NORSOK STANDARD L-005

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Compact flanged connections

Standards Norway
Strandveien 18, P.O.Box 242
N-1326 Lysaker
NORWAY

Telephone: + 47 67 83 8600
Fax: + 47 67 83 86 01
Email: norsok@standard.no
Website: www.standard.no

Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authorities regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Manufacturing Industries). NORSOK standards are administered and published by NTS (Norwegian Technology Centre).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. NORSOK shall not be held responsible for identifying any or all such patent rights.

This standard is based on common principles utilized by VERAX[1)], Vector International AS and Off.N.Galperti SpA.

The CFC as described in clause 5 is based upon the SPO compact flange developed by Vector International AS.

Annex A, B, C and D are normative for products according to clause 5, whilst Annex E, F and G are informative.

Introduction

This NORSOK standard is developed to provide an industry standard for a CFC which is an alternative to conventional flanges as specified in ASME standards, European Standard and International Standard, with reduced weight and smaller overall dimensions. In addition leak tightness reliability is increased by its inherent design features and make up procedures. The CFC may also be an alternative to other types of clamp and hub type mechanical connectors.

The use of load carrying sealing elements, traditionally referred to as "gaskets", will normally violate the fundamental requirements of this NORSOK standard.

NORSOK draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the product given in clause 5. However, the holder of this patent right – Patent no. NO177160 – has accepted free use of the flange configurations within the application limits contained in clause 5 of this NORSOK standard.

NORSOK takes no position concerning the evidence, validity and scope of this patent right.

1) VERAX, SPO CFS and GC - Compact Flanges are trade names of products supplied by VERAX, Vector International AS and Off.N.Galperti SpA. This information is given for the convenience of users of this NORSOK standard and does not constitute an endorsement by NORSOK of the products named. Equivalent products may be used if they can be shown to lead to the same results.

1 Scope

This NORSOK standard provides general design and manufacturing requirements for CFCs used for joining equipment, valves, piping and other piping components. A specific and complete CFC product standard is included in clause 5.

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements and guidelines of the standards referenced below.

Please note that particular normative references for the product standard are given in clause 5.

2.1 Normative references

EN 1092-1: 2001	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges
EN 1779:1999	Non-destructive testing - Leak testing - Criteria for method and technique selection

2.2 Informative references

API 6D	Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.20	Metallic Gaskets For Pipe Flanges: Ring Joint Spiral Wound And Jacketed
ASME B16.25	Buttwelding ends
ASME B16.34	Valves - Flanged, Threaded and Welding End
ASME B18.2.2	Square and Hex Nuts (Inch Series)
ASME B31.3	Process Piping
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe
ASME VIII Div. 2	Boiler and Pressure Vessel Code – Alternative Rules
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-temperature Service
EN 1591-1	Flanges and their joints - Design rules for gasketed circular flange connections - Part 1: Calculation method
EN 13445-3	Unfired pressure vessels – Part 3: Design
EN 13480	Metallic industrial piping
EN 13480-2	Metallic industrial piping – Part 2: Materials
ISO 2768-1	General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications
ISO 4200	Plain end steel tubes, welded and seamless. General tables of dimensions and masses per unit length.
ISO 4287	Geometrical product specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters
ISO 4288	Geometric Product Specification (GPS) — Surface texture — Profile method: Rules and procedures for the assessment of surface texture
NORSOK M-630	Material data sheets for piping

3 Definitions and abbreviations

3.1 Definitions

3.1.1
can
verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.2
class
CL
ASME pressure class (ASME B16.5 and ASME B16.34)

3.1.3
compact flanged connection CFC
non-gasketed bolted static pipe connection including two flanges and where the bolt loads are transferred through metal to metal contact between the flange faces

3.1.4
gasket
barrier to prevent the passage of fluids, which does transmit all loads between flanges, as shown in EN 1591-1, Figure 3

3.1.5
may
verbal form used to indicate a course of action permissible within the limits of the standard

3.1.6
purchaser
individual or organisation that buys the pipe connection on behalf of the user and/or operator or for its own use

3.1.7
seal
component providing a barrier to prevent the passage of fluids, transmitting no significant loads between the flanges

3.1.8
shall
verbal form used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.9
should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.10
supplier
individual or organisation that takes the responsibility for the supply of the pipe connection and its conformance with this NORSOK standard

3.2 Abbreviations

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BL	blind flange
CFC	compact flanged connection
CL	class
DN	nominal pipe diameter (mm)
EN	European Standard
ID	internal diameter
IF	integral flange (as part of some other equipment or component)
ISO	International Organisation for Standardisation
IX	a special metallic seal ring applied in clause 5
LB	line blinds (including PS and PB)
NCF5	NORSOK compact flange according to clause 5

NPS	nominal pipe size (inch)
OD	outer diameter
PB	paddle blank
PED	Pressure Equipment Directive
PN	nominal pressure (bar)
PS	paddle spacer
PTFE	polytetrafluoroethylene (Teflon®)
RI	rigid interface
WN	weld neck
XS	extra strong

4 Fundamental design requirements

4.1 General

This clause specifies the minimum design requirements CFCs shall fulfil in order to be compliant with this NORSOK standard.

Supplier specific CFCs may refer to this NORSOK standard when additional requirements to the minimum requirements specified in this NORSOK standard are agreed between purchaser and supplier. The intension is to allow alternative designs to the products supplied in accordance with clause 5.

A specific and complete CFC dimensional standard ranging from DN 15 to DN 1200 in pressure classes CL 150 to CL 2500 (max. DN 600 for CL 2500) is included in clause 5.

CFCs shall comply with the requirements in the piping or pressure vessel code agreed between the supplier and the purchaser.

CFCs shall:

- Be designed for face-to-face make-up for transfer of the bolt loading through the flange faces.
- Be designed so that a static mode is maintained in the bolted joint up to a specified static mode pressure defined by the purchaser. Static mode is maintained as long as the difference between maximum and minimum nominal load sustained by the bolts in the joint does not exceed 5 % of minimum guaranteed yield load when measured from zero to static mode pressure at room temperature, and at minimum required bolt preload. The static mode pressure shall be at least equal to or greater than hydrostatic test pressure.

4.2 Materials

Flanges covered by this NORSOK standard shall be made from forgings, forged bars, castings and (for BL and LB flanges only) plates. For WN flanges, the manufacture shall be from forgings or forged bars. For IF and RI flanges the manufacture shall be from forgings or castings. Flange type BL and LB can be manufactured from plate materials.

