International Association of Oil & Gas Producers

SPECIFICATION
S-619

September
2021

# Specification for Unfired, Fusion Welded Pressure Vessels

Public Review Draft

JIP33
JOINT INDUSTRY PROGRAMME

**Revision history**

| VERSION | DATE | PURPOSE |
|---|---|---|
| 1.1 | September 2021 | Issued for Public Review |
| 1.0 | December 2018 | First Edition |

Public Review Draft

## 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).

### Disclaimer

Whilst every effort has been made to ensure the accuracy of the information contained in this publication, neither IOGP nor any of its Members past present or future warrants its accuracy or will, regardless of its or their negligence, assume liability for any foreseeable or unforeseeable use made thereof, which liability is hereby excluded. Consequently, such use is at the recipient's own risk on the basis that any use by the recipient constitutes agreement to the terms of this disclaimer. The recipient is obliged to inform any subsequent recipient of such terms.

Please note that this publication is provided for informational purposes and adoption of any of its recommendations is at the discretion of the user. Except as explicitly stated otherwise, this publication must not be considered as a substitute for government policies or decisions or reference to the relevant legislation relating to information contained in it.

Where the publication contains a statement that it is to be used as an industry standard, IOGP and its Members past, present, and future expressly disclaim all liability in respect of all claims, losses or damages arising from the use or application of the information contained in this publication in any industrial application.

Any reference to third party names is for appropriate acknowledgement of their ownership and does not constitute a sponsorship or endorsement.

### Copyright notice

The contents of these pages are © International Association of Oil & Gas Producers. Permission is given to reproduce this report in whole or in part provided (i) that the copyright of IOGP and (ii) the sources are acknowledged. All other rights are reserved. Any other use requires the prior written permission of IOGP.

These Terms and Conditions shall be governed by and construed in accordance with the laws of England and Wales. Disputes arising here from shall be exclusively subject to the jurisdiction of the courts of England and Wales.

# 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).

Public Review Draft

# Table of Contents


Foreword ..... 1
Introduction ..... 5
1 Scope ..... 7
2 Normative references ..... 7
3 Terms, definitions, acronyms, abbreviations and symbols ..... 8
3.1 Terms and definitions ..... 8
3.2 Acronyms, abbreviations and symbols ..... 9
4 Design ..... 10
4.1 General ..... 10
4.2 Corrosion allowance ..... 11
4.3 Wind, seismic and snow loads ..... 12
4.4 Design loads and load combinations ..... 13
4.5 Lifting loads ..... 14
4.6 Local loads ..... 14
4.7 Nozzles, manways and reinforcements ..... 15
4.8 Custom designed flanges ..... 18
4.9 Flange bolting ..... 18
4.10 Skirt support ..... 18
4.11 Leg supports ..... 19
4.12 Saddles ..... 19
4.14 Brackets ..... 20
5 Materials ..... 20
5.2 Permanent attachments ..... 20
6 Fabrication ..... 21
6.1 General ..... 21
6.2 Welding ..... 22
7 Heat treatment ..... 22
8 Non-destructive examination ..... 22
8.1 General ..... 22
8.2 Radiographic and ultrasonic examination ..... 23
8.3 Magnetic particle or liquid penetrant examination ..... 23
9 Pressure testing ..... 23
10 Preparation for shipment ..... 24
10.1 General ..... 24
10.2 Protection ..... 24
10.3 Identification ..... 25
Annex A (normative) Additional requirements for sour service vessels ..... 27


Public Review Draft

Annex B (normative) Additional requirements for integrally clad and weld overlay vessels ..... 28
Annex C (normative) Additional requirements for carbon steel vessels ..... 31
Annex D (normative) Additional requirements for austenitic stainless steel, 22Cr and 25Cr duplex vessels ..... 33
Annex E (normative) Vessel tolerances ..... 36
Annex F (normative) Requirements for maximum allowable corrosion allowance (MACA) ..... 39
Annex G (normative) Additional requirements for vessels in cyclic service ..... 41
Annex H (normative) Additional requirements for carbon steel vessels in caustic and lean amine service vessels ..... 43
Annex I (normative) Additional requirements for vessels in hydrogen service ..... 44
Annex J (normative) Standard drawings ..... 45
Bibliography ..... 74

## List of Tables

Table 1 — Design load combinations ..... 13
Table 2 — Design load combination definitions ..... 13
Table 3 — Fabricated flanged nozzles ..... 16
Table C.1 — Maximum allowable CE ..... 31
Table D.1 — Repair limits ..... 34

## List of Figures

Figure 1 — Design corrosion allowance ..... 12
Figure 2 — Through-wall-cut ..... 16
Figure 3 — Vessel tolerances (SI units) ..... 37
Figure 4 — Vessel tolerances (US Customary units) ..... 38
Figure J.1.a — Vortex breakers (sheet 1 of 2) ..... 46
Figure J.1.b — Vortex breakers (sheet 2 of 2) ..... 47
Figure J.2 — Internal ladder rungs ..... 48
Figure J.3.a — Skirts openings (sheet 1 of 2) ..... 49
Figure J.3.b — Skirts openings (sheet 2 of 2) ..... 50
Figure J.4 — Tangential nozzle with anti-erosion plate ..... 51
Figure J.5 — Earthing (grounding) lug ..... 52
Figure J.6.a — Clad restoration (sheet 1 of 2) ..... 53
Figure J.6.b — Clad restoration (sheet 2 of 2) ..... 54
Figure J.7 — Support clips for fireproofing ..... 55
Figure J.8.a — Insulation supports (hot and cold) (sheet 1 of 7) ..... 56
Figure J.8.b — Insulation supports (hot and cold) (sheet 2 of 7) ..... 57
Figure J.8.c — Insulation supports (hot and cold) (sheet 3 of 7) ..... 58
Figure J.8.d — Insulation supports (hot and cold) (sheet 4 of 7) ..... 59

Public Review Draft

Figure J.8.e — Insulation supports (hot and cold) (sheet 5 of 7) ....60
Figure J.8.f — Insulation supports (hot and cold) (sheet 6 of 7) ....61
Figure J.8.g — Insulation supports (hot and cold) (sheet 7 of 7) ....62
Figure J.9 — Saddles for horizontal vessels ....63
Figure J.10 — Support lugs and rings ....64
Figure J.11 — Foundation template for skirt supported vessels ....65
Figure J.12.a — Manway davit (sheet 1 of 4) ....66
Figure J.12.b — Manway davit (sheet 2 of 4) ....67
Figure J.12.c — Manway davit (sheet 3 of 4) ....68
Figure J.12.d — Manway davit (sheet 4 of 4) ....69
Figure J.13.a — Nozzle standout (sheet 1 of 2)| ....70
Figure J.13.b — Nozzle standout (sheet 2 of 2) ....71
Figure J.14.a — Outlet strainer (sheet 1 of 2) ....72
Figure J.14.b — Outlet strainer (sheet 2 of 2) ....73

Public Review Draft

# 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.

Public Review Draft

**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.

Public Review Draft

# 1 Scope

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

Vessels fabricated as per this specification are intended for use in the typical services associated with oil and gas production facilities, mid-stream or pipeline facilities, gas plants, liquefied natural gas (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;

   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 owner/user's 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.

# 2 Normative references

The following publications are referred to in this document, the procurement data sheet (S-619D) or the IRS (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 660, *Shell-and-Tube Heat Exchangers*

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

Public Review Draft

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

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 MR0175-1 , *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 1: General principles for selection of cracking-resistant materials*

ISO 15156-2/ NACE MR0175-2, *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low-alloy steels, and the use of cast irons*

ISO 15156-3/ NACE MR0175-3, *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

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

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

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**
fittings dimensioned and manufactured in conformance with ASME B16.9 or equivalent standard

Public Review Draft

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

Note 1 to entry: hydrogen charging services include wet hydrogen sulphide, or sour, hydrofluoric acids 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

## 3.2 Acronyms, abbreviations and symbols

### 3.2.1 Acronyms and abbreviations

| | |
|---|---|
| ACCP | ASNT Central Certification Program |
| API | American Petroleum Institute |
| ASME | American Society of Mechanical Engineers |
| ASNT | American Society for Nondestructive Testing |
| ASTM | American Society for Testing and Materials |
| AWS | American Welding Society |
| BPVC | boiler and pressure vessel code |
| CE | carbon equivalent (% C + % Mn / 6 + (% Cr + % Mo + % V) / 5 + (% Ni + % Cu) / 15) |
| CLR | crack length ratio |
| CSR | crack sensitivity ratio |
| CTR | crack thickness ratio |
| DN | nominal diameter |
| FN | ferrite number |
| HIC | hydrogen-induced cracking |
| HRC | Rockwell hardness, C scale |
| HV | Vickers hardness |
| LNG | Liquefied natural gas |
| MACA | maximum allowable corrosion allowance |
| MAP | maximum allowable pressure |
| MAWP | maximum allowable working pressure |
| MT | magnetic particle testing |
| NPS | nominal pipe size |
| NPT | national pipe thread |
| PMI | positive material identification |
| PSA | pressure swing absorber |
| PT | penetrant testing |
| PWHT | post weld heat treatment |
| WRC | Welding Research Council |

Public Review Draft

### 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

*t* minimum thickness of the vessel wall

$t_{min}$ required thickness of vessel wall at the nozzle or welded attachment.

# 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 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);

*cα* 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 maximum allowable working pressure (MAWP), new and cold maximum allowable pressure (MAP) or maximum allowable corrosion allowance (MACA) of the vessel shall not be limited by fittings, nozzle reinforcement, nozzle neck thickness, nozzle flange or flange bolting.

### 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.

Public Review Draft

**4.1.7**

The design of pressure components in common element designs shall include the effect of coincident vacuum in an adjacent chamber.

**4.1.8**

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

**4.1.9**

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.

**4.1.10**

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

**4.1.11**

Partial penetration welds shall not be permitted.

**4.1.12**

Design by analysis methodology shall not be used to justify a thinner thickness for a pressure component.

**4.1.13**

Vessel supports shall have an earthing lug.

## 4.2 Corrosion allowance

**4.2.1**

The corrosion allowance for internal parts including attachment welds shall be 50 % of the design corrosion allowance per exposed side for internal parts that can be removed from the pressure vessel.

**4.2.2**

The corrosion allowance for internal parts including attachment welds shall be equal to the design corrosion allowance per exposed side for internal parts that are welded to the pressure retaining portion of the pressure vessel.

**4.2.3**

The corrosion allowance for internal parts including attachment welds shall be no corrosion allowance for internal parts made of stainless steel or components with a corrosion resistant weld overlay.

Public Review Draft

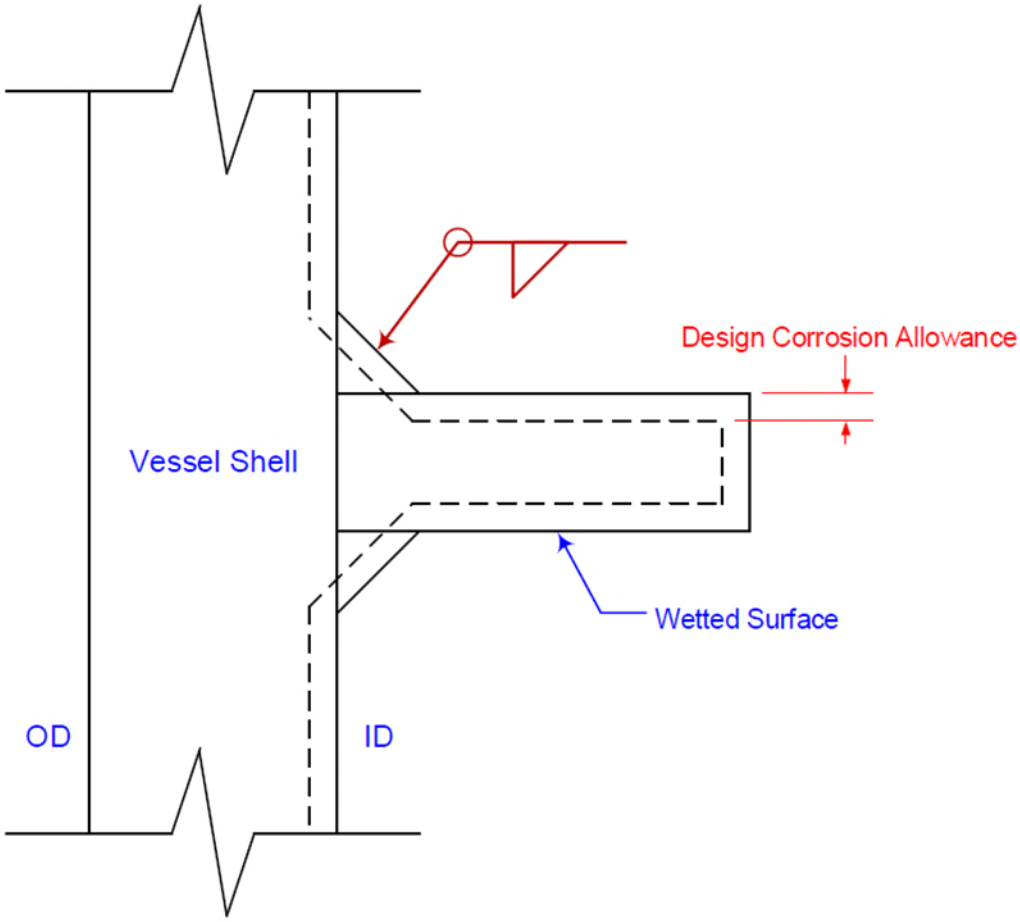



**Figure 1 — Design corrosion allowance**

**4.2.4**

The total design corrosion allowance for vessel supports made of carbon steel shall be 1,5 mm (0,06 in).

**4.2.5**

Corrosion allowance shall not be considered on gasket seating surface.

## 4.3 Wind, seismic and snow loads

**4.3.1**

Wind, seismic, and snow loads shall be calculated as per the applicable code and any additional data 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.

Public Re

#### 4.3.3

Deflection at the top of vertical vessels shall not exceed 1:200 of height *h*.

#### 4.3.4

The effective diameter of the vessel shall be used in wind load calculations.

### 4.4 Design loads and load combinations

#### 4.4.1

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 loads and full snow load |
| L3 + L6 + L11 + L12 + L13 + L14 + L16 | Operating condition (corroded and un-corroded) with full pressure, full seismic loads and full snow load |
| L4 + L8 + (0,25)L10 + L12 | Shop (or initial) hydrostatic test condition (uncorroded) |
| L4 + L9 + (0,25)L10 + L12 | 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 |

Public Review Draft

| | |
|---|---|
| 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 | E.g. 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] Internals that are removed for a field hydrotest shall be identified in the 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 have 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 stresses caused by concentrated loads on nozzles or any external structural attachment due to piping reactions, supported equipment, lifting of vessel etc. shall be evaluated.

### 4.6.2

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

Public Review Draft

#### 4.6.3

Extrapolation beyond the stated limits shall not be permitted.

#### 4.6.4

Allowable nozzle loads at nozzle to shell or nozzle to head junction shall be in accordance with API Standard 660.

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 proposed piping layout and/or nozzle flexibility can be considered.

## 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 ½ of the shell thickness;

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 the fit-up of set-on type nozzles, liquid penetrant or magnetic particle examination of the surface of the through wall cut (see Figure 1) shall be performed with zero defects.

#### 4.7.1.3

Prior to the fit-up of set-on type nozzles, a lamination check by 100 % ultrasonic examination of the base plate to a distance of 100 mm (4 in) around the nozzle opening shall be performed with zero defects.

#### 4.7.1.4

The acceptance criteria for non-destructive examination shall be zero defects.

Public Review Draft

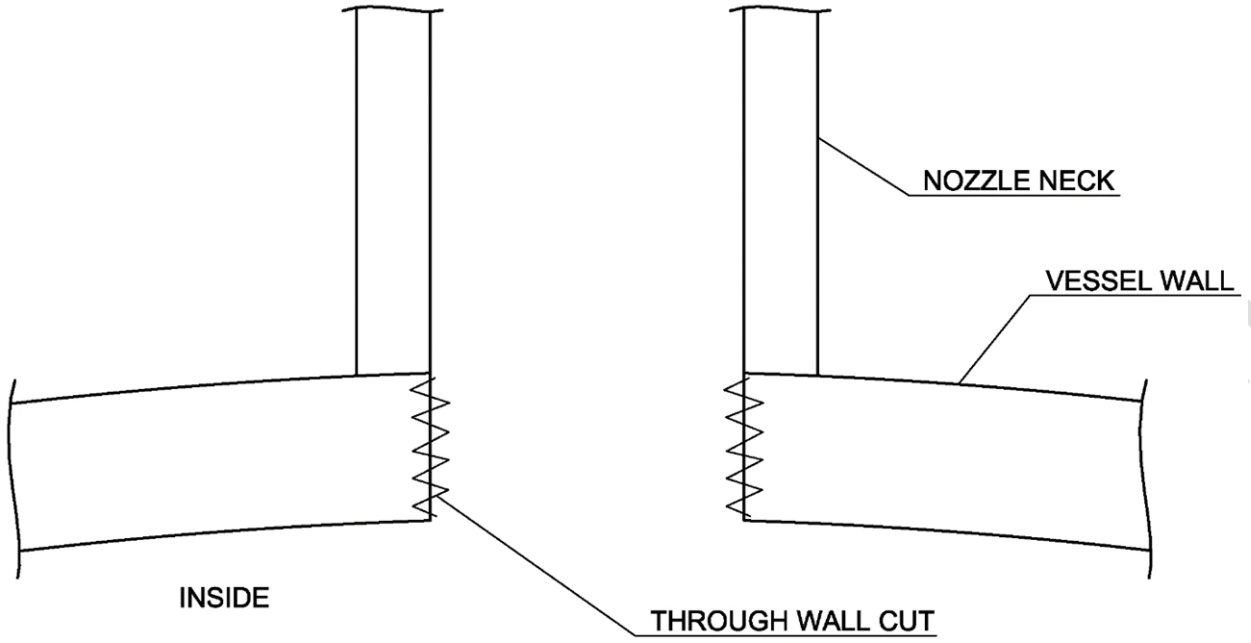



**Figure 2 — Through-wall-cut**

**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).

**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 nominal wall thickness in accordance with Table 3.

**Table** Error! Bookmark not defined. **— Fabricated flanged nozzles**

| Flanged nozzles size | Nominal wall thickness of seamless pipe | | |
|---|---|---|---|
| DN 40 (NPS 1½) | 7,14 mm (0,281 in) | or | 10,15 mm (0,400 in) |
| DN 50 (NPS 2) | 8,74 mm (0,344 in) | or | 11,07 mm (0,436 in) |

**4.7.5**

Fittings shall not be directly welded to the vessel wall.

