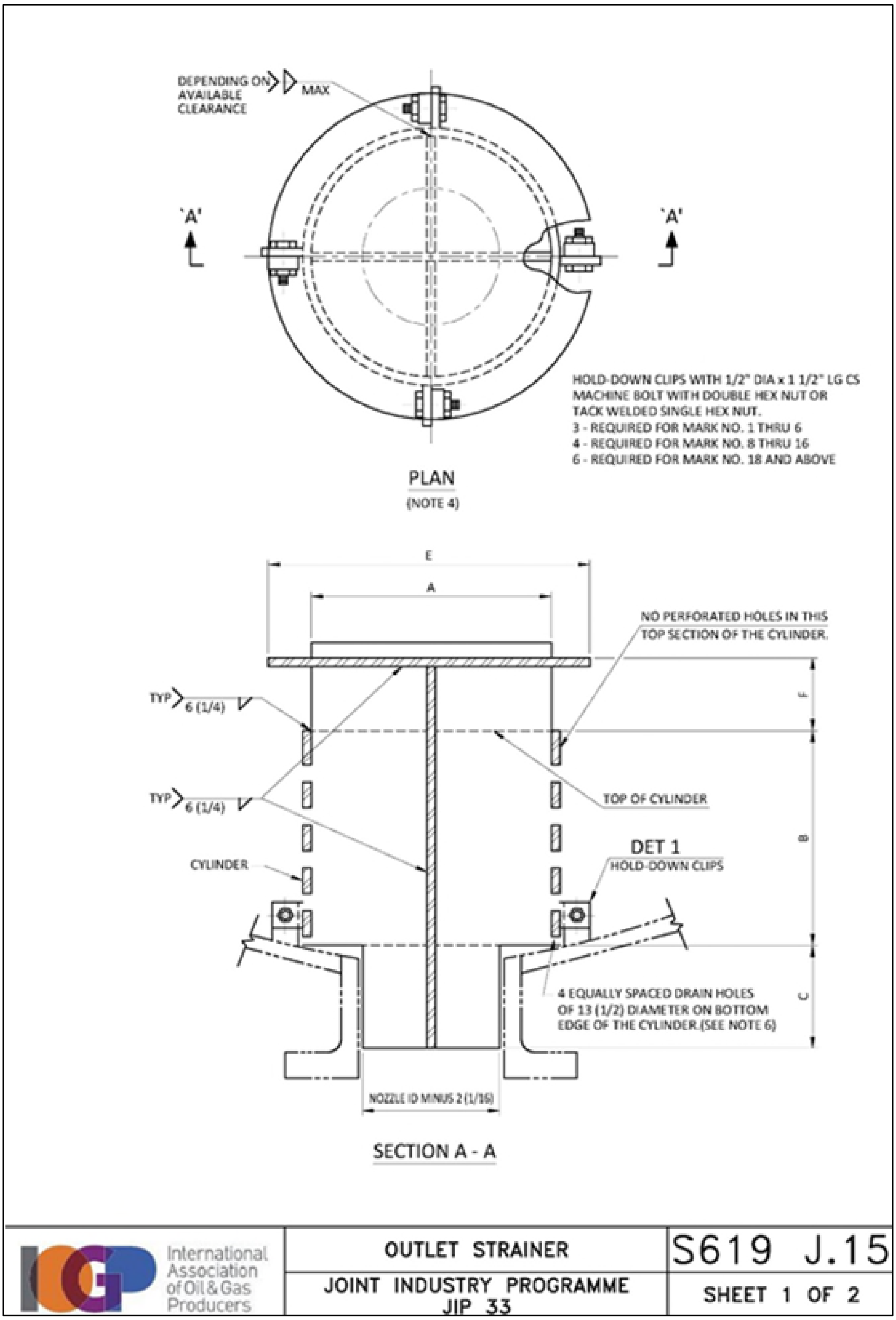
FLANGE CLASS	MINIMUM NOZZLE STANDOUT LENGTH 'X'											
	DN 40 AND DN 50	DN 80	DN 100	DN 150	DN 200	DN 250	DN 300	DN 350	DN 400	DN 450	DN 500	DN 600
	NPS 1 1/2 AND NPS 2	NPS 3	NPS 4	NPS 6	NPS 8	NPS 10	NPS 12	NPS 14	NPS 16	NPS 18	NPS 20	NPS 24
CL-150	200 (8)	200 (8)	200 (8)	200 (8)	200 (8)	200 (8)	220 (9)	220 (9)	220 (9)	220 (9)	220 (9)	320 (13)
CL-300	200 (8)	200 (8)	200 (8)	200 (8)	220 (9)	220 (9)	220 (9)	220 (9)	220 (9)	220 (9)	220 (9)	320 (13)
CL-600	200 (8)	200 (8)	200 (8)	220 (9)	220 (9)	220 (9)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	320 (13)
CL-900	200 (8)	200 (8)	220 (9)	220 (9)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	320 (13)
CL-1500	220 (9)	220 (9)	260 (10 1/2)	260 (10 1/2)	260 (10 1/2)	320 (13)	320 (13)	320 (13)	320 (13)	400 (16)	400 (16)	400 (16)
CL-2500	260 (10 1/2)	260 (10 1/2)	320 (13)	320 (13)	320 (13)	400 (16)	400 (16)					