For WN flanges, all mechanical test specimens shall be located to coincide with the WN position.

For forged bars, mechanical test specimens shall be made for both the longitudinal and the transverse direction.

The hot isostatic pressed process is an acceptable alternative to forging.

No repair welding shall be permitted without prior approval of the purchaser. All welding shall be carried out in accordance with a written procedure.

4.3 Strength

CFCs shall generally have a level of structural safety that is comparable to that of the connecting pipe or piping component. CFCs shall be designed against the following possible modes of failure, as appropriate:

- Gross plastic deformation (excessive yielding).
- Leak tightness.
- Fatigue failure.

Furthermore, considerations shall be given to maximum and minimum assembly bolt preload and possible loss of bolt preload during operation due to combination of minimum assembly bolt load, pressure, external loads and thermal effects. Minimum assembly bolt load shall be determined based on assessment of accuracy of bolt preload method, short-term and long-term bolt relaxation.

Sufficient resistance against the relevant failure modes shall be demonstrated by a calculation method, which has been validated by testing. This testing shall also verify the static mode as defined by 4.1, by applying a relevant pressure and external load test. When the internal pressure is gradually increased, it shall be demonstrated by measurement of force or elongation of the bolts, that the above requirement is met up to the specified strength pressure

The calculation methods or experimental testing method (e.g. Pressure Equipment Directive (PED), Annex I - 2.2.4) shall provide sufficient safety margins consistent, where applicable, with the requirements in the piping or pressure vessel code agreed between the supplier and the purchaser. Calculation or testing shall demonstrate that shakedown is achieved at a load level defined as the ultimate capacity. Two cycles of maximum tensile or bending load is sufficient for this purpose.

Calculations shall be made for design conditions that include pressure, external loads, assembly loads, thermal effects and tightness. Design conditions include assembly (bolt-up) condition, hydrostatic test condition and operating conditions. Calculations shall be performed using dimensions of the flange joint in the corroded and the uncorroded condition, and the more severe case shall control. Corrosion shall be considered on all exposed surfaces.

Stresses resulting from bolt pre-loading shall be regarded as secondary stresses during testing and operation.

Nominal design stress for bolts shall be determined by the same rule as used for nominal design stress of flanges and shells, e.g. same safety factor on yield stress. Bolt materials shall be selected with due consideration to creep and relaxation.

4.4 Corrosion resistance

A CFC shall either be designed, or materials shall be selected, so that main sealing areas can not be subject to corrosion. Corrosion allowance on internally or externally exposed surfaces shall be specified by the purchaser.

4.5 Temperature

The Purchaser shall specify the actual temperature range for the application.

4.6 Leakage

The maximum leakage for correctly assembled connections may be specified by the supplier according to EN 1779, and shall be expressed as leakage rate in units of gas throughput ($Pa \cdot m^3/s$) for a specific gas, i.e helium at room temperature and at max working pressure conditions. The circumferential length for this leakage shall also be specified. It is the responsibility of the Supplier to verify that this leakage is not exceeded for the specified design conditions.

Default testing method shall be according to EN 1779. The Purchaser may specify other test methods.

4.7 Information requirements for supplier specific CFC

A supplier specific product standard shall be documented by the following items of information:

- General description of suppliers CFC design and features.
- Necessary design and verification documentation required by applicable code reference.
- Dimensions in mm:
  - Overall dimensions.
  - Welding neck configuration.

  - Pipe wall thickness.
- Weight of complete CFC in kg.
- Temperature coverage.
- Maximum allowable pressure at ambient temperature.
- Pressure/temperature (P/T) dependency.
- Maximum hydrostatic test pressure in bar.
- Load carrying capacity:
  - Bending moment in kNm.
  - Axial load in kN.
  - Static mode pressure at ambient temperature in bar.
- Maximum guaranteed leakage rate.
- Handling procedures.
- Welding and assembly procedures.
- Maintenance procedures.

4.8 Designation and marking

4.8.1 Designation

In line with EN 1092-1, the following shall designate the flanges in accordance with this NORSOK standard. The designation elements shall be separated by a slash. The number of characters is not fixed.

- NORSOK standard identification: NFC4 or NCF5 to identify clause in this NORSOK standard.
- Flange type abbreviation according to Table 1.
- Type of flange facing according to clause 5 or supplier specific notation.
- Nominal flange size.
- Pressure class designation (PN, CL or rated pressure).
- Pipe dimensions:
  - for standard pipes, the wall thickness in mm to one decimal accuracy.
  - for non-standard pipes, the pipe bore and wall thickness.
- Material designation.

See 5.5 for typical examples.

4.8.2 Marking

All flanges, other than integral flanges shall be marked with the suppliers trade mark followed by the flange designation and material charge (cast) identification, see below. All elements shall be separated by a slash. The number of characters is not fixed. Flanges that are identical for several pressure classes shall be marked with the highest pressure class.

- Supplier's name or trade mark.
- Designation according to 4.8.1.
- Cast number of melt identification or suitable quality control number traceable to the cast number.

See 5.12 for typical examples.

5 Product standard

5.1 General

This clause gives a product standard for CFC that meets the requirements of clause 4. This product standard is designed according to ASME VIII Div.2, Appendix 4/6 and EN 13445-3, Annex B, and has been developed for use in process piping, ref. ASME B31.3 and EN 13480. Additional requirements may be relevant for other applications, e.g. subsea and pipeline risers in the oil and gas industry.

The NORSOK CFC product standard specifies detailed manufacturing requirements for circular steel flanged connections in class designations CL 150 (PN 20) to CL 1500 (PN 260) for nominal sizes from DN 15 (NPS ½) to DN 1200 (NPS 48) and CL 2500 (PN 420) for nominal sizes from DN 15 (NPS ½) to DN 600 (NPS 24). NPS is in accordance with ASME B36.10M and ASME B36.19M.

The product standard covers WN flanges, BLs, spacers and spacer blinds, valve/equipment integral flanges and RI flanges.

The product standard covers the temperature range from -101°C to +250°C.

The product standard contains:
- Flange dimensions and material requirements.
- Seal ring dimensions and material requirements for steel seal rings.
- Bolting dimensions and material requirements.
- Weights of all flange standard components.
- Structural capacity equations.
- Installation and assembly instructions, maintenance.
- Necessary information for manufacturing of flanges and seal components; tolerances, surface finishing and marking.