**4.7.6**

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

**4.7.7**

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

Public Review

**4.7.8**

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.

**4.7.9**

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

**4.7.10**

Nozzle to vessel wall joints shall have full penetration welds.

**4.7.11**

Internal reinforcing pads shall not be used for nozzles.

**4.7.12**

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

### 4.7.13 Set-in nozzles

**4.7.13.1**

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

**4.7.13.2**

Inside edges of set-in type nozzles wall shall be rounded off.

**4.7.14**

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

**4.7.15**

Reinforcing pads for nozzles shall be limited to two pieces.

### 4.7.16 Nozzle reinforcing pads

**4.7.16.1**

The thickness of nozzle reinforcing pads shall be no thinner than the nominal vessel wall thickness *t* minus the total corrosion allowance.

**4.7.16.2**

The thickness of nozzle reinforcing pads shall not exceed 50 mm (2 in).

**4.7.17**

Removable internals shall pass through vessel manways.

Public Review Draft

## 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

Nubbins shall not be permitted.

### 4.8.4

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

### 4.8.5

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.

### 4.8.6

The flatness of gasket 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

Studs shall extend beyond the nut by at least three threads at each end.

### 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

The exposed length of stud bolts shall be protected with a heavy hex nut.

## 4.10 Skirt support

### 4.10.1

Skirts shall be no thinner than the lesser of 6 mm (¼ in) inclusive of any skirt corrosion allowance or the nominal thickness of the vessel component to which it is attached.

Public Review Draft

**4.10.2**

Access openings in skirts shall be provided.

**4.10.3**

No piping shall run through skirt access openings.

**4.10.4**

No flanged connection shall be allowed inside the skirt.

**4.10.5**

Skirt openings shall be provided with rings or collars sized to ensure that the structural stability of the skirt is not compromised.

**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  permitted if the following conditions are met:

a) the vessel internal diameter is not greater than 1500 mm (60 in);

b) the design temperature is not greater than 230 °C (450 °F);

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

d) the vessel is not in cyclic service.

**4.11.2**

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 the applicable loading on the saddles.

**4.13**

Vessels designed for internal pressure only shall be stamped for the calculated maximum allowable external pressures (MAEP) at the internal pressure design temperature and steam out temperature.

Public Review Draft

## 4.14 Brackets

### 4.14.1

The nameplate bracket shall be a "C" shape.

### 4.14.2

The nameplate bracket shall be welded to the shell along the two edges in contact with the shell or head.

### 4.14.3

Brackets to vessel wall welds shall be full fillets on one side.

### 4.14.4

The bracket material thickness shall be minimum 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 directly welded 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.

### 5.3

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

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

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.

Public Review Draft

**5.5**

Repair welding of forged or rolled base materials shall not be permitted.

**5.6**

Positive material identification of alloy steel pressure containing parts, 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, nozzle reinforcing plates, wear plates) shall be provided with one vent hole in each segment at the lowest practical point of the pad or attachment.

**6.1.2**

Continuously welded internal attachments shall be provided with a vent hole or un-welded length of 25 mm (1 in) at the lowest point.

**6.1.3**

Reinforcement pad vent holes shall be tapped DN 8 (¼ NPT).

**6.1.4**

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.

**6.1.5**

Production test plates shall be subjected to the same welding procedure and heat treatment cycles used for production welds in the shell or head.

**6.1.6**

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.

**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 ground flush.

**6.1.8**

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.

Public Review Draft

#### 6.1.9

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

### 6.1.10 Permanent marking

#### 6.1.10.1

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

#### 6.1.10.2

Permanent marking shall be done before post weld heat treatment (PWHT).

#### 6.1.11

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

#### 6.1.12

Fitness for service or an equivalent calculation shall not be used as a justification for not repairing defects.

#### 6.1.13

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 with following additional requirements.

#### 6.2.2

Welds directly to pressure parts shall be continuous.

# 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 for final acceptance of the vessel shall be performed after the completion of welding, weld repairs and PWHT, and prior to pressure testing.

Public Review Draft

**8.1.2**

The person responsible for the non-destructive examination shall be qualified to ISO 9712 level III, ASNT Central Certification Program (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**

Ultrasonic examination shall be acceptable in lieu of radiographic examination where allowed by the design code.

**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 shall be examined.

**8.2.3**

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

**8.2.4**

When spot radiography is specified, the locations of the spot radiographs shall be designated.

## 8.3 Magnetic particle or liquid penetrant examination

**8.3.1**

If not specified by the design code, the minimum extent of magnetic particle (MT) or penetrant test (PT) shall be as per ASME *BPVC,* Section VIII, Division 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.

# 9 Pressure testing

**9.1**

Vessels shall be hydrostatically tested using water.

**9.2**

The hold time at hydrotest pressure shall be not less than one hour.

Public Review Draft

### 9.3

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

### 9.4

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

### 9.5

Hydrostatic pressure testing shall be performed with gaskets and bolting identical to those required in service.

NOTE These gaskets can be service gaskets if the bolted joint is not disassembled after completion of hydrostatic pressure testing.

### 9.6

No paint, primer or any other type of coating shall 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 plugging material used 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 damage to the surface of the vessel or contamination of the vessel material.

#### 10.1.5

Baseplates, saddles or skirts shall be welded to the deck of ships, barges, railcars and trailers even if the vessel has been post weld heat treated.

### 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.

Public Review Draft

**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 suitably protected.

**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**

Nitrogen or other means of creating an oxygen-deficient atmosphere shall not be used for vessel purging during transportation and storage.

**10.2.7.2**

When an inert gas purge is specified, the pressure shall be maintained at no less than a gauge pressure of 35 kPa (5 psig) indicated by a pressure gauge during transportation and storage.

**10.2.7.3**

Gauges shall be protected from damage during transportation.

**10.2.7.4**

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.

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.

Public Review Draft

### 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 manways and other points of access to the interior of the vessel.

Public Review Draft

# 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 magnetic particle 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) crack length ratio (CLR) lesser than or equal to 15 % per specimen;

b) crack thickness ratio (CTR) lesser than or equal to 5 % per specimen;

c) crack sensitivity ratio (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).

Public Review Draft

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

This annex covers 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 or 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 thickness of the cladding. (see Figure D.7)

### 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

If 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 clad thickness below the specified minimum value.

Public Review Draft

## B.3 Integral cladding

### B.3.1

Integrally clad plate shall comply with the requirements of ASTM A264 or ASTM A265.

### B.3.2

Clad plates shall be ultrasonically tested.

### B.3.3

Formed heads or sections shall be ultrasonically tested after forming.

### B.3.4

Cut areas shall be ultrasonically examined within 50 mm (2 in) from the edge of the opening.

### B.3.5 Internal attachments

#### B.3.5.1

Welding of internal attachments to integrally clad plates shall be permitted if the following conditions are met:

a) the induced weld stress due to mechanical loads on the attachment do not exceed 25 % of the allowable stress for weld;

b) the temperature difference between the shell and the attachment is not expected to exceed 14 °C (25 °F).

#### B.3.5.2

Internal welded attachments that do not meet all the requirements in B.2.5.1 shall be welded directly to the base metal after stripping back the cladding locally.

#### B.3.5.3

Cladding of integrally clad plate locally stripped back 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:

a) A detailed arrangement drawing showing:

   1) functionality of the nozzle or flange;

   2) set in or set on;

Public Review Draft

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) The method of preparation after overlay welding.

d) The examination after overlay welding including:

1) thickness;

2) liquid penetrant.

### 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 have a smooth contour finish with a minimum radius of 6 mm (¼ in).

### B.4.5

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

### B.4.6

Weld overlaid surfaces shall be penetrant tested after final machining.

### B.4.7

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

### B.4.8

Linear indications shall be repaired.

Public Review Draft

# Annex C
(normative)
# Additional requirements for carbon steel vessels

## C.1

Plates having a nominal thickness greater than or equal to 50 mm (2 in) shall be subjected to ultrasonic examination.

## C.2

Forgings (except standard flanges) having a nominal thickness greater than or equal to 50 mm (2 in) shall be subject to ultrasonic examination.

## C.3

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.4

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

## C.5

Cold formed heads shall be normalized after forming.

## C.6

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

## C.7

When magnetic particle testing is applicable, internal welds shall be examined using the wet-fluorescent method.

## C.8

External welds shall be examined using either the wet-visible or wet-fluorescent method.

## C.9

Minimum acceptable harpy impact energy values, at minimum design metal temperature or impact testing temperature specified in design code, whichever is lower, shall be average 27 J (20 ft-lb) and single 20 J (15 ft-lb) or as specified in the design code, whichever is higher.

Public Review Draft

## C.10

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

## C.11

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

Public Review Draft

# 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 solution annealed condition.

### D.1.2

Stainless steel grades 321 and 347 shall be stabilized after solution annealing heat treatment.

### D.1.3

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

### D.1.4

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

### D.1.5

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 and duplex materials.

### D.2.2

Exterior surfaces shall be protected from chloride exposure.

### D.2.3

Materials for marking, painting or inspection containing halides and heavy metals shall not be used.

### D.2.4

Aluminium and zinc based 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).

Public Review Draft

## D.3 Ferrite control

### D.3.1

The ferrite number (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 as a minimum 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

All 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 |

Public Review Draft

### D.6.3

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

Public Review Draft

# 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°.

Public Review Draft

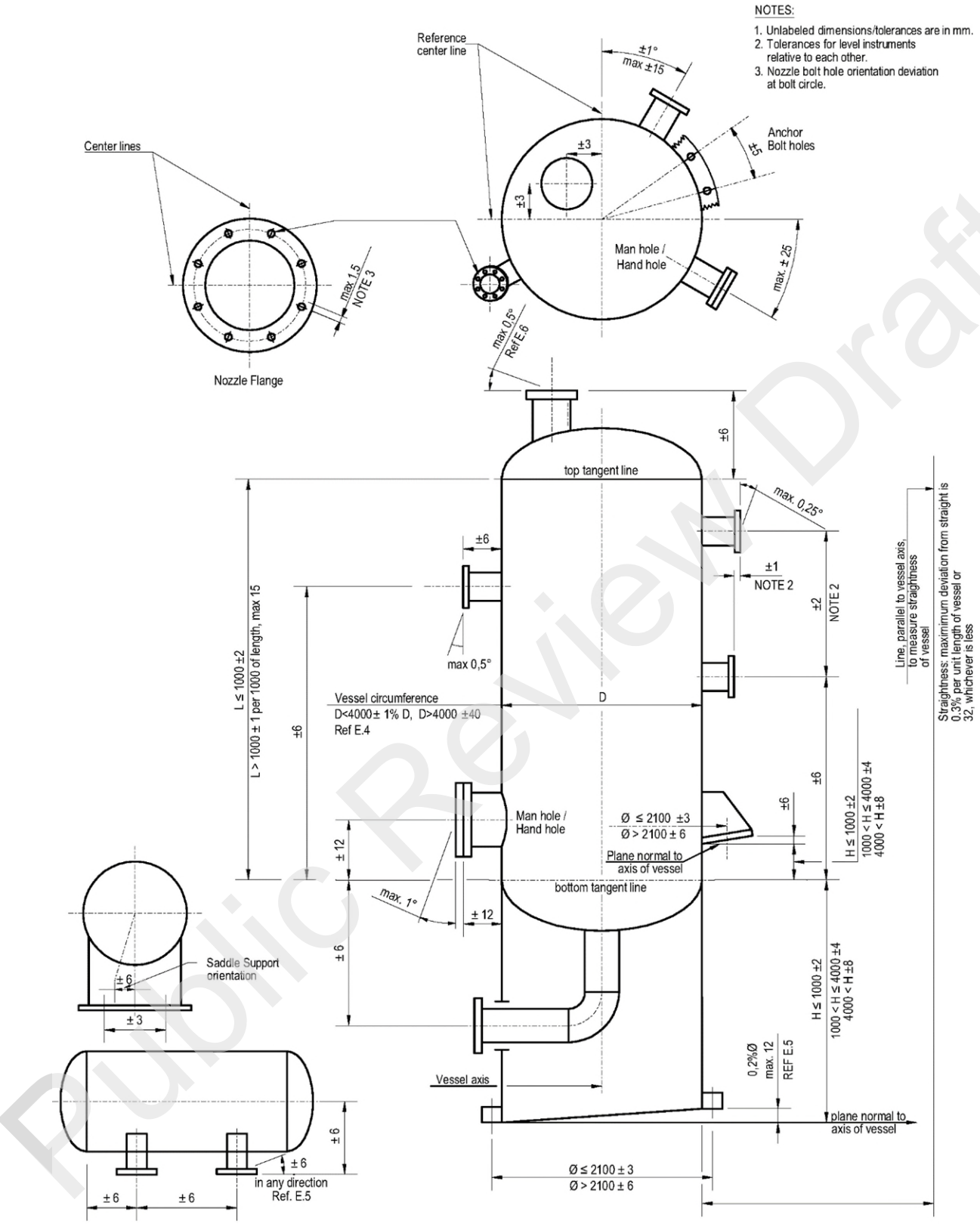



**Figure 3 — Vessel tolerances (SI units)**

Public Review Draft

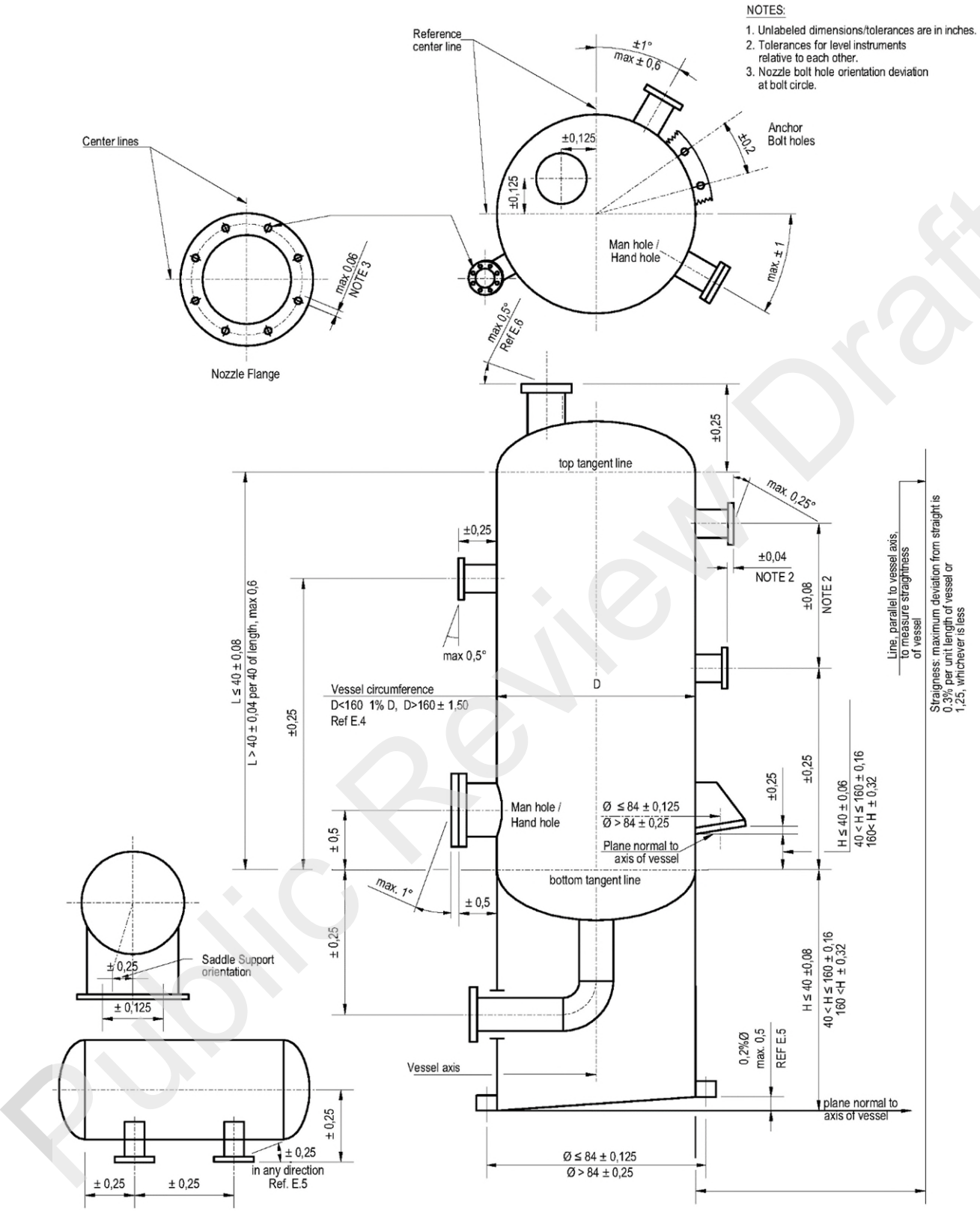



**Figure 4 — Vessel tolerances (US customary units)**

Public Review Draft

# 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 as per the design code. MACA is 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 corrosion allowance (CA). CA is not required by the ASME Code nor this specification to be displayed on the nameplate.

Calculation of MAWP is not required for vessels described in ASME *BPVC*, Section VIII, Division 1. The MAWP may be calculated as an option. This calculated MAWP may be slightly higher than a 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 reinforcement of openings shall be calculated after the MACA for the parent component has been determined.