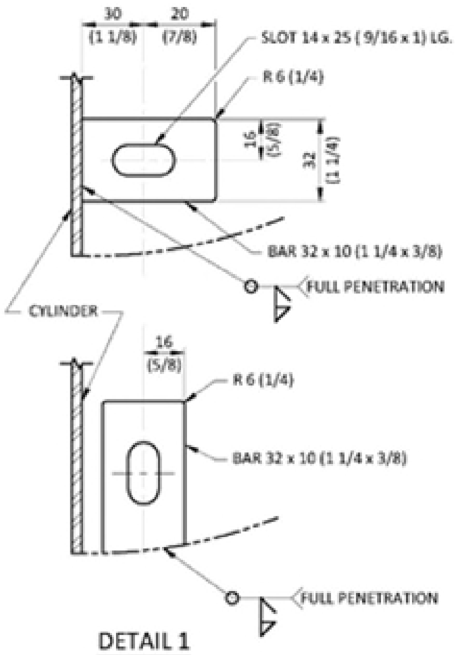
NOTES :-

1. UNLESS SPECIFIED, ALL DIMENSIONS ARE IN MILLIMETRES (INCHES).

International Association of Oil & Gas Producers	NOZZLE STANDOUT	S619 J.14
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 2 OF 2

J.15 Outlet strainer





DETAIL 1

NOZZLE SIZE DN (NPS)	40 (1 1/2)	50 (2)	80 (3)	100 (4)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)
A	75 (3)	100 (4)	125 (5)	150 (6)	200 (8)	300 (12)	350 (14)	400 (16)	450 (18)	500 (20)	600 (24)	675 (27)
B	75 (3)	100 (4)	125 (5)	150 (6)	150 (6)	150 (6)	200 (8)	250 (10)	275 (11)	350 (14)	350 (14)	400 (16)
C	100 (4)	100 (4)	100 (4)	100 (4)	100 (4)	125 (5)	125 (5)	125 (5)	150 (6)	150 (6)	150 (6)	150 (6)
E	100 (4)	125 (5)	150 (6)	190 (7 1/2)	250 (10)	370 (14 1/2)	455 (17 1/2)	500 (20)	575 (23)	650 (26)	750 (30)	825 (33)
F	19 (3/4)	25 (1)	32 (1 1/4)	38 (1 1/2)	50 (2)	75 (3)	90 (3 1/2)	100 (4)	100 (4)	125 (5)	150 (6)	175 (7)

NOTES :-

1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. ENTIRE SURFACE OF CYLINDER SHALL BE PERFORATED WITH 10 (3/8) DIAMETER HOLES AT 12 (1/2) CENTERS ON TRIANGULAR PITCH.
3. ALL COMPONENTS TO HAVE A MINIMUM CORRODED THICKNESS OF 3 (1/8).
4. TWO CROSS MEMBERS AS SHOWN FOR ALL MARK NO'S, BUT FOR NO'S 1 THRU 3 TERMINATE ONE CROSS MEMBER AT BOTTOM OF DIMENSION "B".
5. NOTE THAT FOR NOZZLES 10 INCH. AND LARGER, THESE STRAINERS MAY NOT FIT THROUGH A MANWAY AND MUST BE INSTALLED BEFORE CLOSING UP THE VESSEL, OR FABRICATED IN TWO PARTS AND WELDED TOGETHER INSIDE THE VESSEL.
6. LOCATE DRAIN HOLES AWAY FROM HOLD DOWN CLIP WELD AND CROSS PLATE WELDS AREA TO AVOID INTERFERENCE.