5.2 Particular normative references for clause 5

API 6D	Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.20	Metallic Gaskets For Pipe Flanges: Ring Joint Spiral Wound And Jacketed
ASME B16.25	Buttwelding ends
ASME B16.34	Valves - Flanged, Threaded and Welding End
ASME B18.2.2	Square and Hex Nuts (Inch Series)
ASME B31.3	Process Piping
ASME B36.10M	Welded and Seamless Wrought Steel Pipe
ASME B36.19M	Stainless Steel Pipe
ASME VIII Div. 2	Boiler and Pressure Vessel Code – Alternative Rules
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-temperature Service
EN 13445-3	Unfired pressure vessels – Part 3: Design
EN 13480	Metallic industrial pipingISO 2768-1 General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications
ISO 4287	Geometrical product specification (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters
ISO 4288	Geometric Product Specification (GPS) — Surface texture — Profile method: Rules and procedures for the assessment of surface texture
ISO 4200	Plain end steel tubes, welded and seamless. General tables of dimensions and masses per unit length.

5.3 General description of flange design and features

Figure 1 shows the NCF5 and its seal system.

The flange face includes a slightly convex bevel with the highest point, called the heel, adjacent to the bore and a small outer wedge around the outer diameter of the flange. The NCF5 is made up by tightening/tensioning the flange bolting which pulls the two connector halves together.

For the IX seal ring, axial forces are exerted on the taper of the metal seal ring and translated into a radial sealing force. Furthermore with increased pre-load, the bevel is closed and face to face contact is achieved at the outer wedge while most of the bolt pre-load is transferred as compressive forces between the flange faces at the heel, see Figure 1. The arrows in the figure indicate the applied forces/pressure and the contact forces after make-up and during normal operation.

The principle design of the flange face includes two independent seals. The first seal is created by application of seal seating stress at the flange heel. However, an undamaged flange heel may not seal at any extreme load condition, but the heel contact will be maintained for pressure values up to 1,8 times the flange rating at room temperature. This requirement is only applicable when the WN thickness fulfils the code requirement for minimum pipe wall thickness for the actual material. This pressure will also represent the static mode pressure. The flange also remains in contact along its outer circumference at the flange faces for all allowable load levels. The main seal is the IX seal ring. The seal ring force is provided by the elastic stored energy in the stressed seal ring. Any heel leakage will give internal pressure acting on the seal ring inside intensifying the sealing action.

The design aims at preventing exposure to oxygen and other corrosive agents. Thus, this prevents corrosion of the flange faces, the stressed length of the bolts and the seal ring.

The back face of the flange in the made-up position is parallel to the flange face in order to prevent bending of the bolts in the assembled condition.

Note: For assemblies between RI and BL flanges the heel seal will not be effective. The formal requirement for heel contact cannot be met. Normally this will give acceptable functionality of the connection. If heel seal is required, the blind flange shall be made with a face angle.

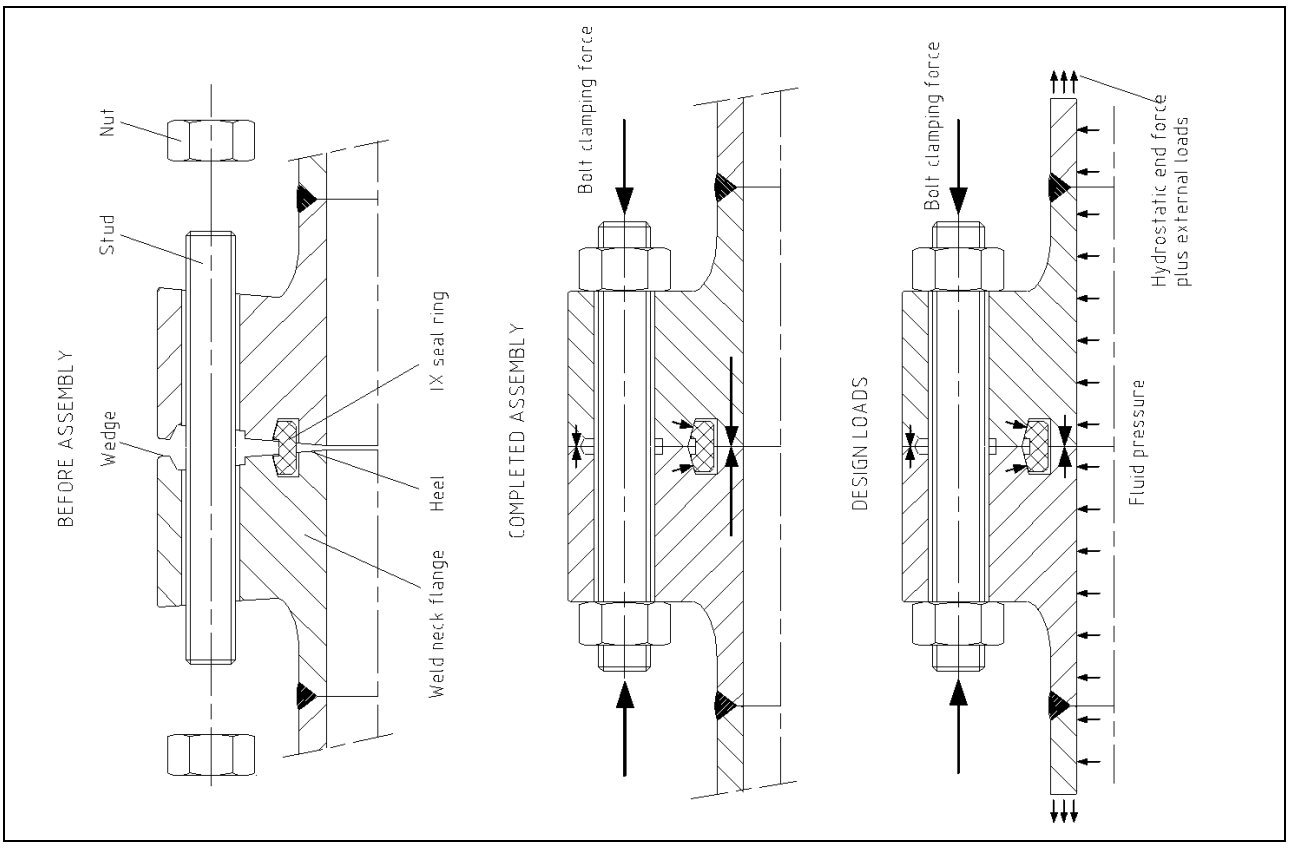

Figure 1 – How the NCF5 works

5.4 Standard components

The types of flanges specified in this subclause are given in Table 1 and Figure 2 showing the flange types with the relevant designations.