## F.3

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

EXAMPLE A shell may be designed with a required thickness of 5,710 mm (0,225 in) plus a design CA of 3,175 mm (0,125 in) at 8,890 mm (0,350 in). This is rounded to 8,890 mm (0,375 in) as the next commonly available thickness. If the fabricator chooses or is required by TEMA to use 12,700 mm (0,500 in) plate, the MACA is calculated based on 8,890 mm (0,350 in), thus MACA is 3,810 mm (0,150 in). The excess 3,175 mm (0,125 in) can be allocated to opening reinforcement, external nozzle loads, or at the fabricator’s option added to the MACA.

## F.4

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

## F.5

When attached to a formed head or formed transition component, the CA of minor components shall not exceed 150 % of the vessel design corrosion allowance.

## F.6

The MACA for each major component shall be calculated to the nearest 0,2 mm (0,01 in).

## F.7

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

Public Review Draft

## F.8

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.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.

## 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.

## F.12

The measured minimum thickness shall be used in the as-built calculations and drawings.

Public Review Draft

# 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. lesser than 1000 cycles) and are therefore operating in a lower severity cyclic service application. In other cases, a vessel may be designed for more than 500K 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 latter category include pressure swing absorber (PSA) vessels, molecular sieve dryer vessels, or coke drums.

Appropriate mechanical details for the 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 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 operating in a severe fatigue service application.

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 must 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. Less severe cyclic service vessels intended to be stamped as compliant with ASME *BPVC*, Section VIII, Division 1 are either exempt or pass an evaluation 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 the selected design code, other than ASME *BPVC*, Section VIII, Division 1, does not include screening and evaluation method for fatigue analysis, ASME *BPVC*, Section VIII, Division 2, BS EN 13445 or API 579-1/ASME FFS-1 shall be used.

## G.3

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

a) head-to-shell;

Public Review Draft

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.

## G.6

Butt welds shall be ground flush.

## G.7

Fillet welds shall be blend-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.

NOTE External attachments should be minimized.

## 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 MT or PT.

## G.11

Conical transitions shall be made with knuckle.

## G.12

Lifting attachments on pressure part shall be removed prior to commissioning.

## G.13

The weld toe to weld toe distance between a nozzle and an adjacent structural discontinuity shall be $1{,}8 \times (D \times t_{min})^{0.5}$ or 50 mm (2 in), whichever is greater.

Public Review Draft

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

## H.1

Vessels shall be PWHT at a temperature of 635 °C (1 175 °F ) ± 15 °C (25 °F).

## H.2

The MT method shall be used to detect surface cracks on welds in contact with the process fluid.

Public Review Draft

# Annex I
(normative)
# Additional requirements for vessels in hydrogen 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 and surface examination on wetted surface by MT or PT.

## I.4

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

## I.5

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

## I.6

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

## I.7

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

## I.8

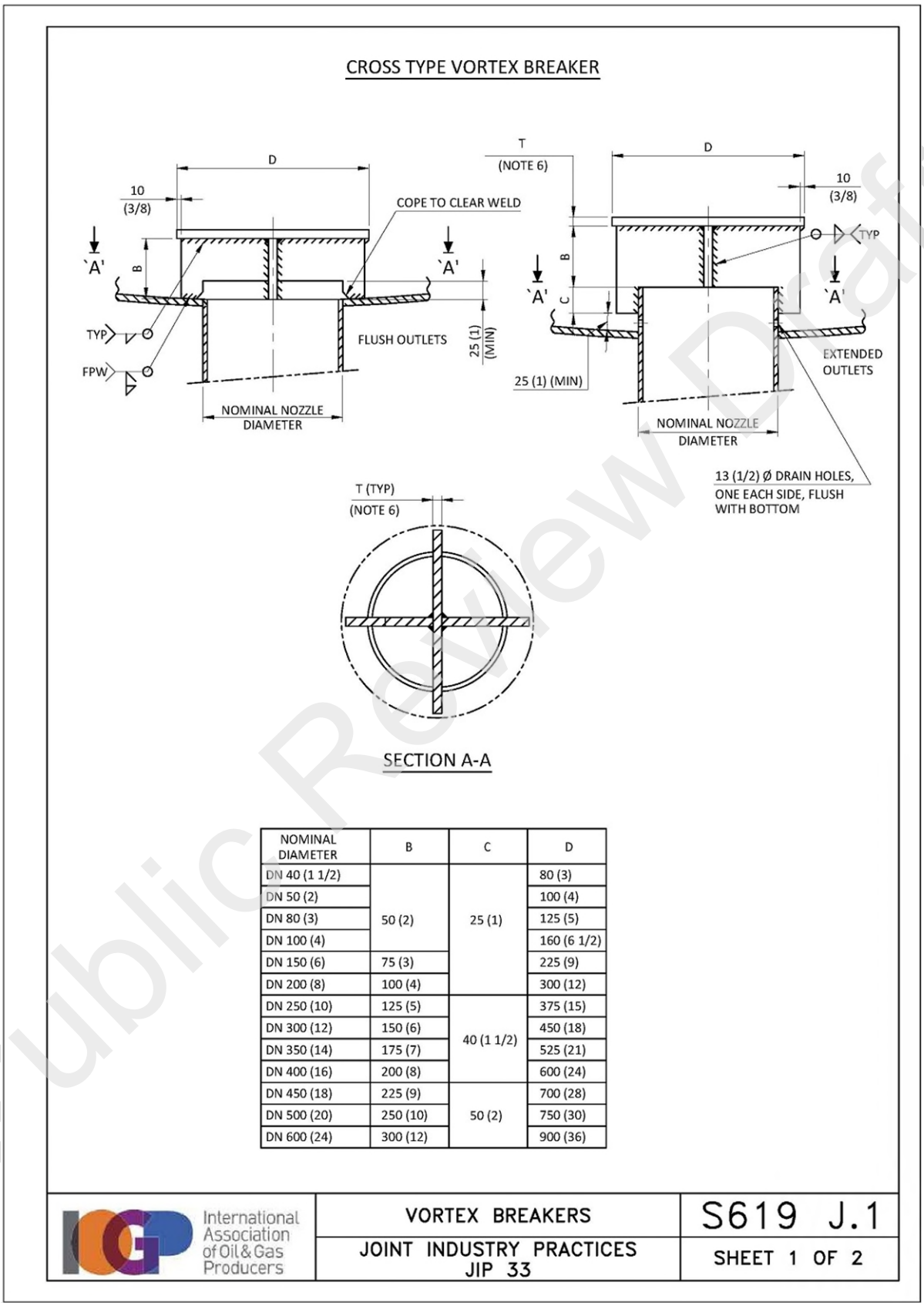
The hardness of attachment welds shall be less than 200 BHN.

Public Review Draft

# Annex J
(normative)
# Standard drawings

Public Review Draft

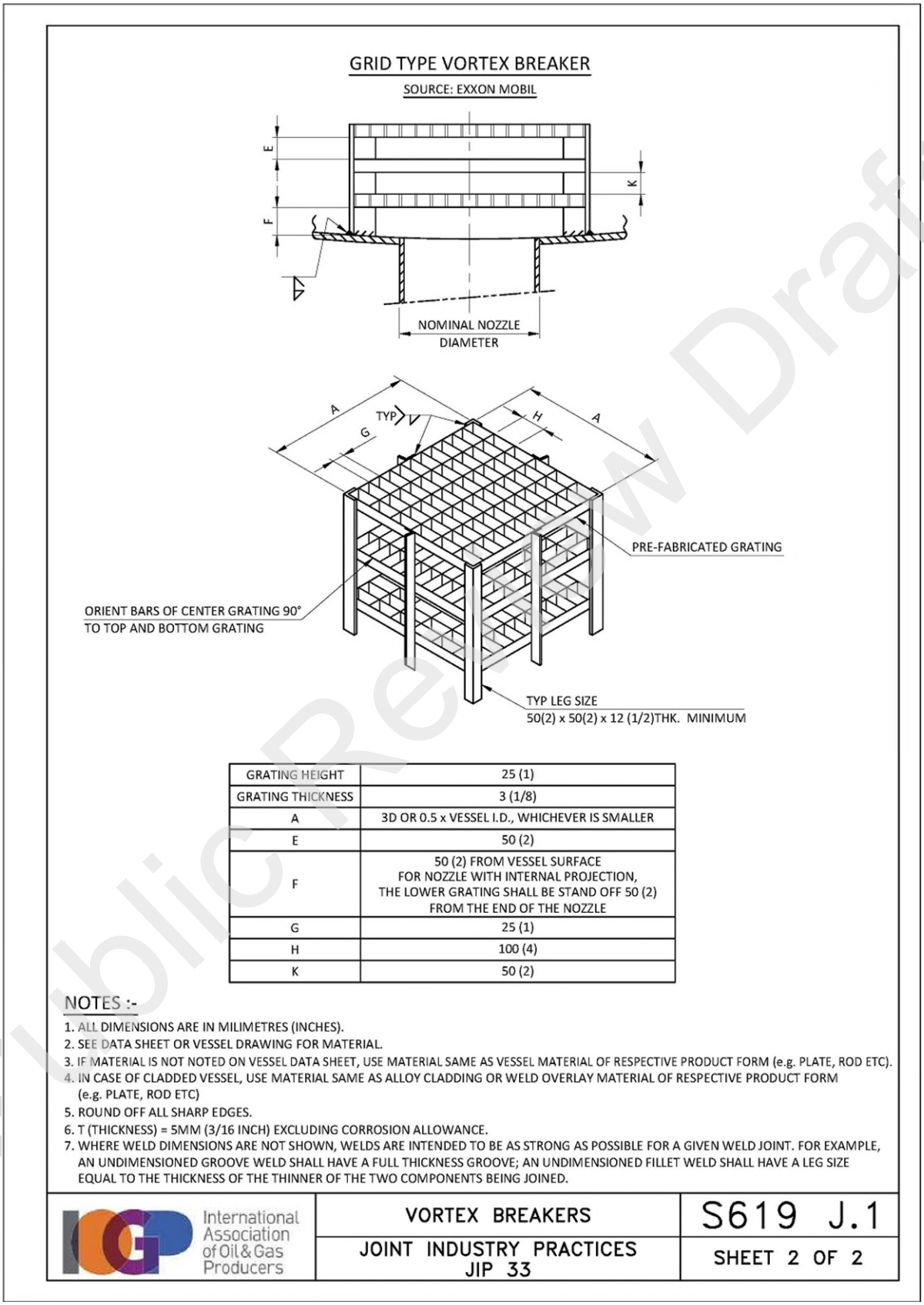
## J.1 Vortex breakers




| 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) |

**Figure J.1.a — Vortex breakers (sheet 1 of 2)**

Public Review Draft




| | |
|---|---|
| GRATING HEIGHT | 25 (1) |
| GRATING THICKNESS | 3 (1/8) |
| A | 3D OR 0.5 x VESSEL I.D., WHICHEVER IS SMALLER |
| E | 50 (2) |
| F | 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 |
| G | 25 (1) |
| H | 100 (4) |
| K | 50 (2) |

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 ETC).
4. IN CASE OF CLADDED VESSEL, USE MATERIAL SAME AS ALLOY CLADDING OR WELD OVERLAY MATERIAL OF RESPECTIVE PRODUCT FORM (e.g. PLATE, ROD ETC)
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.

| | | |
|---|---|---|
| International Association of Oil & Gas Producers | VORTEX BREAKERS | S619 J.1 |
| | JOINT INDUSTRY PRACTICES JIP 33 | SHEET 2 OF 2 |