International Association of Oil & Gas Producers	OUTLET STRAINER	S619 J.15
	JOINT INDUSTRY PROGRAMME JIP 33	SHEET 2 OF 2

Annex K
(normative)
Allowable nozzle loads for nozzle sizes DN 650 (NPS 24) to DN 1500 (NPS 60)

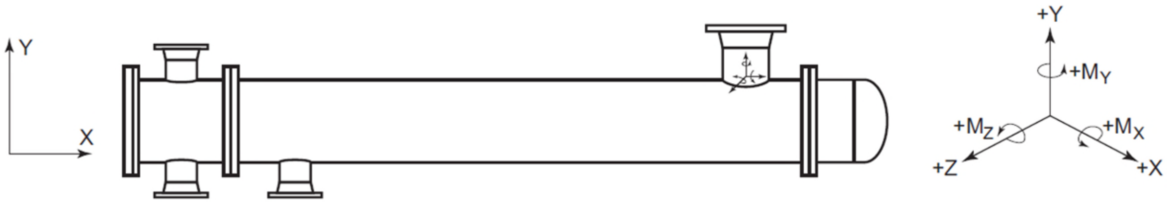


Figure K.1 — Directions of moments and forces on nozzles

Table K.1 — Allowable nozzle loads (for nozzle sizes NPS 650 (24 in) to NPS 1500 (60 in)