Table 1 – Types of flanges

Type abbreviation	Description
WN	Weld neck flange
BL	Blind flange
IF	Integral flange as part of some other equipment or component
RI	Rigid interface as part of some other equipment or component
PB	Paddle blank
PS	Paddle spacer

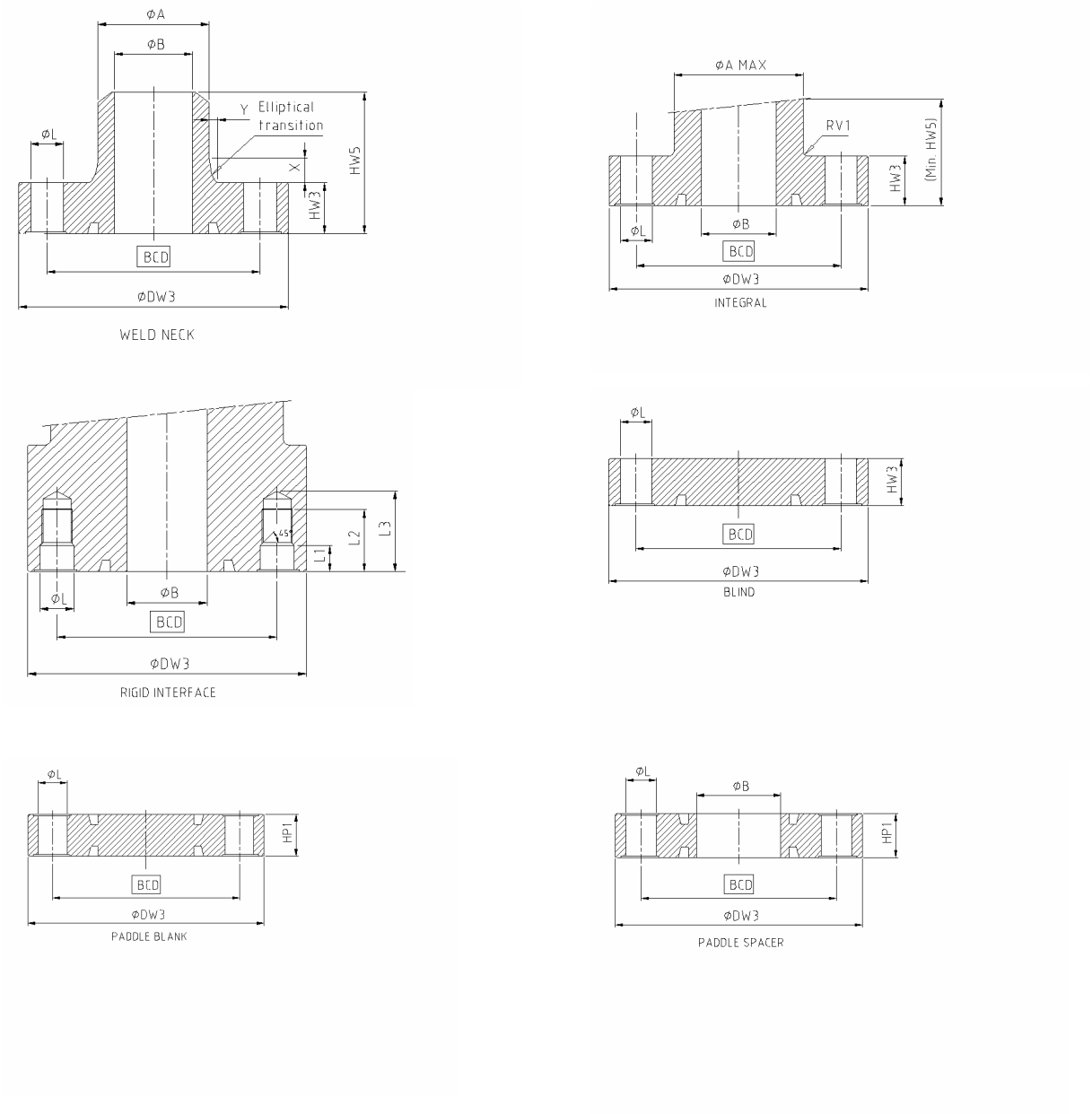

Figure 2 – Components in the NCF5 standard

5.5 Designation

The flange designations shall be according to 4.8.1.

Examples of designation are given below:

Example 1
Designation of WN flange in CL 600 with IX groove, nominal size DN 250 with pipe schedule 40S i.e. 9,3 mm wall thickness and material A182F51 (duplex):

NCF5/WN/IX/DN250/CL600/9.3/A182F51

Example 2
Designation of WN flange in CL 2500 with IX groove, nominal size DN 200 with pipe wall thickness equal to 30,0 mm and material A182F51 (duplex):

NCF5/WN/IX/DN200/CL2500/30.0/A182F51

5.6 General requirements

5.6.1 Flange material

The NCF5 covers flanges made of steel. It is assumed that the flange material has a Young's modulus in the range 190 000 MPa to 210 000 MPa at room temperature. Minimum specified yield strength for flanges to this NORSOK standard is at room temperature 205 MPa. For lower strength materials, the flange size, the bolt pre-tension force and flange face angle shall be determined based on the actual design requirements. The principles of clause 4 of this NORSOK standard shall then be utilised.

General requirements to the flange material shall follow a recognised standard such as ASME B31.3 or EN 13480-2.

Specific requirements to flange materials:
Minimum elongation: A_5 = 15 %

Materials that may be subject to ductile/brittle transition at the foreseeable conditions in which the flange will be exposed to, shall have minimum absorbed energy measured on an ISO V test-piece of 27 J. The test temperature shall be the minimum scheduled operating temperature, but not above 20 °C.

Stainless steel overlay welding of flange faces and seal groove is not necessary when interfacing carbon steel and stainless steel flanges.

Annex E gives references to flange material specifications that may be used.

5.6.2 Bolting

It is a design requirement to use bolts of the minimum strength as to ASTM A193 gr.B7.

Imperial standard bolts threaded at both ends or full length may be used. Heavy hex nuts (ASME B18.2.2) shall be used. Threads shall be coarse series, CL 2A (ASME B1.1), and nuts shall be coarse series, CL 2B. The specified tolerances shall be met after galvanising or other surface treatment. Nominal diameters of 1 inch and smaller shall be coarse thread series (UNC); nominal diameters of 1⅛ inches and larger shall be of the 8 thread series (8UN).