Public Review Draft

**Figure J.1.b — Vortex breakers (sheet 2 of 2)**

## J.2 Internal ladder rungs

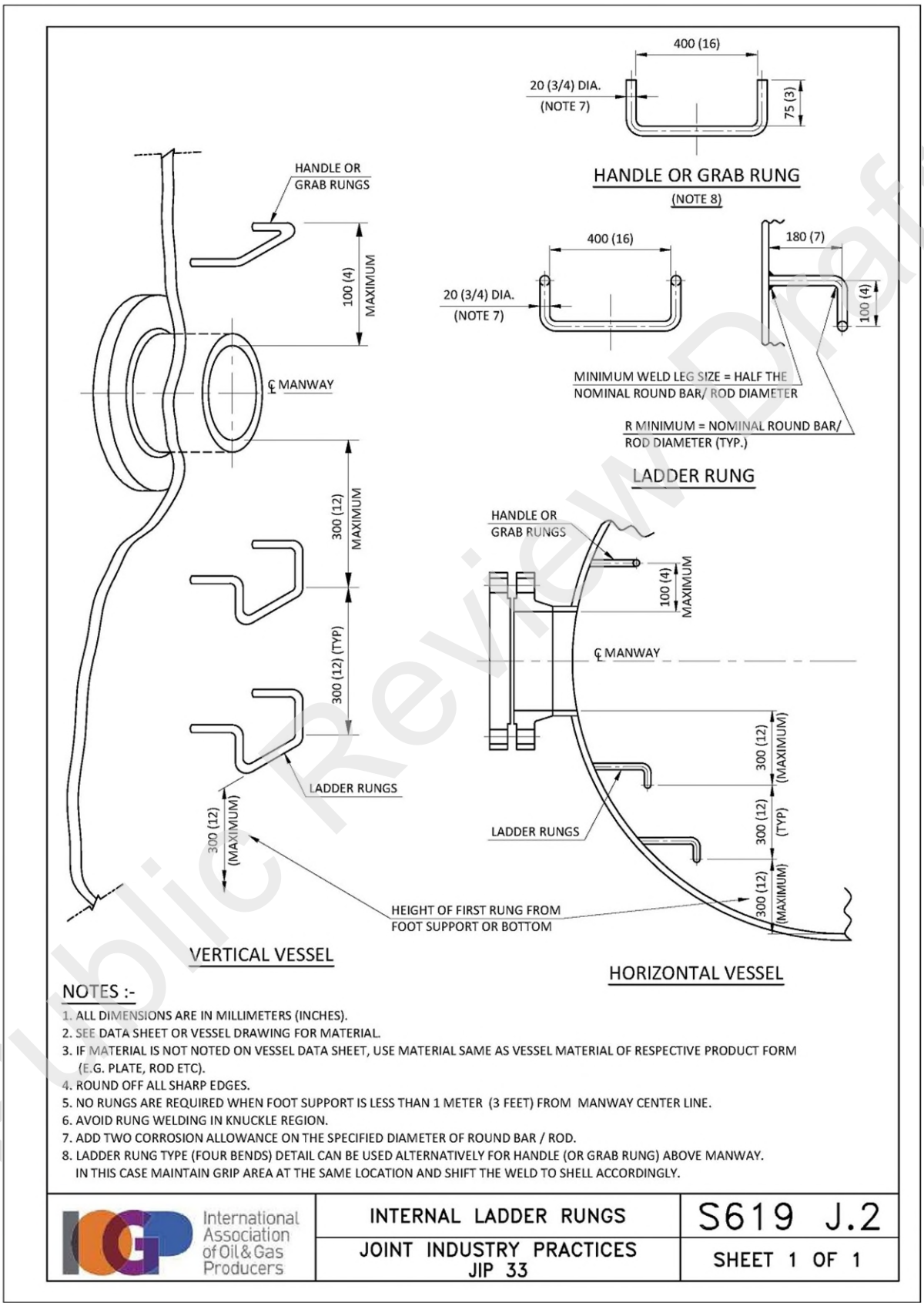



**Figure J.2 — Internal ladder rungs**

Public Review Draft

## J.3 Skirt openings

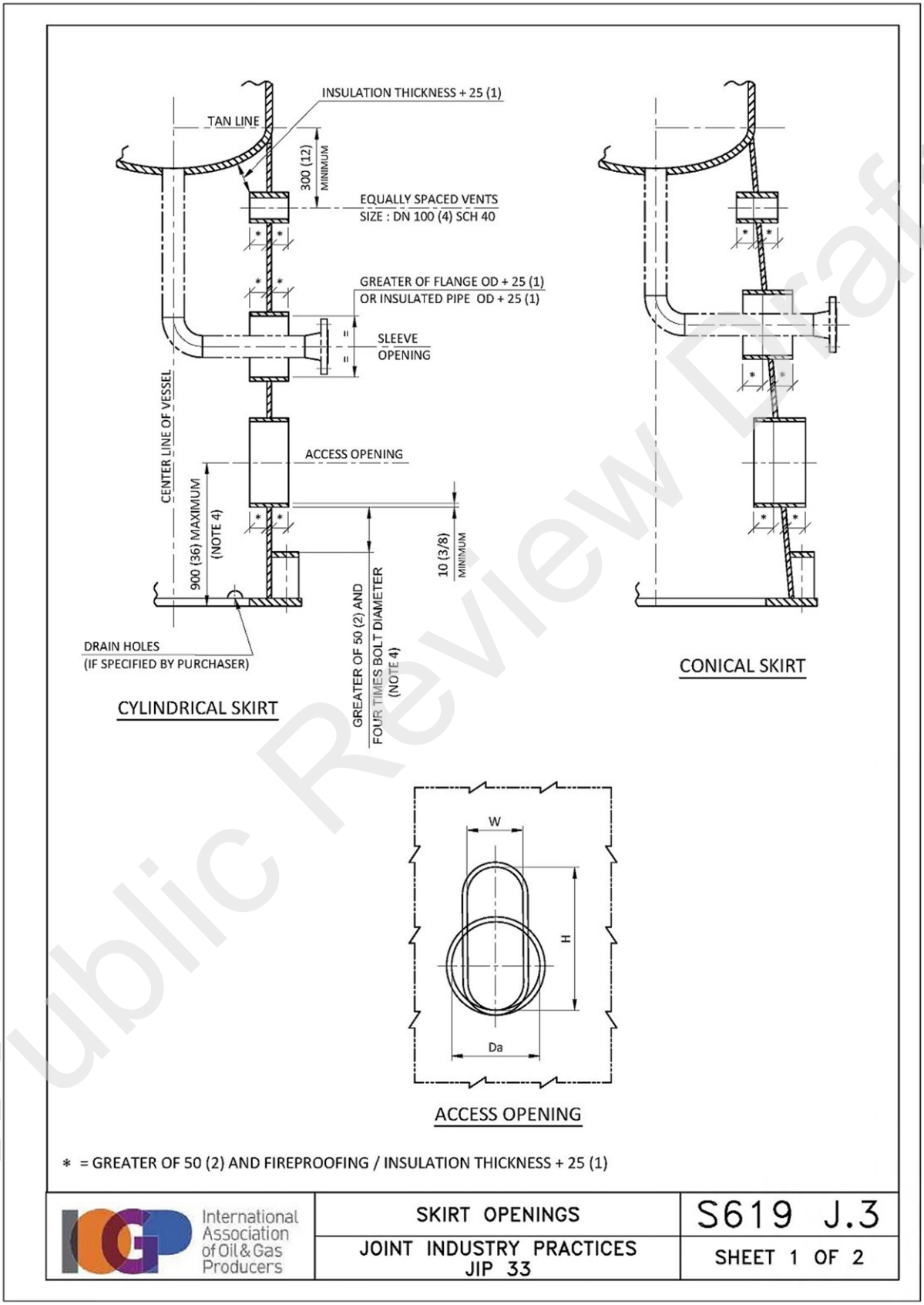
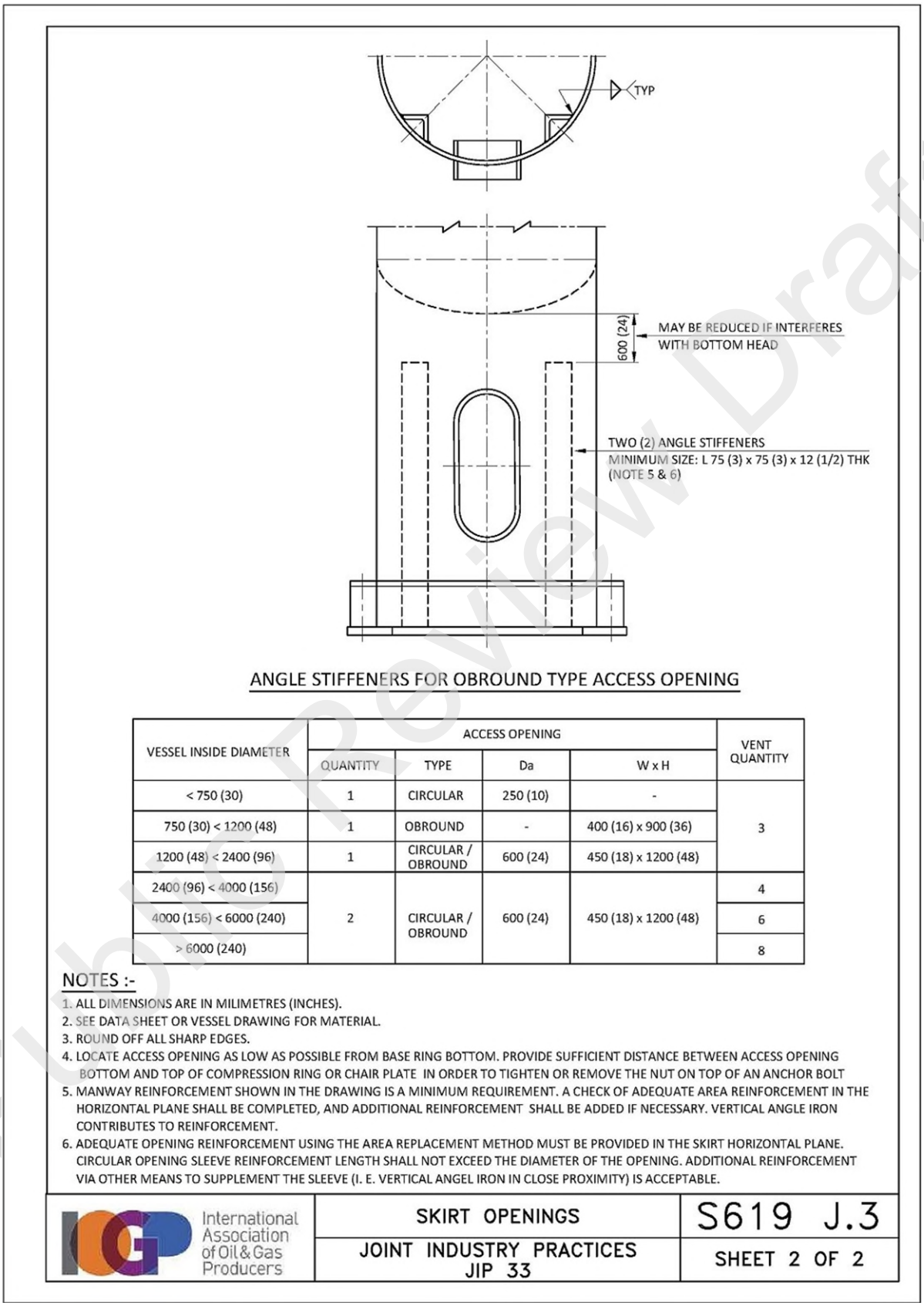



**Figure J.3.a — Skirt openings (sheet 1 of 2)**

Public Review Draft




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 :-

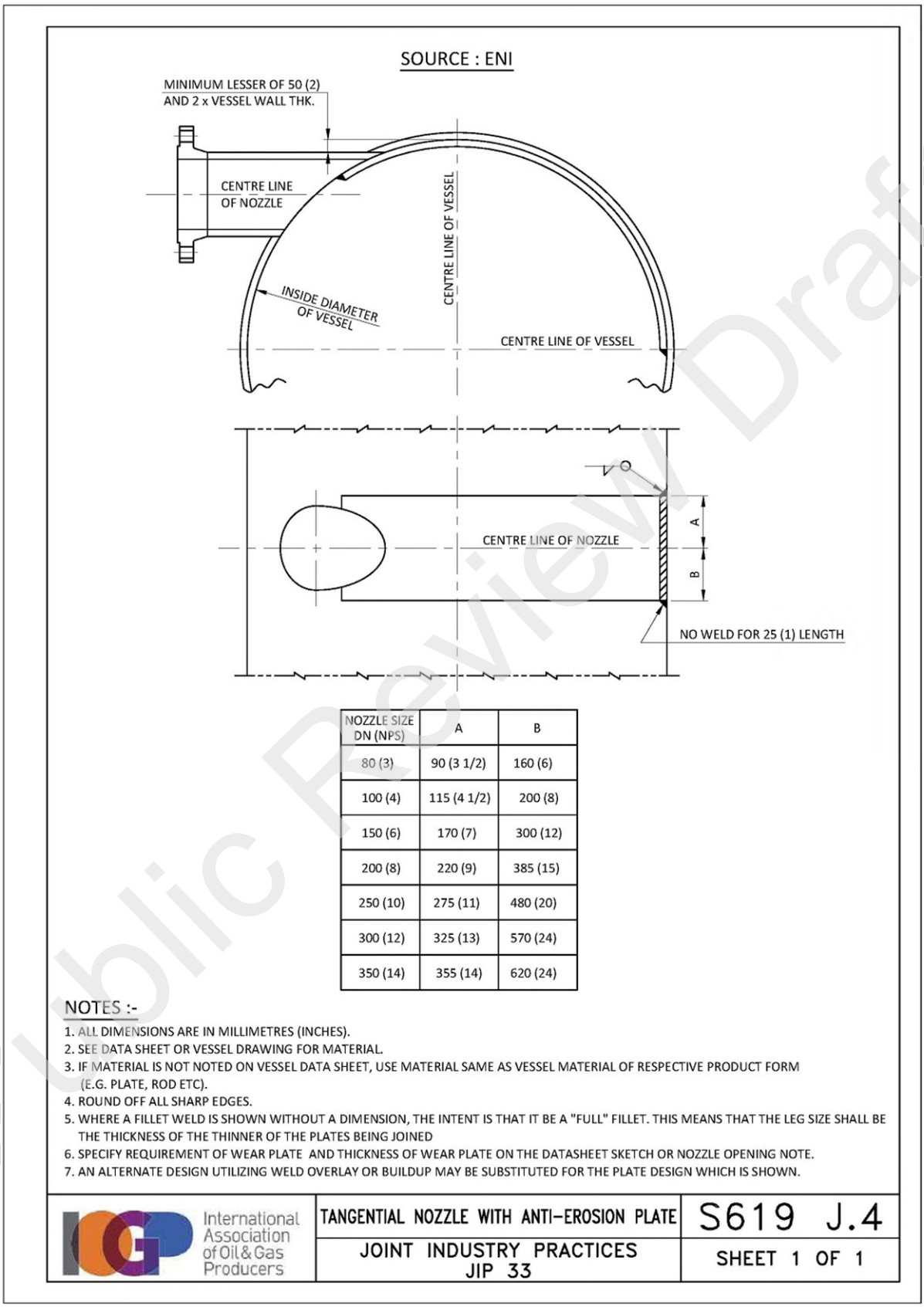
1. ALL DIMENSIONS ARE IN MILIMETRES (INCHES).
2. SEE DATA SHEET OR VESSEL DRAWING FOR MATERIAL.
3. ROUND OFF ALL SHARP EDGES.
4. LOCATE ACCESS OPENING AS LOW AS POSSIBLE FROM BASE RING BOTTOM. PROVIDE SUFFICIENT DISTANCE BETWEEN ACCESS OPENING BOTTOM AND TOP OF COMPRESSION RING OR CHAIR PLATE IN ORDER 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.3 |
| | JOINT INDUSTRY PRACTICES JIP 33 | SHEET 2 OF 2 |

Public Review Draft

**Figure J.3.b — Skirt openings (sheet 2 of 2)**

## J.4 Tangential nozzle anti-erosion plate




| 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) |

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 ETC).
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.4