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
650	26	150	18,950	13,980	28,430	20,970	24,070	17,750	30,200	6,790	24,200	5,440	30,200	6,790
		300	18,950	13,980	28,430	20,970	24,070	17,750	37,320	8,390	29,890	6,720	37,320	8,390
		600	39,670	29,260	59,510	43,890	50,380	37,160	55,070	12,380	44,080	9,910	55,070	12,380
		900	60,310	44,480	90,470	66,730	76,590	56,490	74,600	16,770	59,740	13,430	74,600	16,770
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
700	28	150	23,820	17,570	35,730	26,350	30,250	22,310	33,670	7,570	27,000	6,070	33,670	7,570
		300	23,820	17,570	35,730	26,350	30,250	22,310	37,230	8,370	29,850	6,710	37,230	8,370
		600	49,410	36,440	74,120	54,670	62,750	46,280	56,710	12,750	45,460	10,220	56,710	12,750
		900	74,650	55,060	111,980	82,590	94,810	69,930	79,760	17,930	63,970	14,380	79,760	17,930
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
750	30	150	30,280	22,330	45,420	33,500	38,460	28,370	37,190	8,360	29,800	6,700	37,190	8,360
		300	30,280	22,330	45,420	33,500	38,460	28,370	37,190	8,360	29,800	6,700	37,190	8,360
		600	62,150	45,840	93,230	68,760	78,940	58,220	58,410	13,130	46,840	10,530	58,410	13,130
		900	93,520	68,980	140,290	103,470	118,770	87,600	84,960	19,100	68,150	15,320	84,960	19,100
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
800	32	150	37,330	27,530	56,000	41,300	47,410	34,970	39,630	8,910	31,800	7,150	39,630	8,910
		300	37,330	27,530	56,000	41,300	47,410	34,970	39,630	8,910	31,800	7,150	39,630	8,910
		600	76,580	56,480	114,860	84,720	97,270	71,740	62,320	14,010	50,000	11,240	62,320	14,010
		900	115,240	85,000	172,850	127,490	146,350	107,940	90,610	20,370	72,680	16,340	90,610	20,370
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
900	36	150	53,090	39,160	79,640	58,740	67,420	49,730	44,620	10,030	35,760	8,040	44,620	10,030
		300	53,090	39,160	79,640	58,740	67,420	49,730	44,620	10,030	35,760	8,040	44,620	10,030
		600	108,530	80,050	162,810	120,080	137,830	101,660	70,100	15,760	56,230	12,640	70,100	15,760
		900	164,810	121,560	247,220	182,340	209,310	154,380	101,950	22,920	81,800	18,390	101,950	22,920
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
950	38	150	55,520	40,950	83,270	61,420	70,520	52,010	47,060	10,580	37,770	8,490	47,060	10,580
		300	55,520	40,950	83,270	61,420	70,520	52,010	47,060	10,580	37,770	8,490	47,060	10,580
		600	120,610	88,960	180,920	133,440	153,170	112,970	73,970	16,630	59,340	13,340	73,970	16,630
		900	207,510	153,050	311,270	229,580	263,540	194,380	107,600	24,190	86,340	19,410	107,600	24,190
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1000	40	150	63,990	47,200	95,990	70,800	81,270	59,940	53,110	11,940	42,610	9,580	53,110	11,940
		300	63,990	47,200	95,990	70,800	81,270	59,940	53,110	11,940	42,610	9,580	53,110	11,940
		600	141,330	104,240	212,000	156,360	179,500	132,390	88,520	19,900	70,990	15,960	88,520	19,900
		900	248,100	182,990	372,140	274,480	315,090	232,400	113,300	25,470	90,880	20,430	113,300	25,470
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
1050	42	150	74,230	54,750	111,350	82,130	94,270	69,530	55,740	12,530	44,750	10,060	55,740	12,530
		300	74,230	54,750	111,350	82,130	94,270	69,530	55,740	12,530	44,750	10,060	55,740	12,530
		600	165,910	122,370	248,870	183,560	210,710	155,410	92,920	20,890	74,550	16,760	92,920	20,890
		900	284,000	209,470	426,000	314,200	360,670	266,020	118,950	26,740	95,410	21,450	118,950	26,740
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1100	44	150	87,230	64,340	130,850	96,510	110,780	81,710	58,410	13,130	46,840	10,530	58,410	13,130
		300	87,230	64,340	130,850	96,510	110,780	81,710	58,410	13,130	46,840	10,530	58,410	13,130
		600	193,160	142,470	289,740	213,700	245,310	180,930	97,370	21,890	78,110	17,560	97,370	21,890
		900	309,760	228,470	464,640	342,700	393,400	290,160	124,590	28,010	99,950	22,470	124,590	28,010
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1150	46	150	98,890	72,940	148,340	109,410	125,590	92,630	61,070	13,730	48,970	11,010	61,070	13,730
		300	98,890	72,940	148,340	109,410	125,590	92,630	61,070	13,730	48,970	11,010	61,070	13,730
		600	219,670	162,020	329,500	243,030	278,990	205,770	101,780	22,880	81,670	18,360	101,780	22,880
		900	338,560	249,710	507,840	374,560	429,970	317,130	130,290	29,290	104,530	23,500	130,290	29,290
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	**(lbf·ft)**	**(N-m)**	**(lbf·ft)**	**(N-m)**	**(lbf·ft)**	**(N)**	**(lbs)**	**(N)**	**(lbs)**	**(N)**	**(lbs)**
1200	48	150	114,160	84,200	171,240	126,300	144,980	106,930	63,700	14,320	51,110	11,490	63,700	14,320
		300	114,160	84,200	171,240	126,300	144,980	106,930	63,700	14,320	51,110	11,490	63,700	14,320
		600	252,300	186,090	378,450	279,130	320,420	236,330	106,180	23,870	85,180	19,150	106,180	23,870
		900	368,630	271,890	552,960	407,840	468,160	345,300	135,940	30,560	109,070	24,520	135,940	30,560
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1250	50	150	131,850	97,250	197,790	145,880	167,440	123,500	66,370	14,920	53,250	11,970	66,370	14,920
		300	131,850	97,250	197,790	145,880	167,440	123,500	66,370	14,920	53,250	11,970	66,370	14,920
		600	283,840	209,350	425,750	314,020	360,480	265,880	110,630	24,870	88,740	19,950	110,630	24,870
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1300	52	150	148,120	109,250	222,180	163,870	188,110	138,740	69,040	15,520	55,380	12,450	69,040	15,520
		300	148,120	109,250	222,180	163,870	188,110	138,740	69,040	15,520	55,380	12,450	69,040	15,520
		600	317,980	234,530	476,980	351,800	403,830	297,850	115,030	25,860	92,300	20,750	115,030	25,860
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
1350	54	150	168,000	123,910	252,010	185,870	213,370	157,370	71,710	16,120	57,520	12,930	71,710	16,120
		300	168,000	123,910	252,010	185,870	213,370	157,370	71,710	16,120	57,520	12,930	71,710	16,120
		600	359,500	265,150	539,250	397,730	456,570	336,750	119,480	26,860	95,860	21,550	119,480	26,860
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1400	56	150	187,050	137,960	280,590	206,950	237,550	175,210	74,330	16,710	59,650	13,410	74,330	16,710
		300	187,050	137,960	280,590	206,950	237,550	175,210	74,330	16,710	59,650	13,410	74,330	16,710
		600	399,330	294,530	599,000	441,800	507,140	374,050	123,880	27,850	99,420	22,350	123,880	27,850
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1450	58	150	210,190	155,030	315,300	232,550	266,930	196,880	77,000	17,310	61,790	13,890	77,000	17,310
		300	210,190	155,030	315,300	232,550	266,930	196,880	77,000	17,310	61,790	13,890	77,000	17,310
		600	420,490	310,140	630,750	465,220	534,040	393,890	128,330	28,850	102,930	23,140	128,330	28,850
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table K.1 *(continued)*

DN	NPS	Flange rating	Mx		My		Mz		Fx		Fy		Fz	
			(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N-m)	(lbf·ft)	(N)	(lbs)	(N)	(lbs)	(N)	(lbs)
1500	60	150	232,250	171,300	348,380	256,950	294,960	217,550	79,670	17,910	63,920	14,370	79,670	17,910
		300	232,250	171,300	348,380	256,950	294,960	217,550	79,670	17,910	63,920	14,370	79,670	17,910
		600	450,000	331,900	674,990	497,850	571,500	421,520	132,730	29,840	106,490	23,940	132,730	29,840
		900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		2500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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