Metric bolting may be used if specified by the purchaser. This may affect assembly and bolt preloading procedures. Annex F describes which metric bolts to choose for replacing the listed imperial bolts.

5.6.3 Bolt dimensions and weights

Dimensions and weights of bolts and nuts can be found in Annex C. This annex also describes dimensions of washers/sleeves where this should be used in order to control bolting load during assembly.

5.6.4 Seals

The NCF5 uses a steel seal ring (IX).

The IX seal ring dimensions, design characteristics and typical materials used are given in 5.13.

5.6.5 Pressure/temperature ratings

Generally flanges covered by NCF5 shall be designated as one of the given classes in Table 2

Table 2 – Pressure class designation and ASME rating ceiling values to ASME B16.5

Pressure class		Class abbreviation	Nominal pressure		ASME pressure rating ceiling values	
					psig	barg
Class	150	CL 150	PN	20	290	20.0
Class	300	CL 300	PN	50	750	51.7
Class	600	CL 600	PN	110	1500	103.4
Class	900	CL 900	PN	150	2250	155.2
Class	1500	CL 1500	PN	260	3750	258.6
Class	2500	CL 2500	PN	420	6250	431.0

Flanges covered by a class of the product standard will stand the maximum rating of the corresponding ASME B16.5 class over the temperature range covered by NCF5. This corresponds to a utilization factor of 0,5 according to Annex D, which gives a method for determining the external load capacity for flanged connections.

For integral cast flanges also some design codes use the concept of “casting factors”. The yield strength should in such cases be multiplied by the relevant casting factor before used in the capacity equations

5.7 Dimensions

5.7.1 Range of nominal sizes

A summary of the DNs applicable to each rating class is given in Table 3.

5.7.2 Weld neck (WN) dimensions

The minimum outside diameter of the WN of WN flange is equal to the nominal outside diameter of the pipe. The maximum bore is equal to the specified nominal bore. This assures that the minimum WN thickness is equal to or larger than the wall thickness of the connected pipe.

5.7.3 Flange dimensions

Dimensions of the flanges shall be in accordance with the information given in Annex A (see Table 3 for an overview).

Table 3 – Overview of sizes and rating class (CL)

DN	NPS	CL 150	CL 300	CL 600	CL 900	CL 1500	CL 2500
15	½	Equal to CL 300	•	Equal to CL 2500	Equal to CL 2500	Equal to CL 2500	•
20	¾		•				•
25	1		•				•
40	1 ½		•				•
50	2		•	Equal to CL 1500	Equal to CL 1500	•	•
65	2 ½		•			•	•
80	3		•	Equal to CL 900	•	•	•
100	4		•		•	•	•
125	5		•		•	•	•
150	6		•	•	•	•	•
200	8	•	•	•	•	•	•
250	10	•	•	•	•	•	•
300	12	•	•	•	•	•	•
350	14	•	•	•	•	•	•
400	16	•	•	•	•	•	•
450	18	•	•	•	•	•	•
500	20	•	•	•	•	•	•
550	22	•	•	•	•	•	•
600	24	•	•	•	•	•	•
650	26	•	•	•	•	•	
700	28	•	•	•	•	•	
750	30	•	•	•	•	•	
800	32	•	•	•	•	•	
850	34	•	•	•	•	•	
900	36	•	•	•	•	•	
950	38	•	•	•	•	•	
1000	40	•	•	•	•	•	
1050	42	•	•	•	•	•	
1100	44	•	•	•	•	•	
1150	46	•	•	•	•	•	
1200	48	•	•	•	•	•	

Note: 'Equal to CLxxxx' means that the dimensions are equal for the referred pressure class, the flange shall then be marked with the higher pressure class, see 5.12.

5.7.4 Welding end preparation

Details for the weld preparation for WN flanges are given in ASME B16.25. Other welding end preparations can be agreed between supplier and purchaser.

5.7.5 Bolt holes

All bolt holes shall be equally spaced on the bolt circle diameter.

5.8 Weights of flanges

Calculated weights of flanges are based on nominal dimensions given in Annex A and density equal to 7,85 kg/dm^3.

5.9 Flange faces

This product standard includes grooves for IX-type flange facings. Flange face dimensions are given together with all other flange dimensions in Annex A.

5.10 Surface finish

The flange surfaces shall be machined to comply with the requirements of Table 4 below, see ISO 4287. A sample of at least 10 % of the batch shall be checked by methods defined in ISO 4288.

Table 4 – Surface finish for flanges

Location	R_a min. μm	R_a max. μm
OD surface of IX groove	-	0.8
Flange heel face	-	0.8
Flange face general and IX groove	-	1.6
Bolt holes	-	12.5
All other surfaces	-	6.3

5.11 Tolerances

Tolerances on dimensions of flanges shall be as given in Annex A, Table A.12. Medium tolerances to ISO 2768-1 shall be used for non specified tolerances.

5.12 Marking

5.12.1 General

The flange marking shall be according to 4.8.2.
The example below is for a DN 250 WN flange CL 600 for a pipe wall thickness of 9,3mm. The material is ASTM A182 F51 (duplex SS) and the heat number is F1245.

Example for a supplier by the name of XXX:

XXX/NCF5/WN/IX/DN250/CL600/9.3/A182F51/F1245

5.12.2 Stamping

Where steel stamps are used, the marking shall be positioned on the rim of the flange. Care should be taken to ensure that steel stamp markings are not liable to cause cracks in the flange material, i.e. use soft nose stamps.

5.13 IX seal ring

The IX seal ring design exists in one size per DN covering all pressure classes in this product standard.

5.13.1 Designation

The IX seal ring is designated as described below. The designation elements shall be separated by / (slash). The number of characters is not fixed.

- Standard identification - NCF5.
- Type - and ring size - IX and the appropriate DN.
- Material designation.

Example:
Designation of an IX seal ring for DN 250 and material A182F51 (Duplex):

NCF5/IX250/A182F51

5.13.2 Typical seal ring materials

Typical minimum yield stress and ultimate stress for the seal ring material is 300 MPa and 360 MPa, respectively, in order to allow for reasonably elastic springback. Lower strength may be used, but is not recommended. The user is responsible for selecting a seal ring material which is suitable for the service medium and the design temperature conditions. Seal ring materials are commonly chosen to be compatible with the flange material, i.e. duplex seal ring in duplex flange.