JOINT INDUSTRY PRACTICES JIP 33 | SHEET 1 OF 1

**Figure J.4 — Tangential nozzle with anti-erosion plate**

Public Review Draft

## J.5 Earthing (grounding) lug

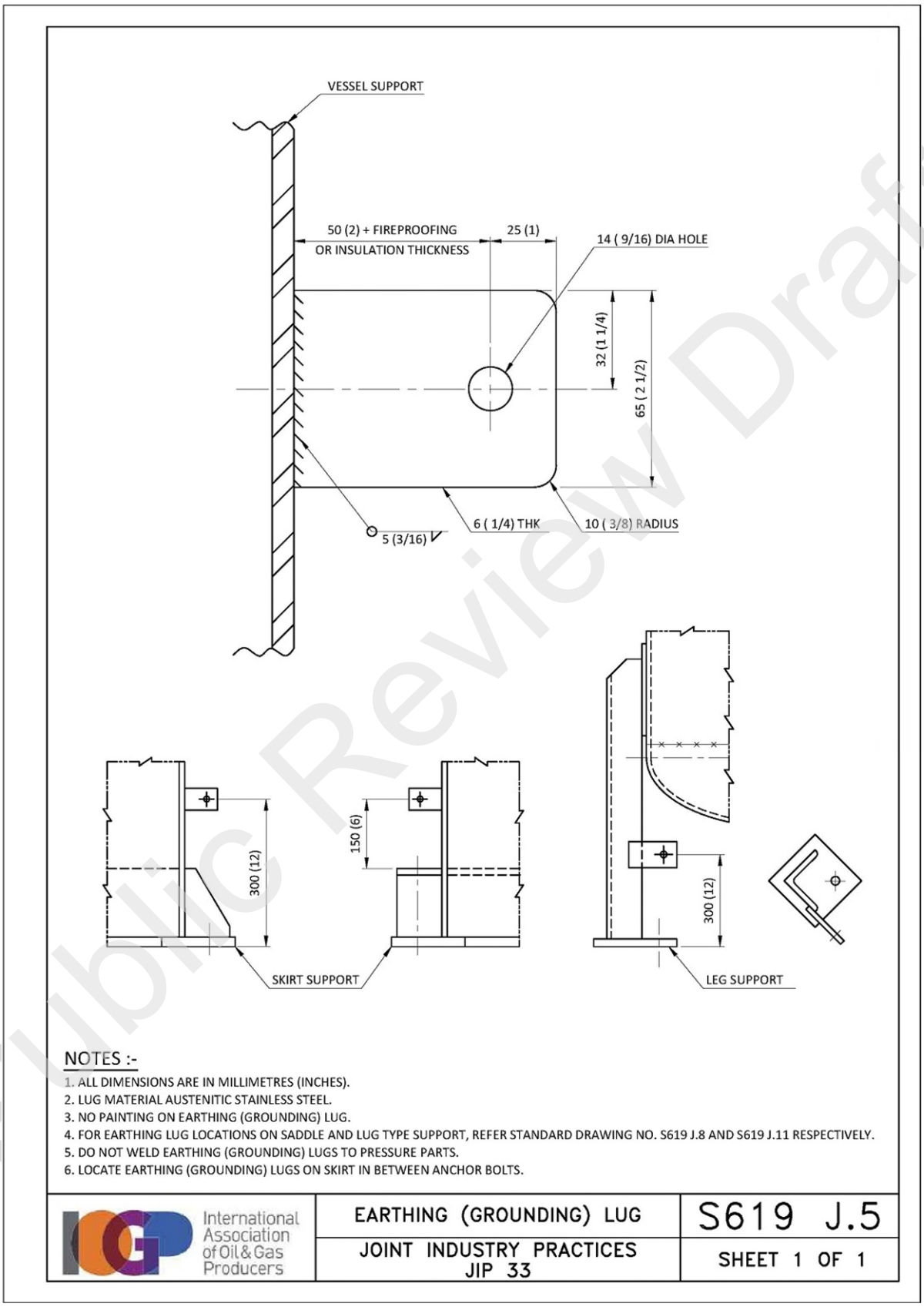



**Figure J.5 — Earthing (grounding) lug**

Public Review Draft

## J.6 Clad restoration details

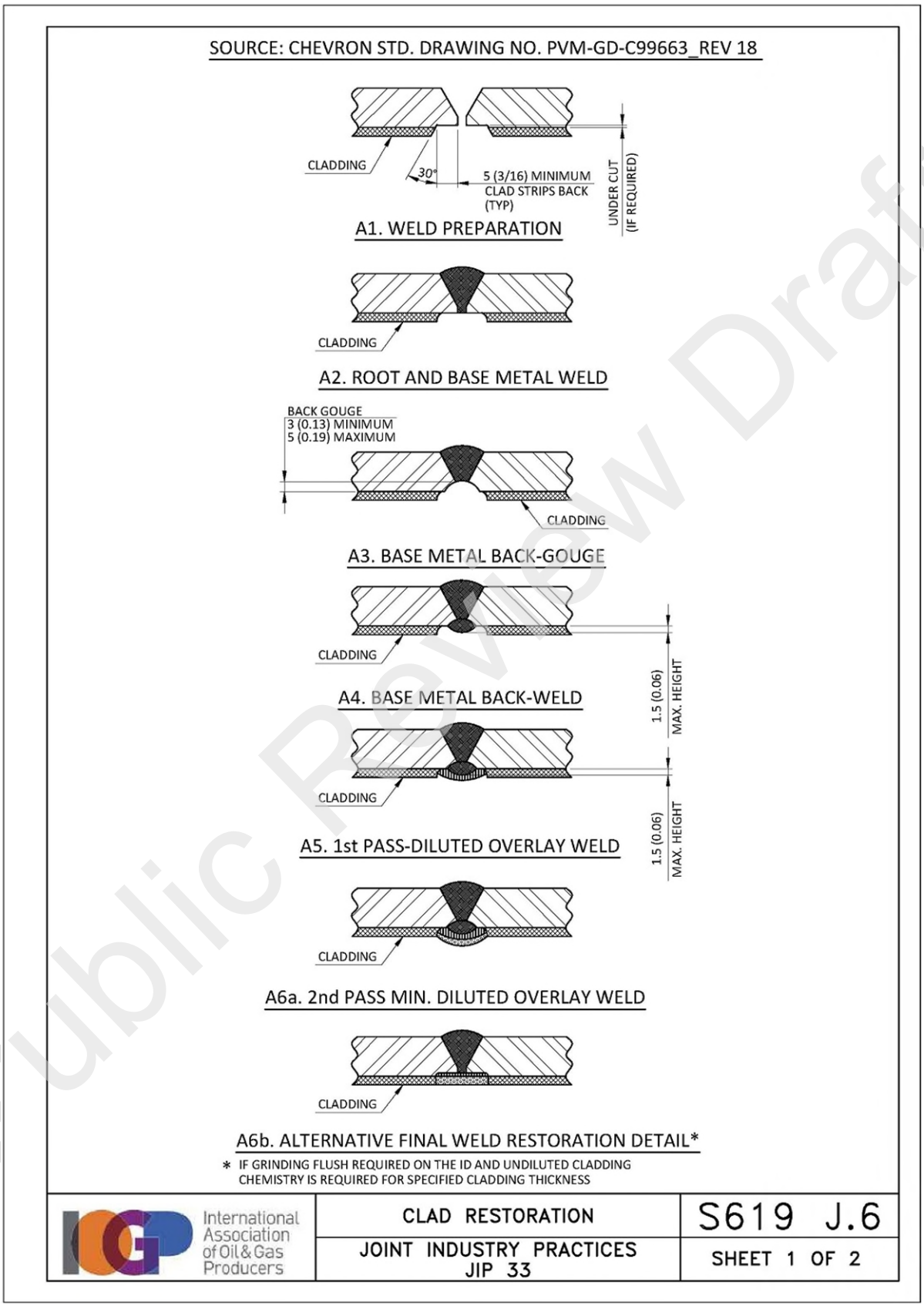



**Figure J.6.a — Clad restoration (sheet 1 of 2)**

Public Review Draft

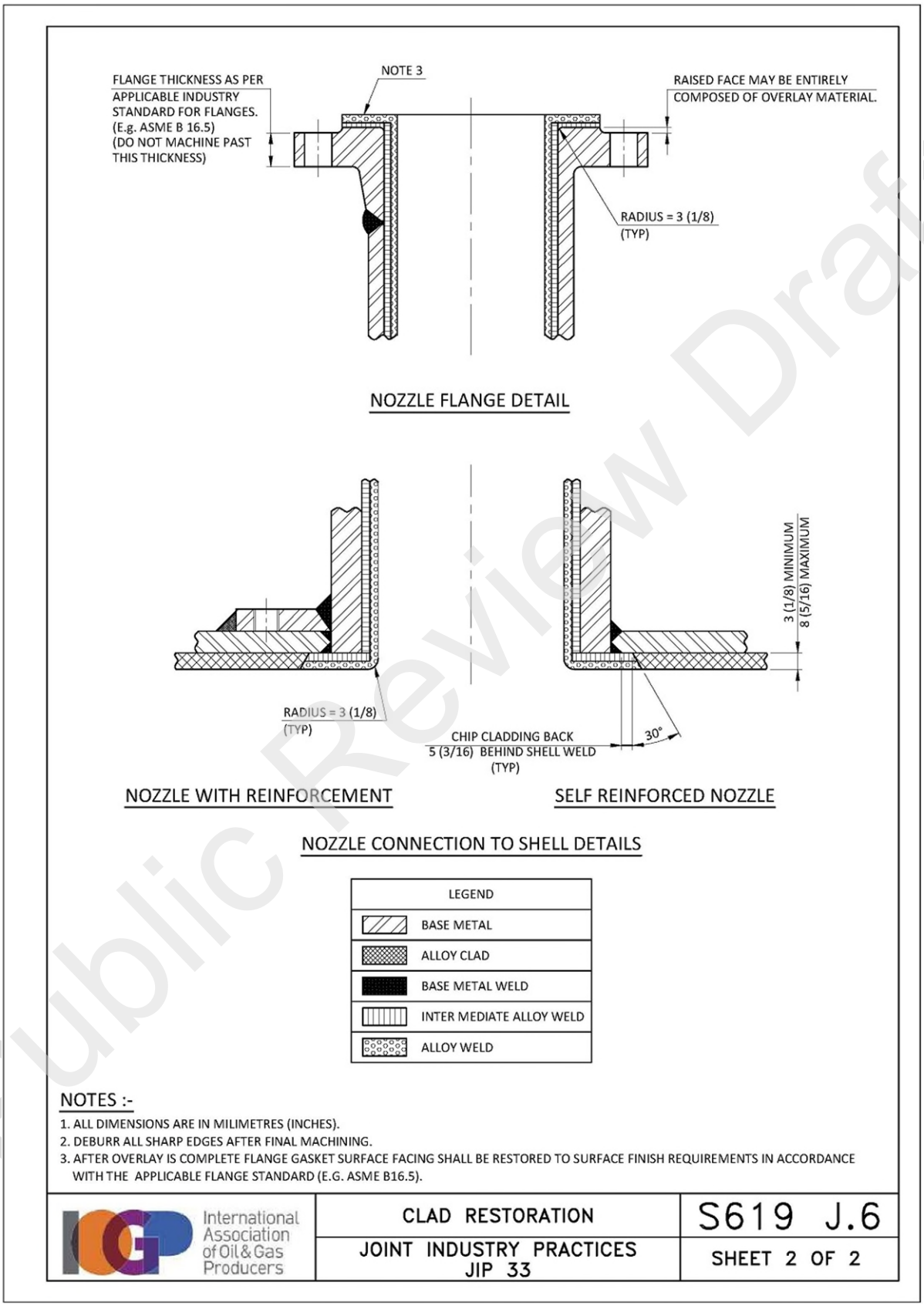



**Figure J.6.b — Clad restoration (sheet 2 of 2)**

Public Review Draft

## J.7 Support clips for fireproofing

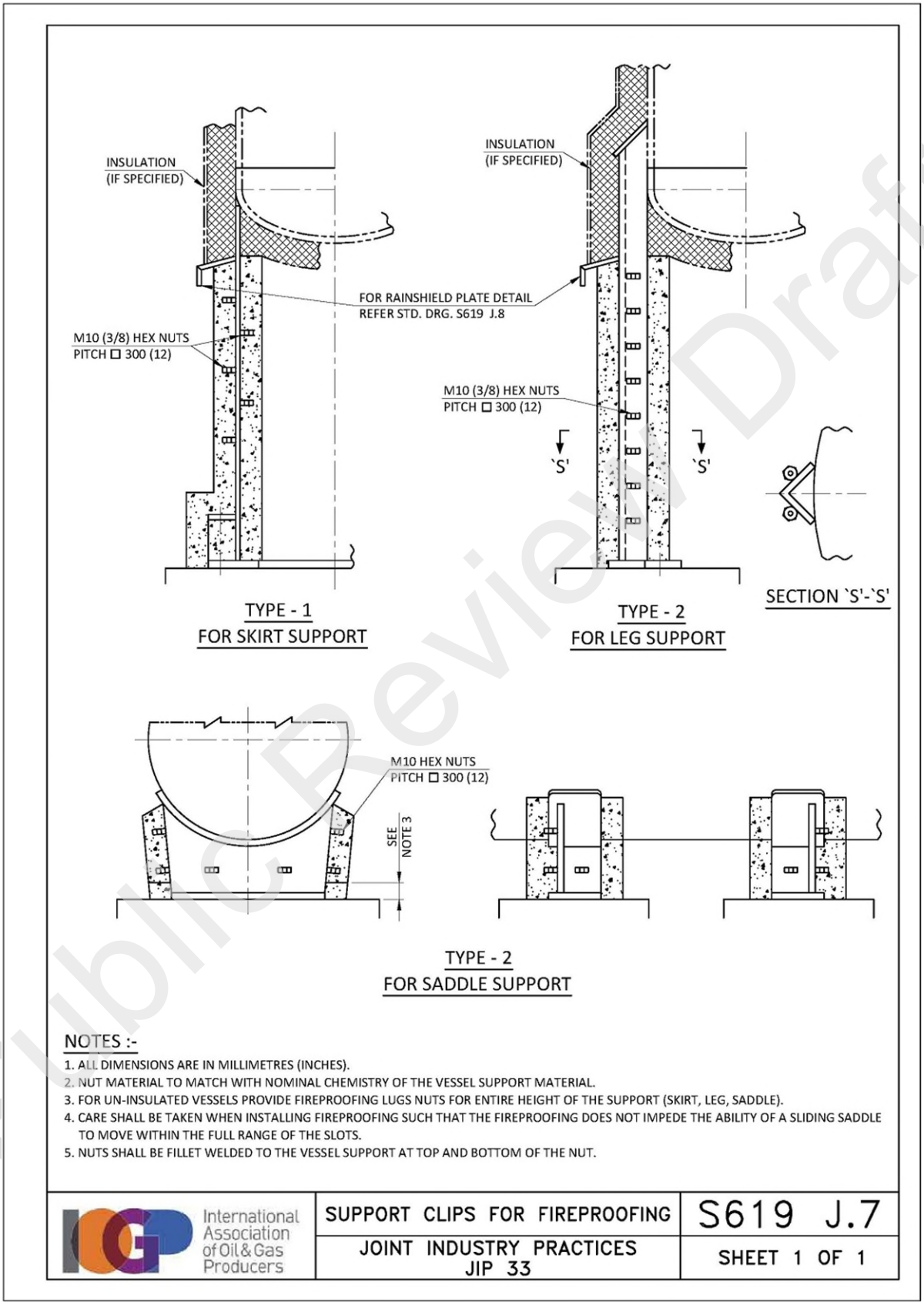



**Figure J.7 — Support clips for fireproofing**

Public Review Draft

## J.8 Insulation supports (hot and cold)

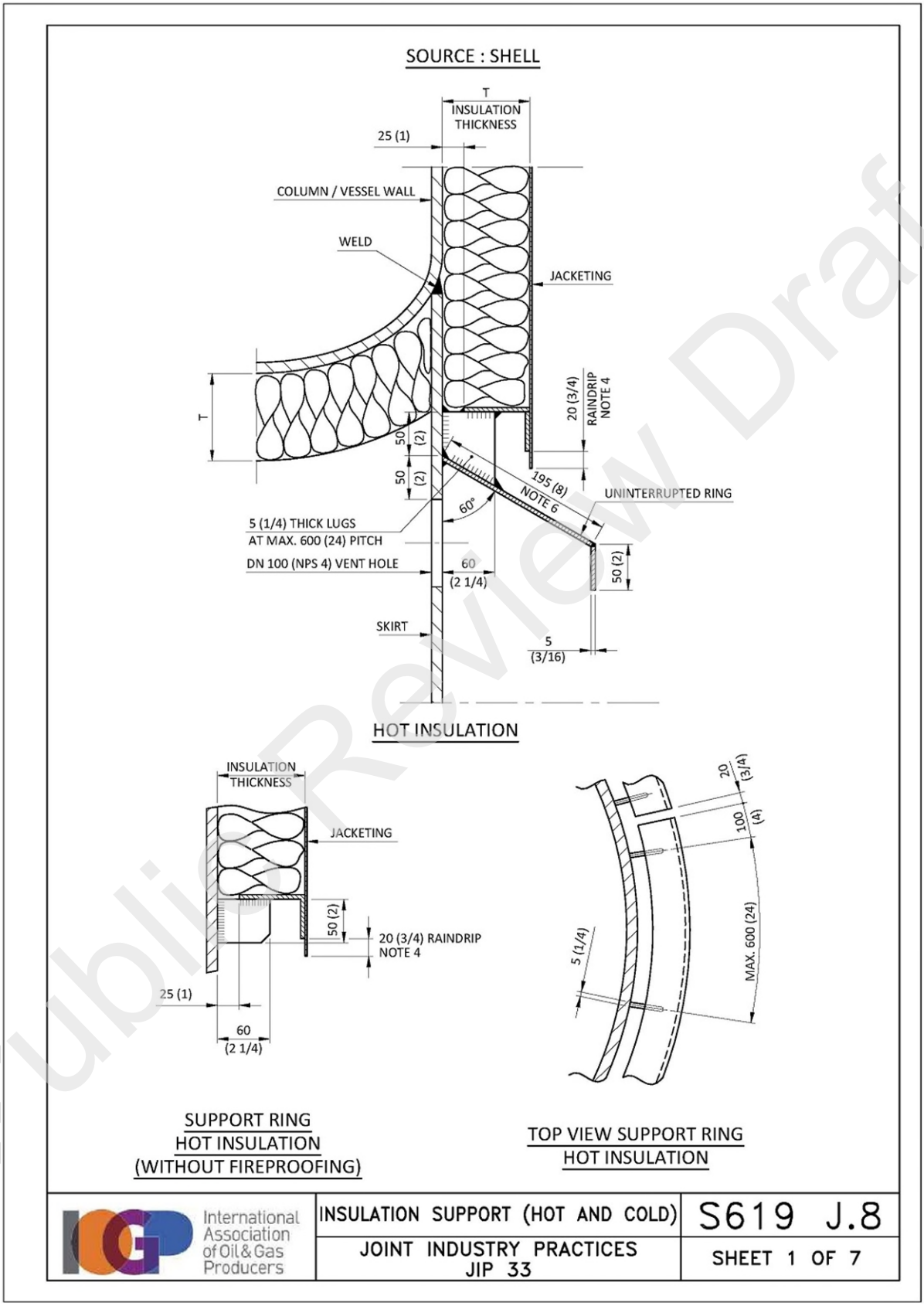



**Figure J.8.a — Insulation supports (hot and cold) (sheet 1 of 7)**

Public Review Draft

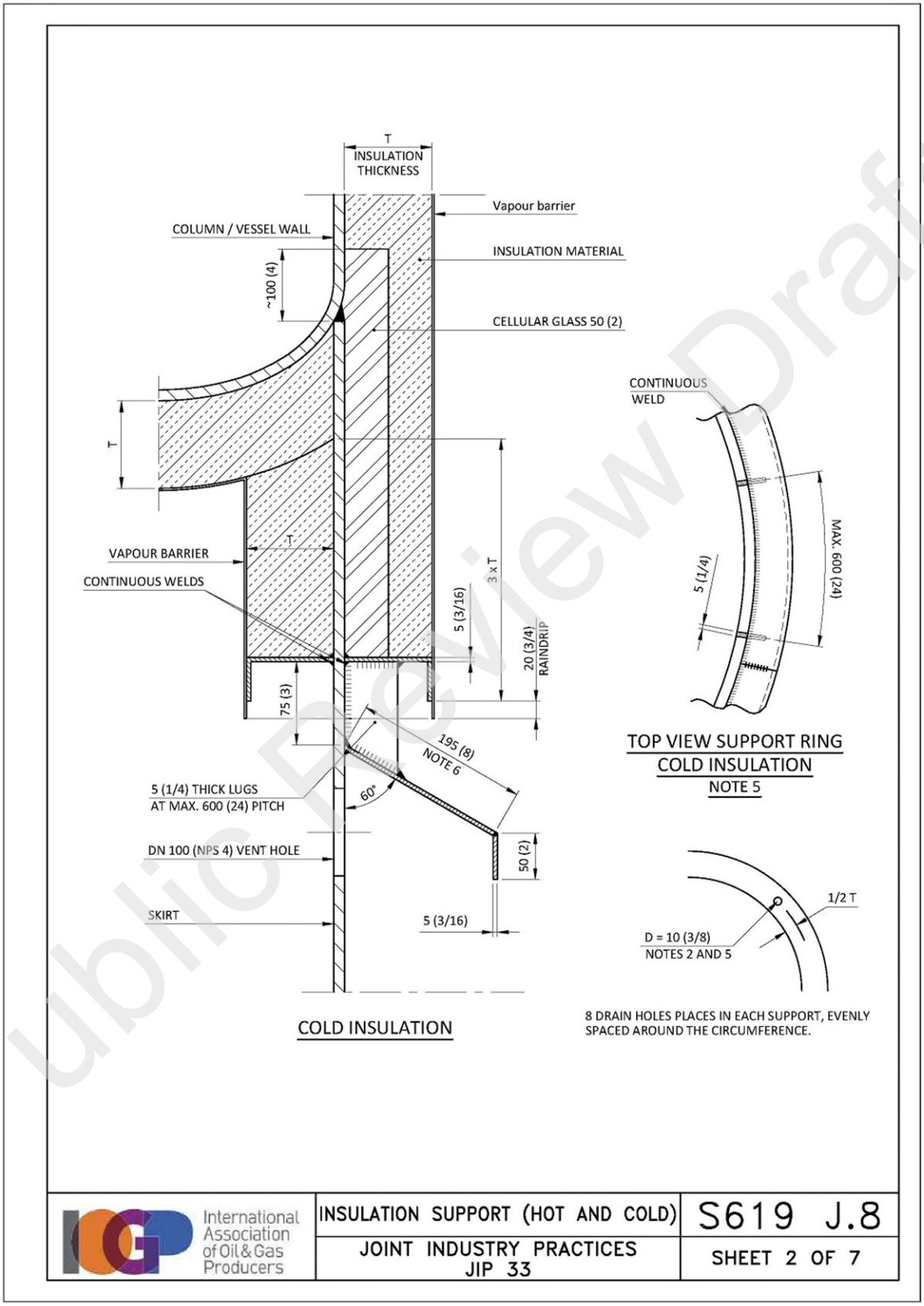