For in service use, Table 5 gives a guideline for seal ring selection.

Annex E gives references to seal ring material specifications that may be used.

Table 5 – Seal ring selection

Flange material	Service temperature	Seal ring material	Seal ring PTFE colour
Carbon steel	-50°C to +250°C	Carbon steel CS360LT	Blue
Stainless steel	-50°C to +250°C	22Cr Duplex	Yellow
Stainless steel	-101°C to +250°C	17/4-PH	Orange

NOTE 1 For testing purposes at ambient temperature,a carbon steel ring can be used for all flange materials.
NOTE 2 Listed seal ring materials may be less resistant to corrosion than the stainless steel of the flanges, and this is justified by the low probability of corrosion due to the stressed contact between heel areas of the mating flanges, and due to the seal at the outer circumference of the flanges preventing ingress of moisture and water.

5.13.3 Dimensions

Metallic IX seal rings shall have dimensions and tolerances as specified in Annex B. Medium tolerances to ISO 2768-1 shall be used for non specified tolerances. Figure B.2 gives nomenclature used in Table B.2 and Table B.3.

5.13.4 Weights

Annex B gives calculated weights of seal rings based on nominal dimensions and density equal to 7,85 kg/dm^3.

5.13.5 Surface finish

All seal ring surfaces shall be machined finished with maximum surface roughness in accordance with Table 6, see ISO 4287.

Table 6 – Surface finish for seal rings

Location	R_a max. μm
Sealing faces	0.8
All other surfaces	6.3

5.13.6 Inspection and testing

No special requirements regarding hardness are required for the IX seal ring as opposed to standard ring-joint gaskets to ASME B16.20.
There is no requirement for Charpy impact testing of seal ring materials.

5.13.7 Coating

Seal rings shall be coated with 10 μm to 30 μm PTFE coating. The colour of the coating shall follow the requirements of Table 5.

5.13.8 Marking

5.13.8.1 General

All seal rings shall be marked with the suppliers trade mark followed by the seal ring designation and material charge (cast) identification, i.e. as follows:
1. Suppliers name
2. Designation
3. Cast number of melt identification or suitable quality control number traceable to the cast number, e.g. F1245.

Example (XXX supplier):

XXX NCF5/IX250/A182F51/F1245

5.13.8.2 Stamping

Where steel stamps are used, the marking shall be positioned on inner diameter of the ring. Care should be taken to ensure that the sealing faces are not damaged.

5.14 Handling, installation and assembly

5.14.1 General

This information serves as a guide during handling, welding and assembly of NCF5. In addition, it contains procedures for preload qualification.

5.14.2 Protection

Flanges shall be supplied with suitable protection of the flange face, such as plywood boards or plastic caps. They should not be removed prior to field assembly to minimise the likelihood of accidental damage - except for inspection, welding and stress relieving of the weld area. Seal rings should be stored in its original packing until final installation. Careful handling is of the utmost importance.

5.14.3 Flange handling

Flanges shall not be lifted by slinging through the bore of the flange, as this may damage the seal surface and the bevelled end. It is preferable to lift using the bolt holes or other suitable lifting points.

5.14.4 Welding

Protect the flange sealing faces with an inhibitor to prevent oxidisation during pre-heating and stress relieving.

Ensure that the sealing faces are protected from scratching and weld splatter. The alignment tolerances are similar as for conventional ASME/ANSI flanges. If flanges welded to the pipe spools are not to be assembled immediately, coat the sealing faces with grease or another type of preservative.

5.14.5 Painting

If the flange is to be shot-blasted and painted, then it is imperative that the plywood board or protective cap is left on preferably also sealed off by strong adhesive tape to prevent damage to the sealing faces. No contact areas shall be painted. This includes flange faces and nut bearing areas.

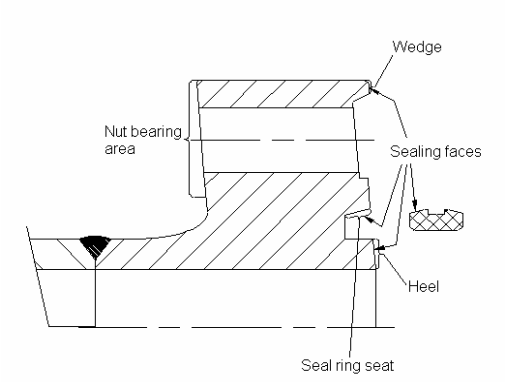

Figure 3 – Flange areas to be protected

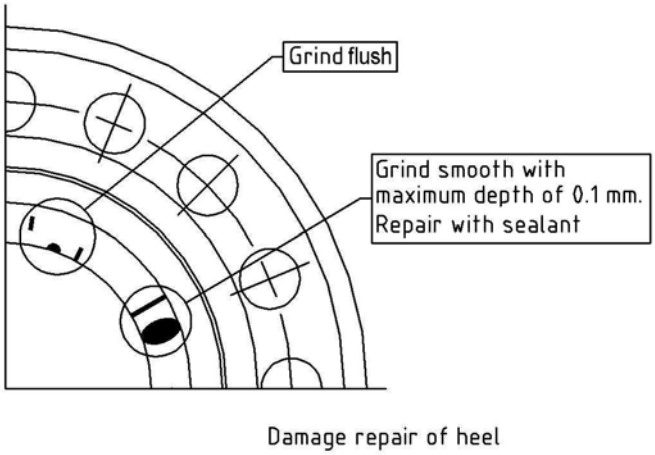

Figure 4 – Repair of heel

5.14.6 Procedure personnel and equipment for assembly

For flanged connections, which rely on axial compression to activate the seal and to ensure a static mode of action, the capacity depends directly on the bolt prestress achieved. Bolt preloading procedures and personell shall be qualified according to 5.14.11. Ensure use of skilled workmen and correct equipment. Final preload tools should be well maintained and should have accuracy within ±2 % of the torque or tension to be applied, see Table 8.

5.14.7 Preparation before final preloading

Clean and check

Use a nonabrasive soft cloth to clean all components with solvent to remove grease, preservation and dirt. Special care should be taken on sealing faces and contact areas. Check that all components are of correct material and size.

Inspection and repair, see Figure 3 and Figure 4, and Table 7

Examine all sealing surfaces for mechanical damage and rust. The sealing faces rely on a good surface finish. These surfaces should therefore be free from leak path scratches, damage marks and other surface irregularities. Use a suitable light source and run the fingertip over seal surfaces to detect dents and gouges. Polish off any small scratches on the heel, seal ring and seal ring seat with fine emery cloth in the circumferential direction only. Polish at least one third of the circumference to ensure a uniform blending of the re-work area. Lateral polishing is unacceptable. Larger flange damages may require flange face remachining.

Table 7 – Damage repair guide

Damage and location	Remedy
Scratch or dent at the heel, covering less than ¾.	Grind with fine emery paper to the required depth. Finish with emery paper grade 240.
Scratch or dent at the heel, covering ¾ or more of the heel width.	Grind with fine emery paper to the required depth. Finish with emery paper grade 240. The depth after grinding should be maximum 0,1 mm. 'Repair' large scratches with a suitable sealant (gasket eliminator).
Small scratch in seal ring seat location	Grind with fine emery paper. Finish with emery paper grade 240.
Outer wedge	Remove any burr standing proud of the surface by grinding/filing.
Seal ring sealing faces	Replace seal ring.

Inspect bolt threads and nut bearing area to verify that there is no evidence of galling or other damage. The surface shall be completely intact. If any sign of damage, discard and replace.

IX seal ring – Installation and check for stand-off
When the seal ring is placed in the groove by hand, it should rock slightly in the groove, i.e. the ring should be unable to firmly contact the groove bottom. If this is not the case the seal will need replacing.

Use a pull up cord as shown on Figure 7 when installing the IX ring between flanges in horizontal piping, and remove the cord when the ring has entered the flange grooves on each side.

Lubricate
Prior to assembly, lubricate the flange heel and IX seating surfaces on the flange with MoS_2 lubricant. Take care that no foreign matters (such as grit) are present in the lubricant. The nut thread and nut bearing surfaces on the flange should be lubricated in accordance to the qualified procedure when torque is used to achieve the final preload.

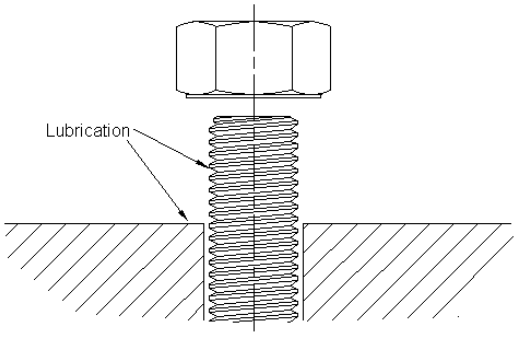

Figure 5 – Thread lubrication

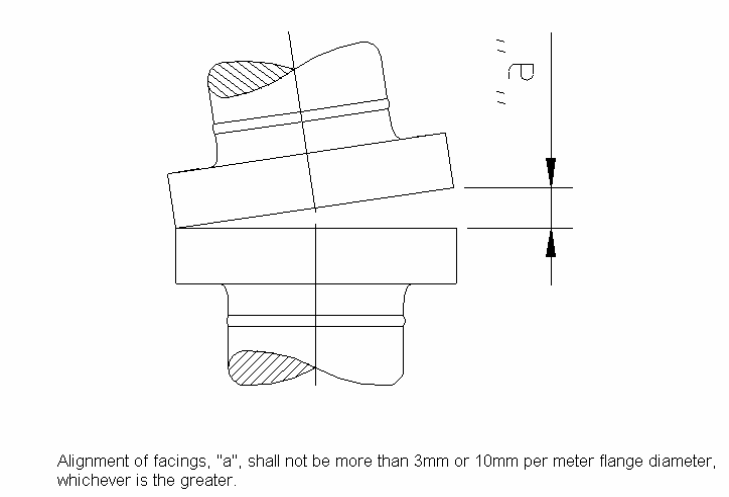

Figure 6 – Flange assembly alignment

Alignment
With the seal ring in the groove of one of the flanges (parallel standoff), bring the other flange into alignment, see Figure 6. The bolt holes should be positioned so that the bolts can be moved easily.

Fitting
The stud shall protrude one to two threads from the nut on the side where the tool is not used. Loosely assemble the studs and nuts. As the flanges are drawn together by the tightening of the bolts, the IX ring will provide the final alignment of the flange prior to full make-up of the joint.

Tighten the bolts using a spanner in a criss-cross pattern, such that the seal ring standoff is closed and there is face-to-face contact at the heel. Typically 10 % of final bolt tightening torque should be sufficient, Table 8 for non-restrained pipework. If not final preload is applied immediately, it is preferably to seal off the flange faces with adhesive tape to avoid foreign particles to enter the gap between the flange faces.

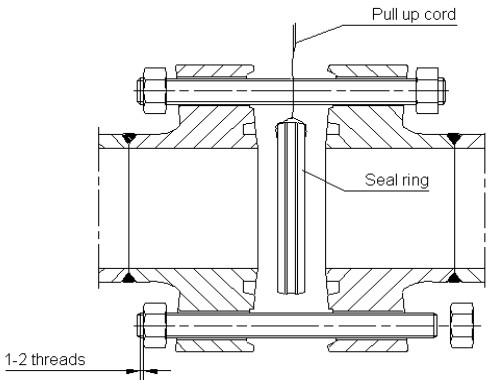

Figure 7 – Seal ring installation

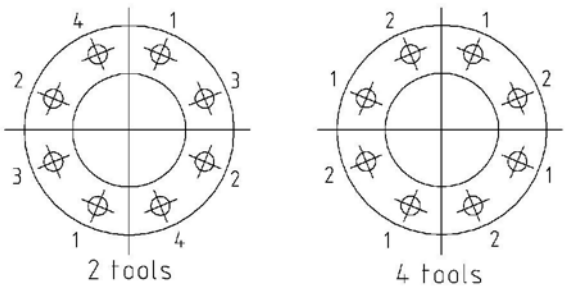

Figure 8 – Bolt pre-loading sequence

5.14.8 Final pre-loading procedure

Tighten bolts in a diagonal sequence as illustrated in Figure 8. The bolt preload shall be applied in suitable steps. Especially when using only one tool the preload used in the first step shall not be greater than 30 % of the total preload. Start with the bolt where the flanges have the largest gap.

Tighten bolts to 100 % of the applied tension or torque values given In Table 8 for imperial standard bolting, and see Annex F for metric bolts. The flanges are stronger than the bolts and can not be overloaded by the bolts. Continue torque or tensioning the bolts until the nuts can not be turned with the preset max load value from the tool. Check that the flange gap at the flange outside diameter is closed all around the circumference of the connection.