**Figure J.8.b — Insulation supports (hot and cold) (sheet 2 of 7)**

Public Review Draft

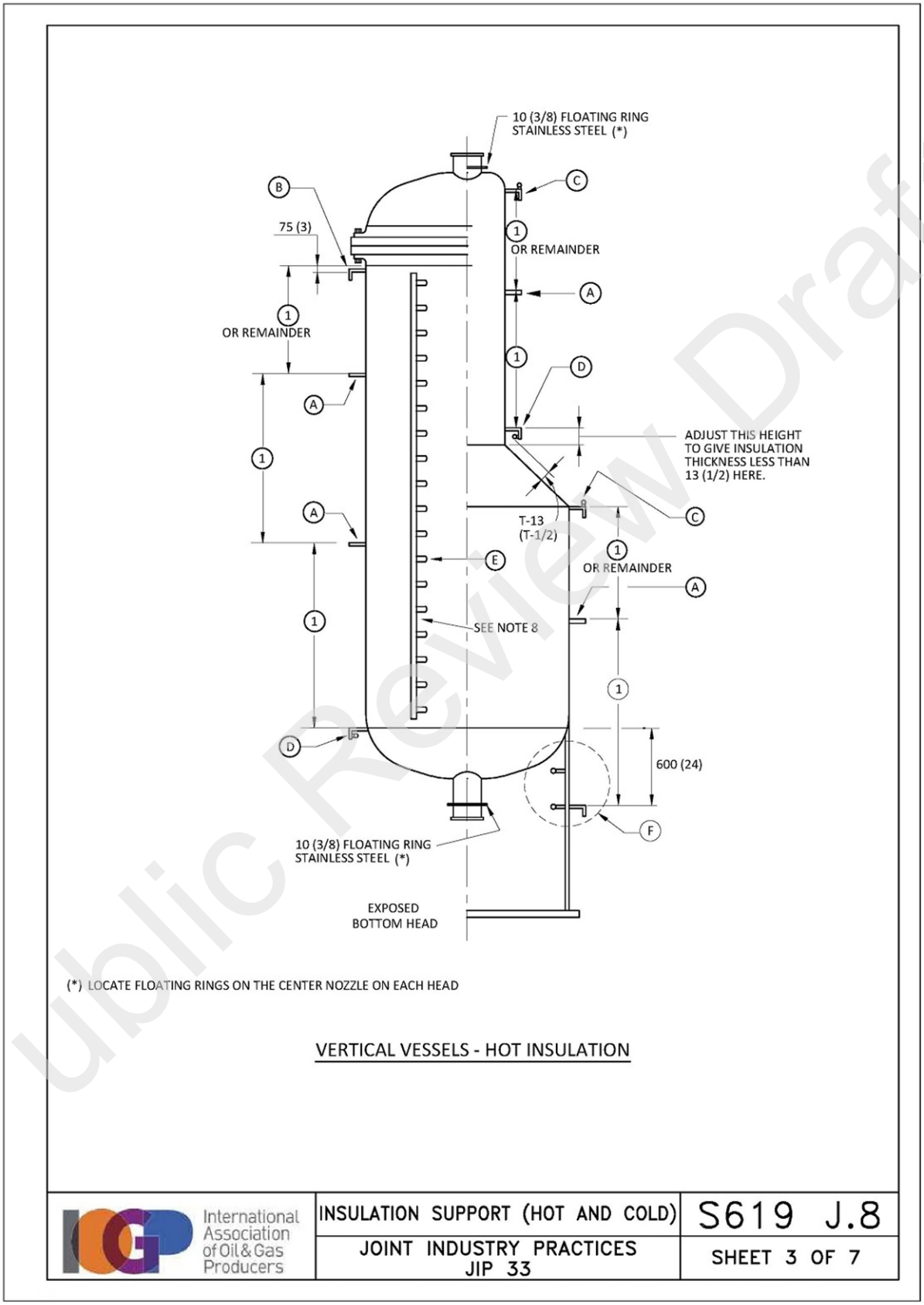



**Figure J.8.c — Insulation supports (hot and cold) (sheet 3 of 7)**

Public Review Draft

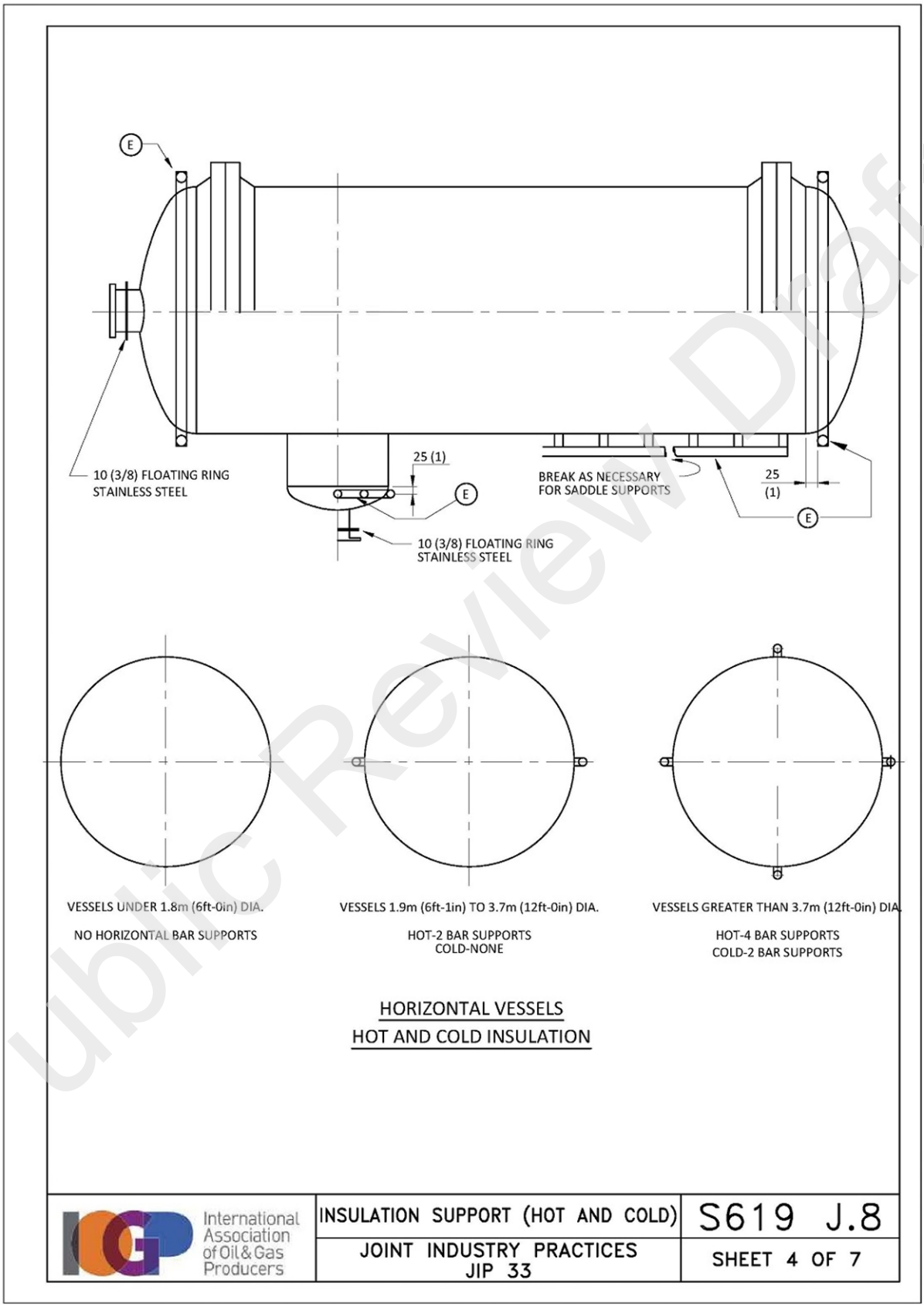



**Figure J.8.d — Insulation supports (hot and cold) (sheet 4 of 7)**

Public Review Draft

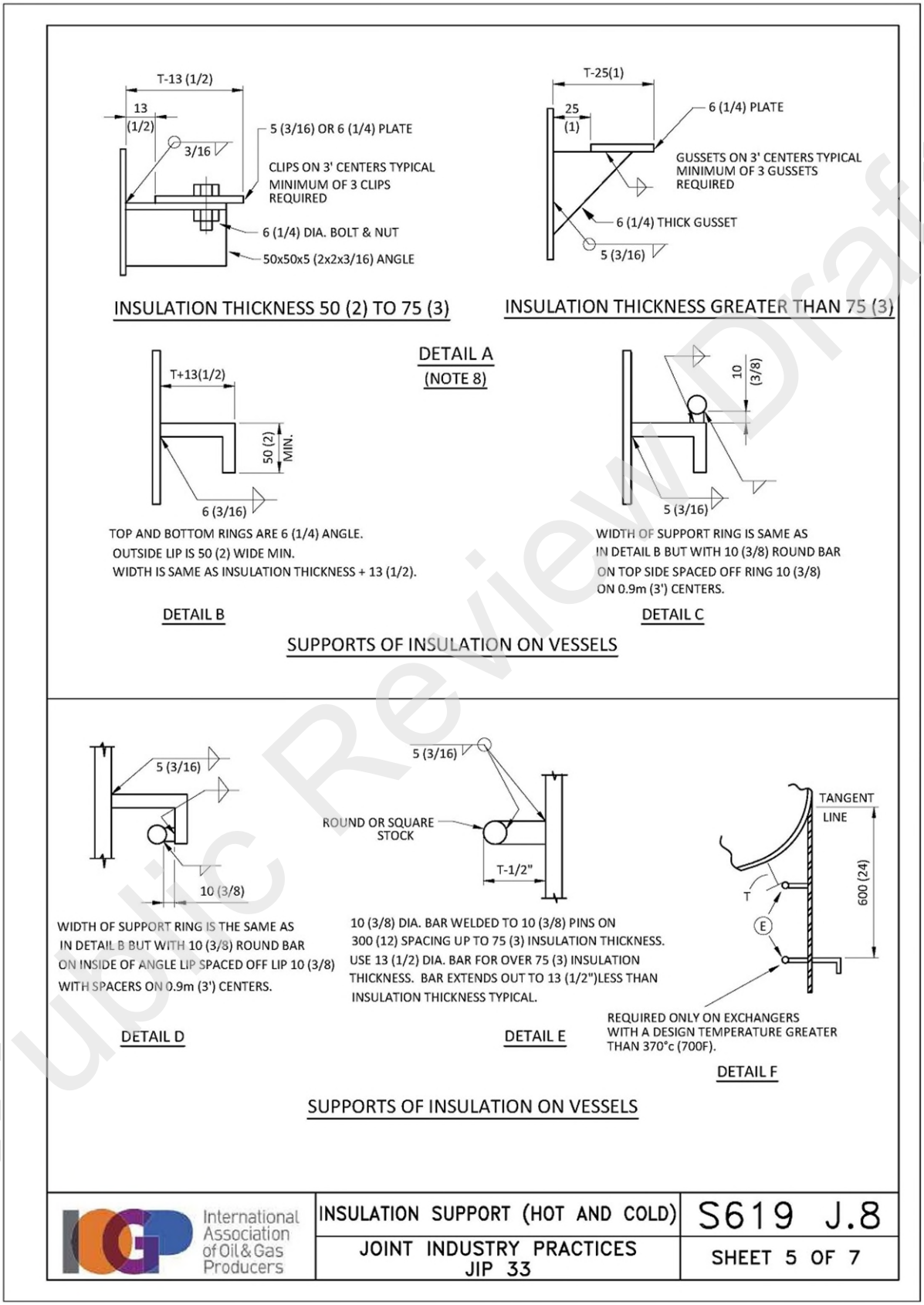



**Figure J.8.e — Insulation supports (hot and cold) (sheet 5 of 7)**

Public Review Draft

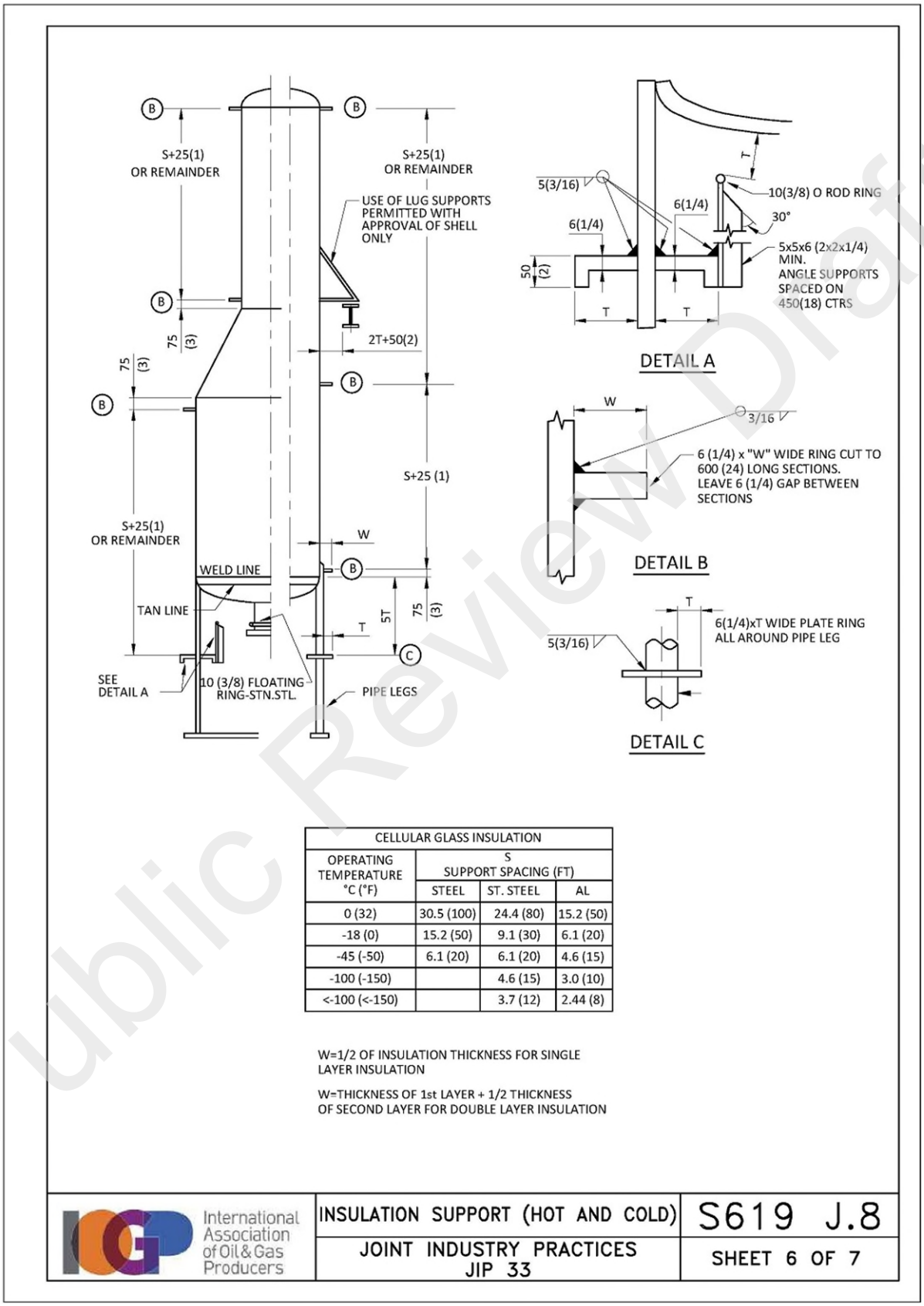
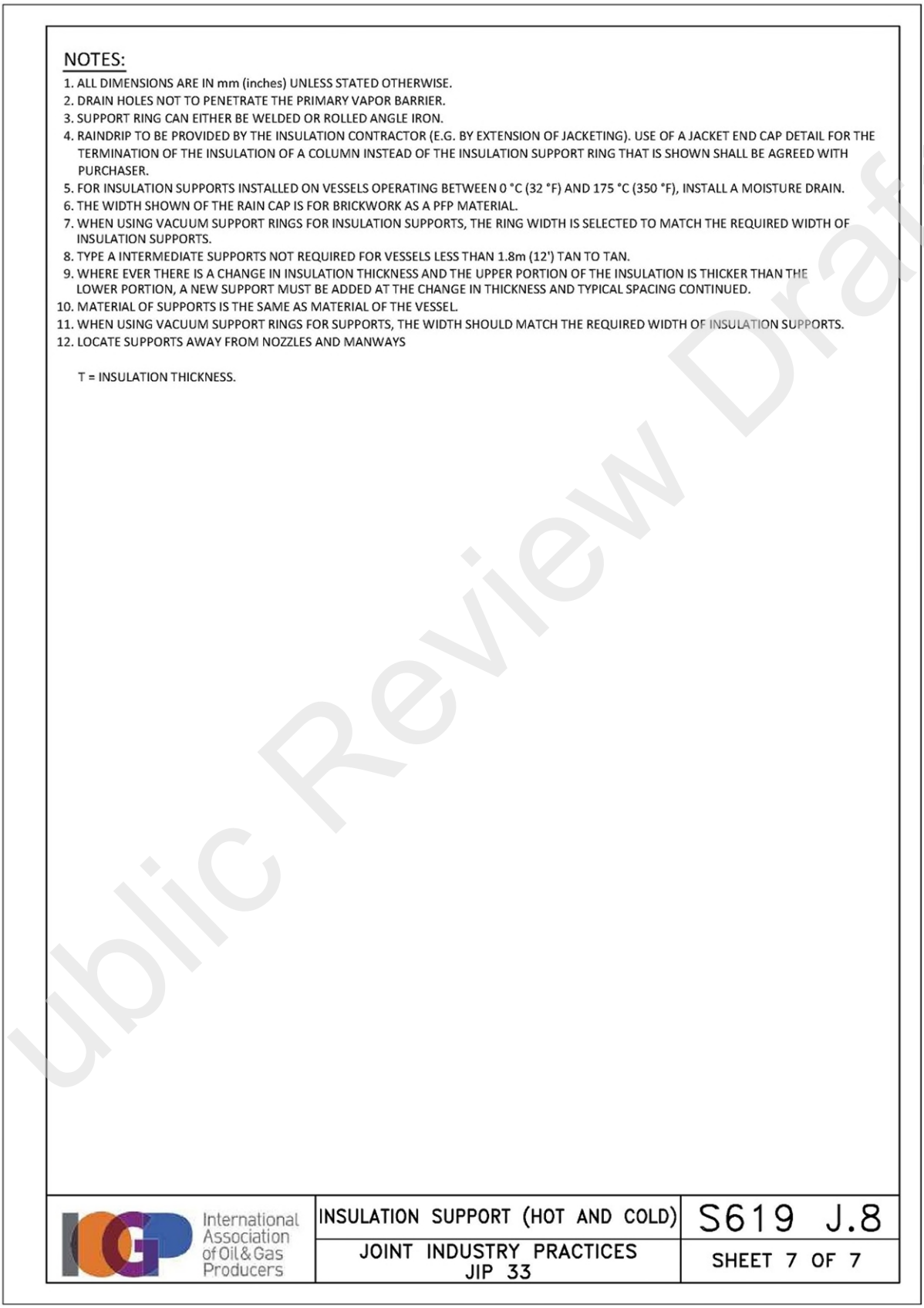



**Figure J.8.f — Insulation supports (hot and cold) (sheet 6 of 7)**

Public Review Draft



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 PFP 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. WHEN USING VACUUM SUPPORT RINGS FOR SUPPORTS, THE WIDTH SHOULD MATCH THE REQUIRED WIDTH OF INSULATION SUPPORTS.
12. LOCATE SUPPORTS AWAY FROM NOZZLES AND MANWAYS

T = INSULATION THICKNESS.



**Figure J.8.g — Insulation supports (hot and cold) (sheet 7 of 7)**

Public Review Draft

## J.9 Saddles for horizontal vessels

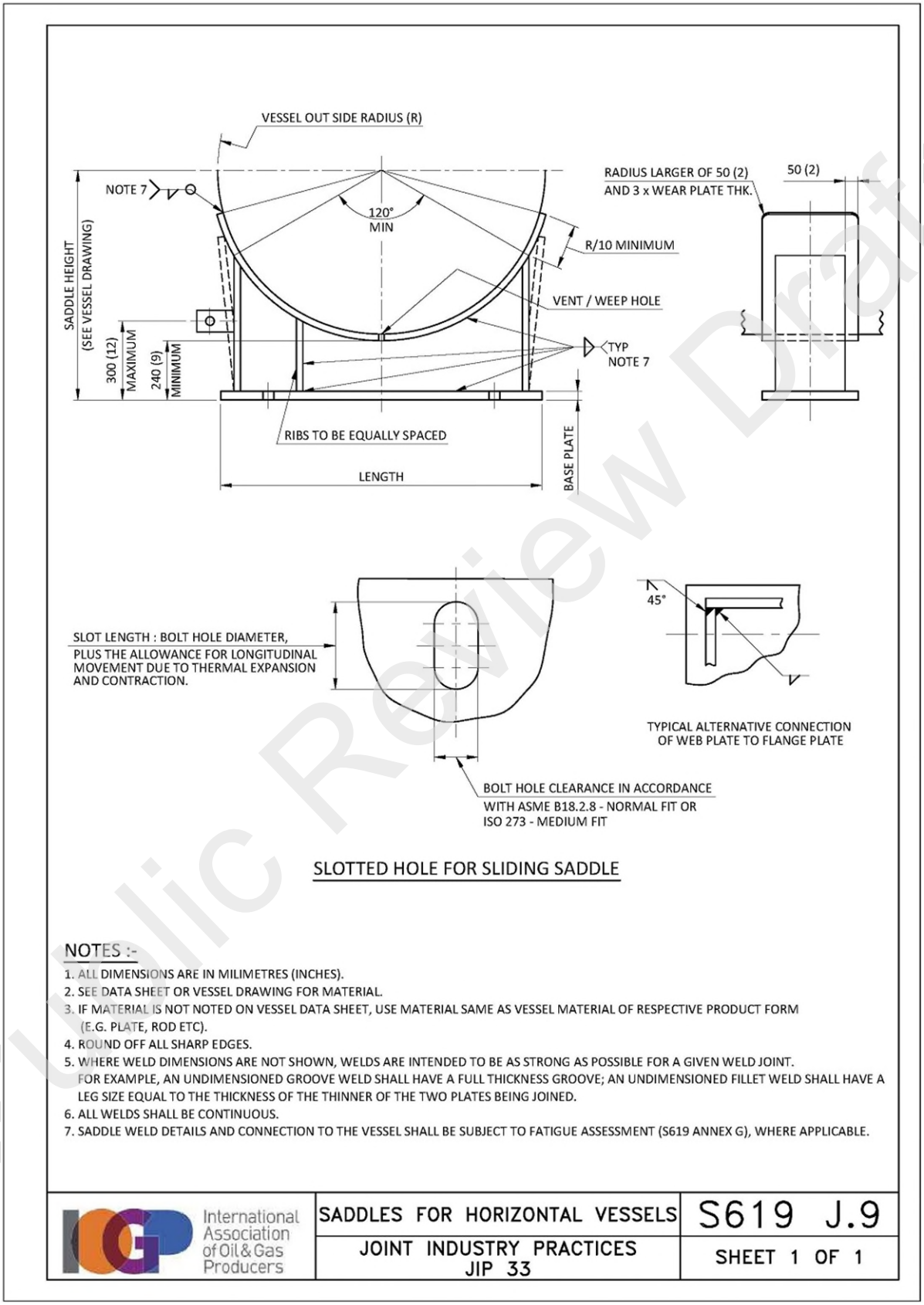



**Figure J.9 — Saddles for horizontal vessels**

Public Review Draft

## J.10 Support lugs and rings

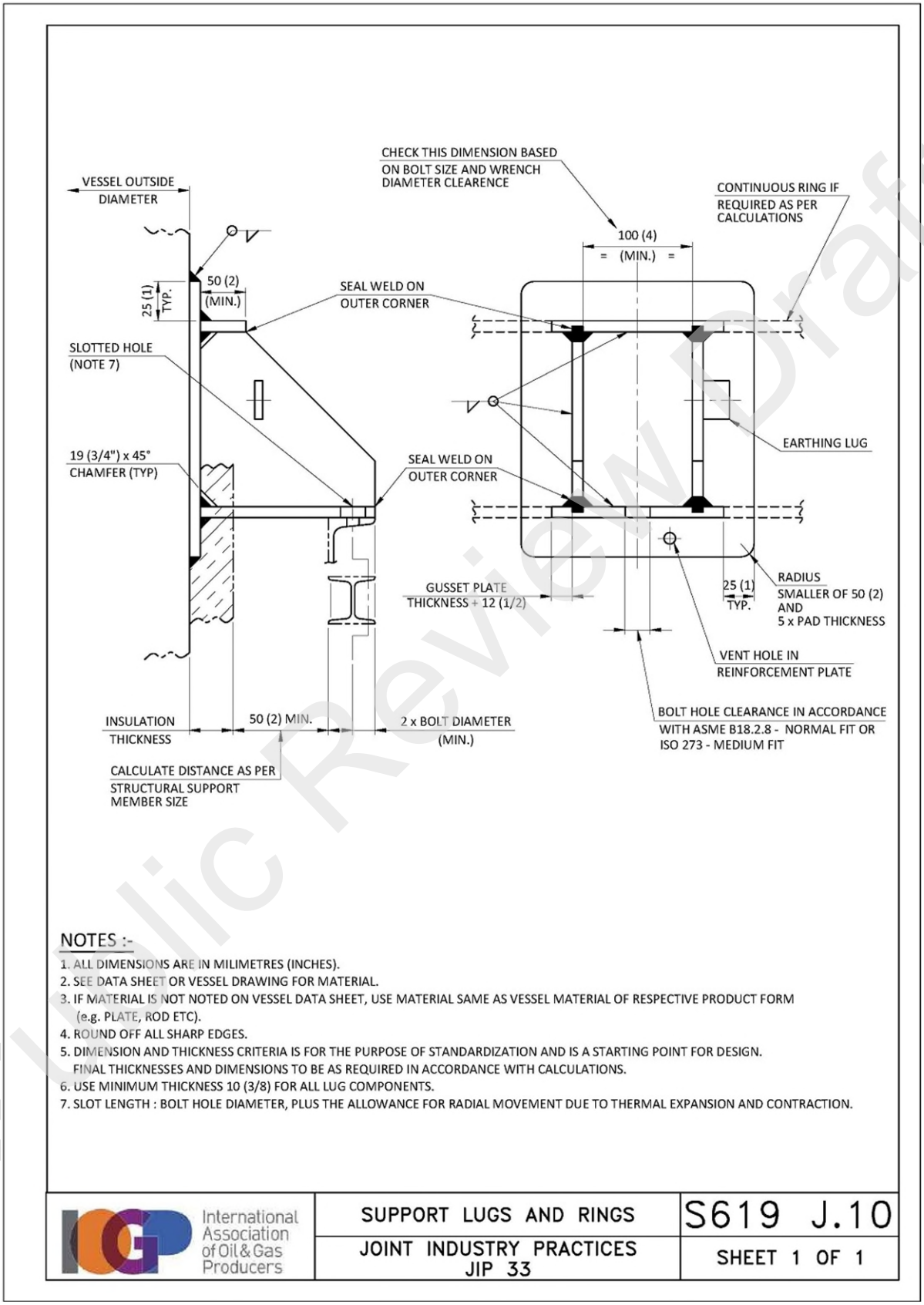



**Figure J.10 — Support lugs and rings**

Public Review Draft

## J.11 Foundation template for skirt supported vessels

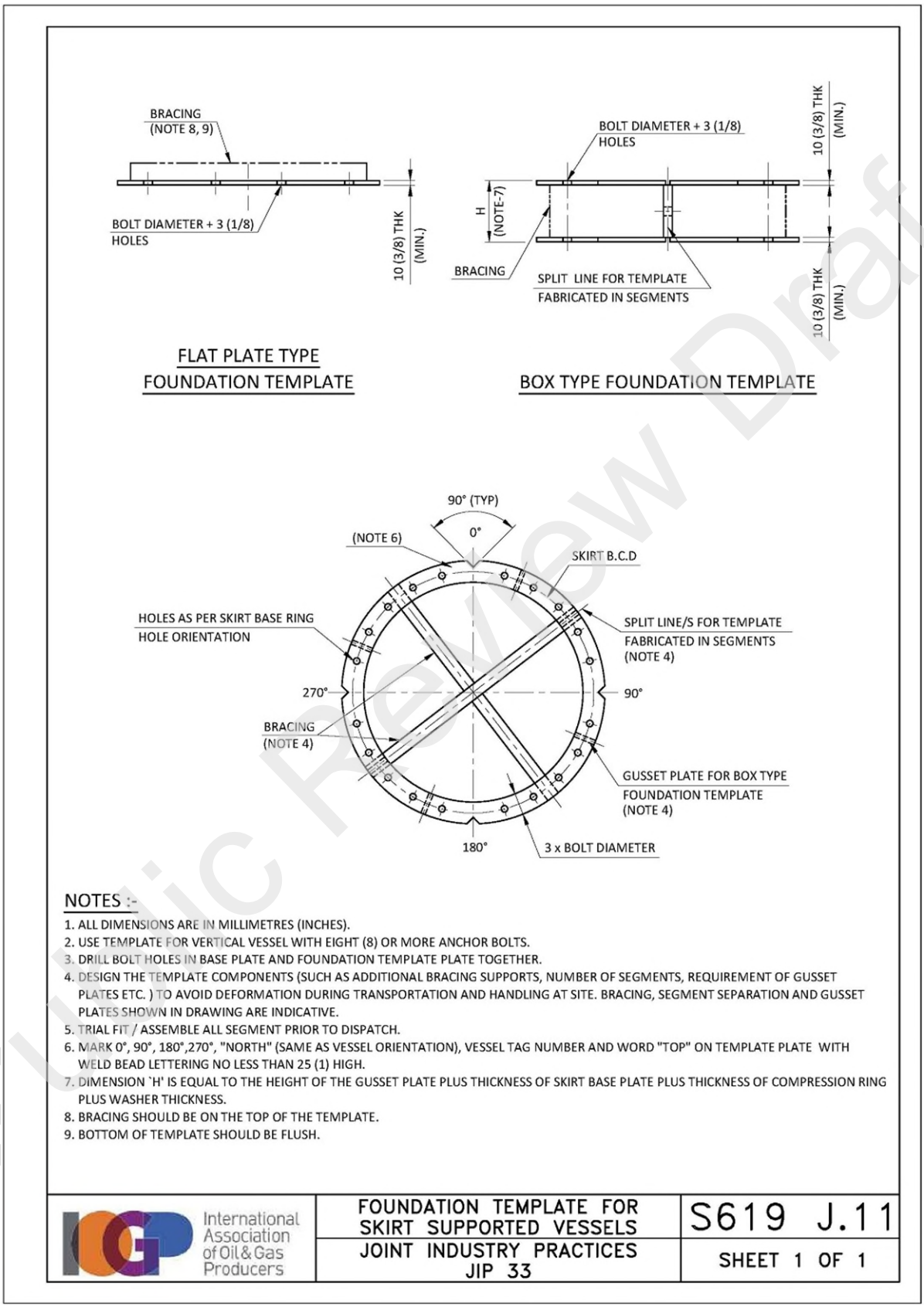



**Figure J.11 — Foundation template for skirt supported vessels**

Public Review Draft

## J.12 Manway davit

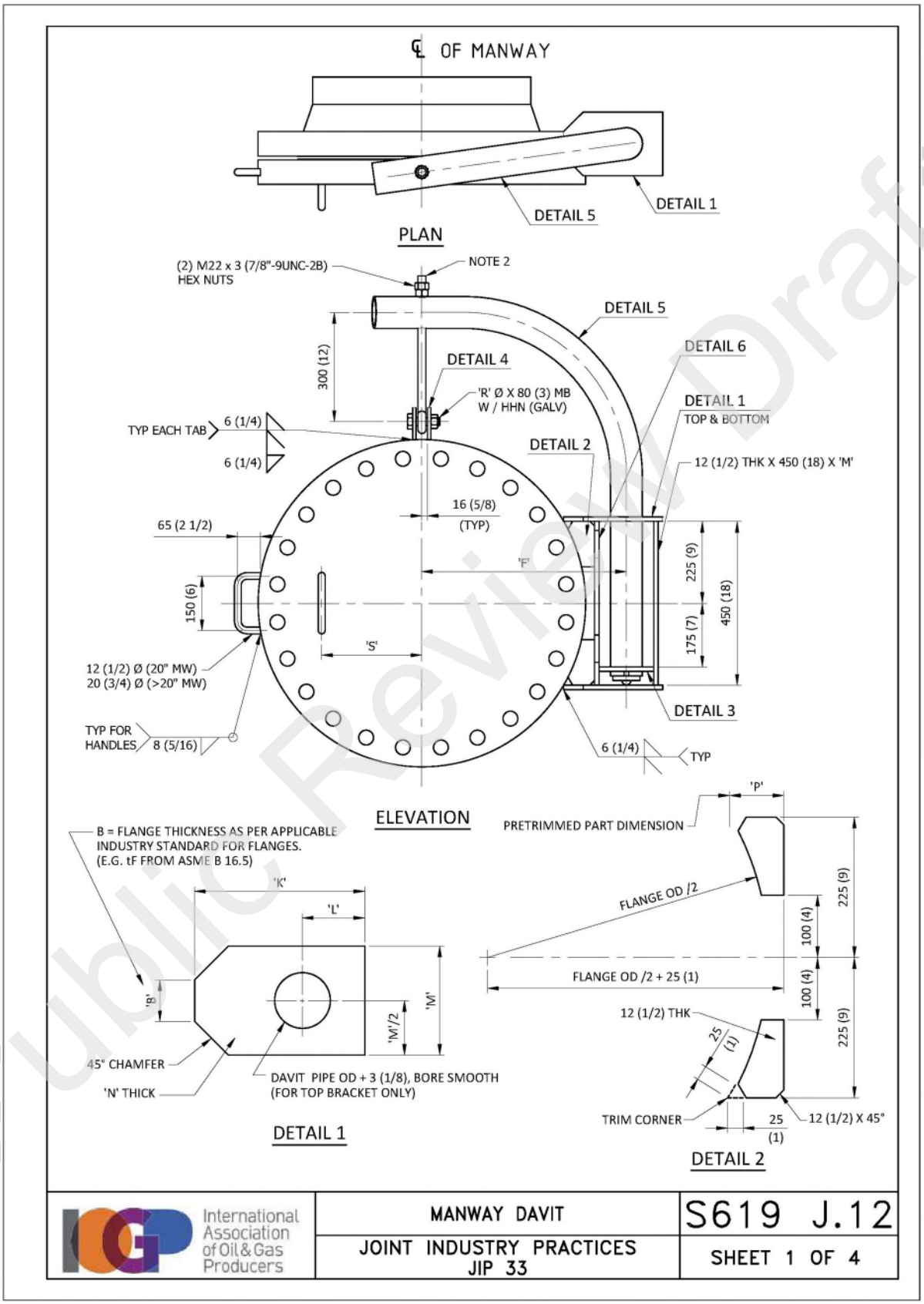



**Figure J.12.a — Manway davit (sheet 1 of 4)**

Public Review Draft

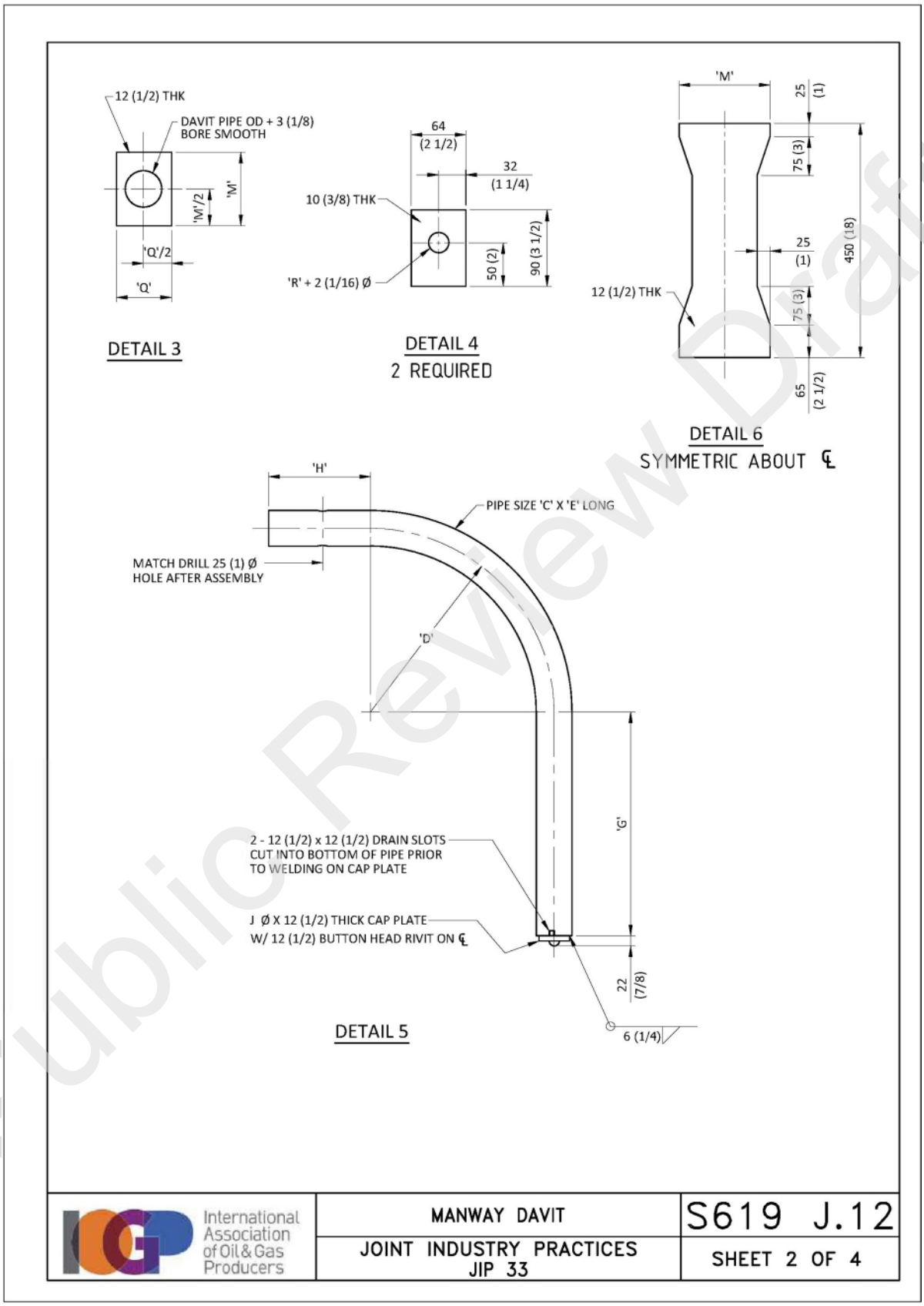



**Figure J.12.b — Manway davit (sheet 2 of 4)**

Public Review Draft

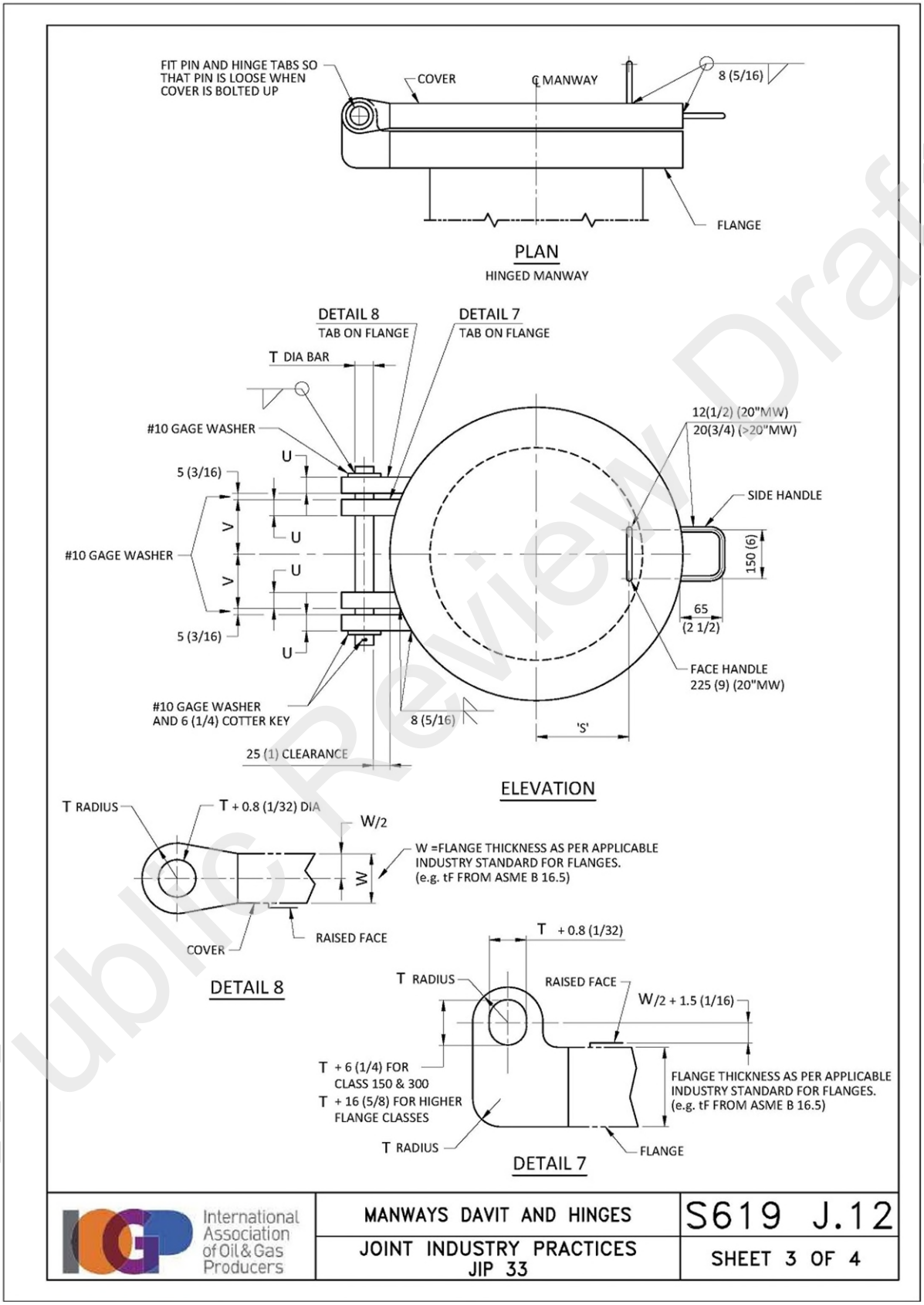



**Figure J.12.c — Manway davit (sheet 3 of 4)**

Public Review Draft

| 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 | | NON-DAVIT DESIGN | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | BOLT DIA | HANDHOLD | PIN DIA | TAB THK | HINGE DIM |
| K | L | M | P | Q | R | S | T | U | V |
| 250.2 (9.85) | 75 (3) | 125 (5) | 110.5 (4.35) | 100 (4) | 22 (0.875) | 225 (9) | 25 (1) | 25 (1) | 150 (6) |
| 239.8 (9.44) | 75 (3) | 125 (5) | 100.1 (3.94) | 100 (4) | 22 (0.875) | 225 (9) | 25 (1) | 25 (1) | 150 (6) |
| 286.3 (11.27) | 100 (4) | 150 (6) | 95.8 (3.77) | 150 (6) | 22 (0.875) | 225 (9) | 32 (1.25) | 25 (1) | 150 (6) |
| 282 (11.10) | 100 (4) | 175 (7) | 91.4 (3.60) | 150 (6) | 22 (0.875) | 225 (9) | 38 (1.5) | 25 (1) | 150 (6) |
| 286.3 (11.27) | 100 (4) | 150 (6) | 95.8 (3.77) | 150 (6) | 22 (0.875) | 275 (11) | 38 (1.5) | 32 (1.25) | 190 (7.5) |
| 277.1 (10.91) | 100 (4) | 175 (7) | 86.6 (3.41) | 150 (6) | 22 (0.875) | 275 (11) | 38 (1.5) | 32 (1.25) | 190 (7.5) |
| 300.8 (11.84) | 115 (4.5) | 200 (8) | 84.8 (3.34) | 175 (7) | 22 (0.875) | 275 (11) | 38 (1.5) | 32 (1.25) | 190 (7.5) |
| 294.1 (11.58) | 115 (4.5) | 200 (8) | 78.2 (3.08) | 175 (7) | 25 (1) | 275 (11) | 50 (2) | 32 (1.25) | 190 (7.5) |
| 279.4 (11.00 ) | 100 (4) | 162.5 (6.5) | 88.9 (3.50) | 150 (6) | 22 (0.875) | 350 (14) | 38 (1.5) | 38 (1.5) | 225 (9) |
| 297.2 (11.70) | 115 (4.5) | 200 (8) | 81.3 (3.20) | 175 (7) | 22 (0.875) | 350 (14) | 38 (1.5) | 38 (1.5) | 225 (9) |
| 295.1 (11.62) | 115 (4.5) | 200 (8) | 79.2 (3.12) | 175 (7) | 25 (1) | 350 (14) | 45 (1.75) | 38 (1.5) | 225 (9) |
| 293.4 (11.55 | 115 (4.5) | 200 (8) | 77.5 (3.05) | 175 (7) | 22 (0.875) | 425 (17) | 38 (1.5) | 38 (1.5) | 225 (9) |
| 287.8 (11.33) | 115 (4.5) | 200 (8) | 71.9 (2.83) | 175 (7) | 25 (1) | 425 (17) | 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 | MANWAY DAVIT | S619 J.12 |
|---|---|---|
| | JOINT INDUSTRY PRACTICES JIP 33 | SHEET 4 OF 4 |

Public review draft

**Figure J.12.d — Manway davit (sheet 4 of 4)**

## J.13 Nozzle standout

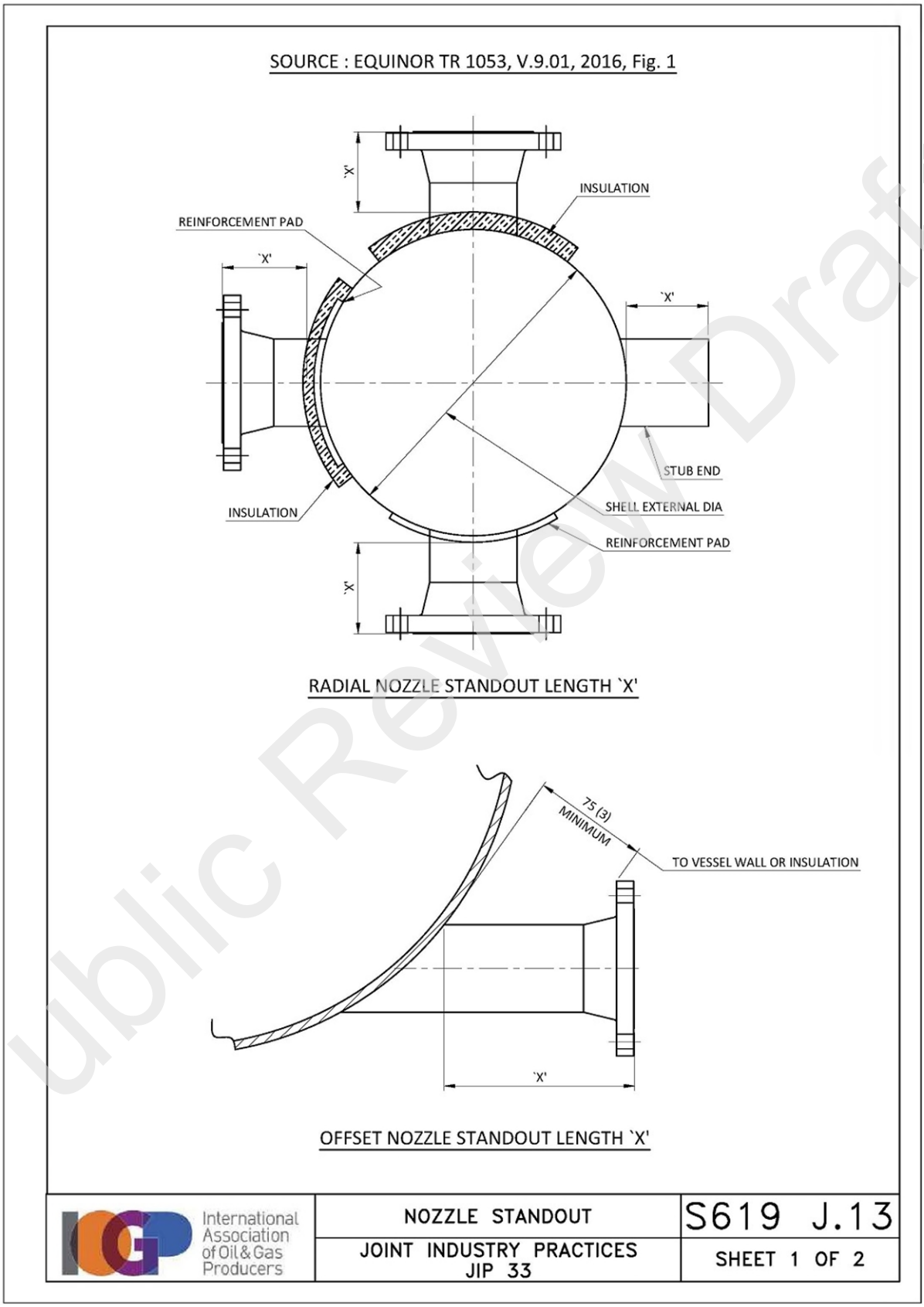



**Figure J.13.a — Nozzle standout (sheet 1 of 2)|**

Public Review Draft

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

| FLANGE CLASS | MINIMUM NOZZLE STANDOUT LENGTH 'X' | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 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

JOINT INDUSTRY PRACTICES
JIP 33

S619 J.13

SHEET 2 OF 2

Public Review Draft

**Figure J.13.b — Nozzle standout (sheet 2 of 2)**

## J.14 Outlet strainer

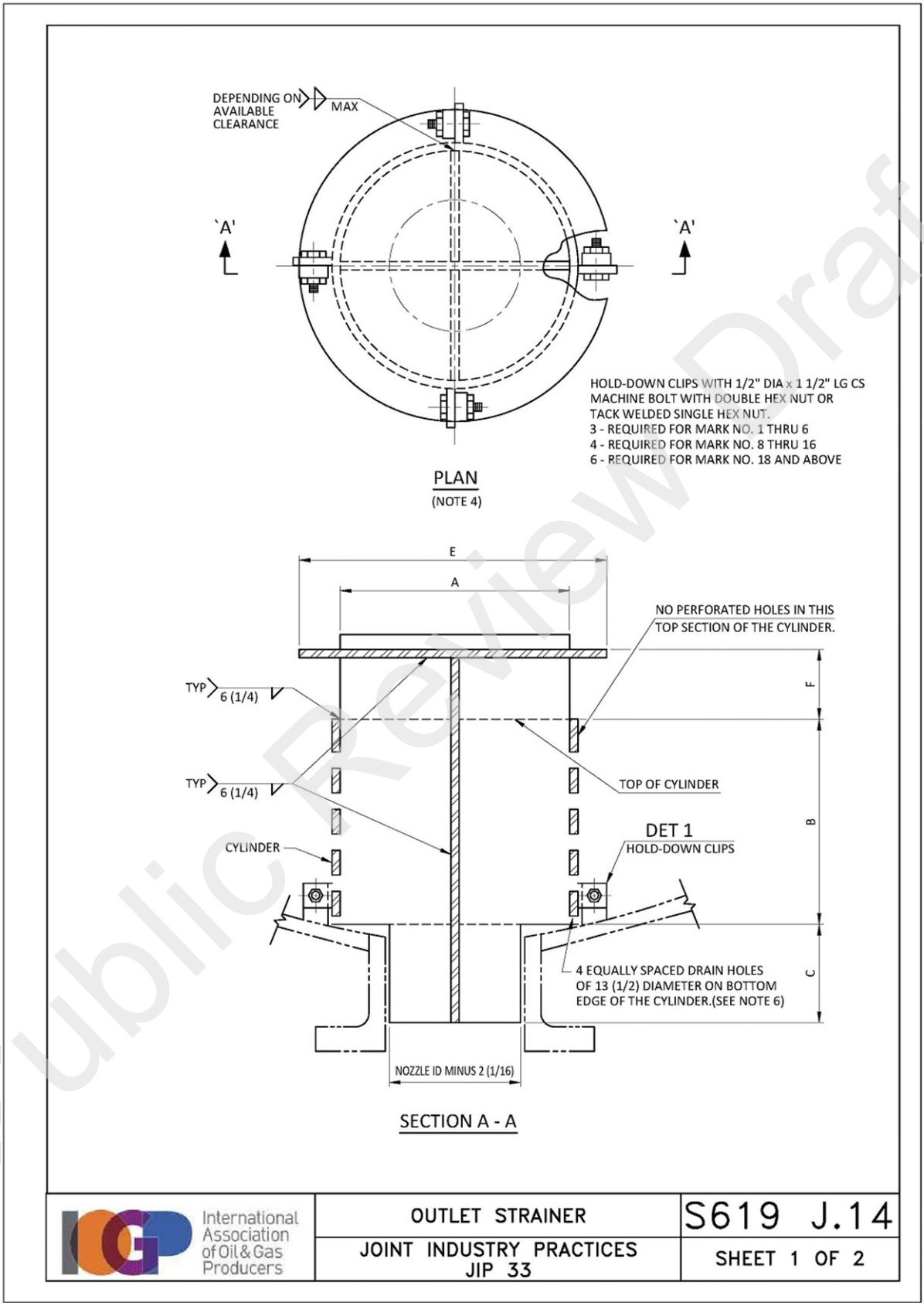
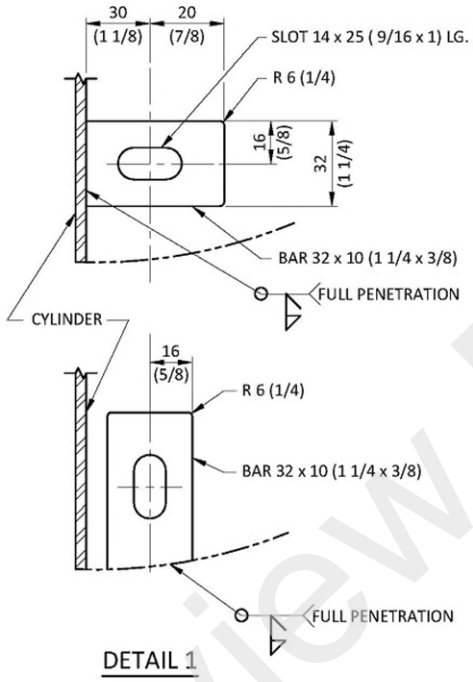



**Figure J.14.a — Outlet strainer (sheet 1 of 2)**

Public Review Draft

**Figure J.14.b — Outlet strainer (sheet 2 of 2)**




| 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.14 |
|---|---|---|
| | JOINT INDUSTRY PRACTICES JIP 33 | SHEET 2 OF 2 |

Public Review Draft

# Bibliography

[1] ASME 2016 Pressure Vessels and Piping Conference, PVP2016-63074, *The Case for MACA: The Optimization of Corrosion Allowance*

[2] ASME 2016 Pressure Vessels and Piping Conference, PVP2016-63075, *Guidelines for MACA: The Optimization of Corrosion Allowance*

Public Review Draft

**Registered Office**
City Tower
Level 14
40 Basinghall Street
London EC2V 5DE
United Kingdom

T +44 (0)20 3763 9700
reception@iogp.org

**Brussels Office**
Avenue de Tervuren 188A
B-1150 Brussels
Belgium

T +32 (0)2 790 7762
reception-europe@iogp.org

**Houston Office**
15377 Memorial Drive
Suite 250
Houston, TX 77079
USA

T +1 (713) 261 0411
reception-americas@iogp.org

www.iogp.org



Draft