5.14.9 Maintenance

NCF5 connections do not require special maintenance if correctly assembled. Seal ring may be reused if they have sufficient standoff, see 5.14.7, and are free from defects. Minor rust, burrs or scratches on sealing faces shall be removed, see 5.14.7, *Inspection and repair*.

Table 8 – Final bolt tension and torque values

Stud bolt size in	Target residual preload [a c] kN	Applied tension with tension tool [b c] kN	Applied torque with torque tool and lubricant μ=0,12 [d] Nm
½-UNC	44		98
⅝-UNC	71		192
¾-UNC	106	134	341
⅞-UNC	147	186	544
1-UNC	193	244	816
1 ⅛-8UN	255	323	1194
1 ¼-8UN	325	412	1671
1 ⅜-8UN	405	512	2261
1 ½-8UN	492	623	2989
1 ⅝-8UN	589	745	3840
1 ¾-8UN	693	878	4859
1 ⅞-8UN	807	1022	6020
2-8UN	929	1177	7351
2 ¼-8UN	1199	1519	10610
2 ½-8UN	1503	1904	14665
2 ¾-8UN	1667	2111	17766
3-8UN	2004	2539	23240
3 ¼-8UN	2373	3006	29736
3 ½-8UN	2773	3512	37258
3 ¾-8UN	3204	4058	46046
4-8UN	3666	4643	56008

NOTE Bolting material: ASTM A193 B7, ASTM B16 and ASTM A320 L7 and L43

[a] Target minimum prestress is 75 % of yield such that a minimum of 70 % is achieved after losses due to time dependent strains (relaxation). Bolt root diameter used.

[b] The applied tension is equivalent to 95 % of yield in bolt in order to ensure that a minimum of 75 % of yield (target residual value) is left when preload is transferred from the tension tool to nut.

[c] Washers may be necessary for some flanges to achieve sufficient residual bolt load with tension tool.

[d] Torque tests with a specified lubrication procedure must be performed to determine the appropriate coefficient of friction. Full filling of threads with lubricant is recommended.

5.14.10 Disassembly

Before disassembling compact flanged connections, verify that all pressure has been bled form the line. As a safeguard, the bolting should be slackened (1/6 turn first time) gradually in a criss cross sequence enabling

a controlled release of fluid. Then remove the bolting completely. Once the flange is fully disassembled and inspected, it is advisable to re-apply suitable surface protection and protection on the flange faces and seal ring.

When disassembling the flanges, great care should be exercised to avoid damaging the outer diameter seal. Hence, the use of standard flange spreaders should be avoided. However, such tools may be used if suitable jacking brackets are welded to the flange diameter. Spreader tools designed for use in the bolt holes may be used.

5.14.11 Bolt tensioning qualification procedure

5.14.11.1 General

This clause describes procedures for qualification of bolt preloading with hydraulic tensioning or hydraulic torque methods. The target minimum prestress should be 75 % of yield such that a minimum of 70 % prestress is achieved after losses due to time dependent strains (relaxation). However, the target value should be lower for bolts of higher strength than required in 5.6.2, and also lower for some metric bolts, see Annex F. This procedure applies to bolt sizes above ½ inch or M12. Standard spanners used by trained personell may be used for smaller sizes, i.e. no special procedure is necessary. However, the personell shall be trained to recognize suitable torque according to yield strength properties of the bolts, and the requirements of 5.14.7 apply.

The requirement for skilled operators is a very important aspect, which often is neglected. The complete assembly of tool and torque/tension measurement instrument must be calibrated together and have a calibration traceable to a recognised international standard. Finally in order to achieve good accuracy and repeatability operators must be technically qualified and experienced in assessing surface conditions, lubricant application and tool performance.

5.14.11.2 Torque preloading

5.14.11.2.1 Background

Preloading by torque is achieved by applying a measured torque to a bolt and nut with a controlled lubrication. For bolts of moderate length the required torque is with good accuracy given by the following expression:

$$T = \frac{F_p}{2}\left(\mu_n d_n + 1.155\mu_t d_t + p/\pi\right)$$

where
- T = torque applied to the bolt
- F_P = required bolt preload
- μ_n = Coefficient of friction of nut bearing surface
- d_n = Effective contact diameter of nut face (average between width of cross flats and diameter of bolt hole)
- μ_t = Coefficient of friction of threads
- d_t = Effective (mean) contact diameter of threads
- p = Thread pitch

The nut and thread friction is set equal to μ in Table 8, i.e. $\mu=\mu_n=\mu_t$. It is seen that the coefficients of friction are of dominant importance to the achieved preload. The coefficients of friction are sensitive to a number of factors: bolt/nut material, bolt surface coating, the type, amount, condition, method of application, contamination, and temperature of the lubrication of the bolt threads and nut bearing surface, the hardness of all parts, the surface finish, the speed with which the nut is tightened, and the fit between threads and thread tolerances.

Consistent application of bolt lubrication is vital in maintaining the consistency of induced bolt stresses at assembly with torque methods. Change of lubrication will change friction coefficient and hence the required torque.

5.14.11.2.2 Equipment

Use the following equipment:

1. A torque wrench with a current calibration certificate or, a hydraulic torque tool with a pressure gauge of class 1.6 or with better accuracy and with a calibration certificate.
2. A hollow load cell with a capacity at least equal to the yield strength of the bolt. The capacity should desirably not exceed twice the yield capacity of the bolt. The load cell shall have a valid (not more than 12 month old) calibration certificate traceable to a recognised national standard from an accredited laboratory.
3. Two solid steel backing plates with one hole in each to suit the bolts.
4. Suitable bolt lubricant such as a MoS_2 lubricant supplied in a closed container such as an aerosol or a tube or box.
5. Five sets of bolts with nuts for calibration test.

5.14.11.2.3 Calibration and qualification

The following procedure shall be followed:

1. Place load cell between reaction plates, enter bolt and nuts and pull hand tight after lubricating according to lubrication procedure. Centre the bolt on the load cell.
2. Apply specified torque value.
3. Record bolt force achieved.
4. Repeat steps 2. and 3. with the remaining bolt sets.
5. Calculate the mean tensile load achieved.
6. Calculate the standard deviation of the tensile load achieved.
7. Calculate the minimum bolt tension as the mean value less one standard deviation and check to see that this exceeds the minimum bolt load specified.
8. Calculate the maximum bolt load as the mean plus one standard deviation and the corresponding axial bolt stress as well as the shear stress due to the applied torque. Check that the equivalent von Mises stress does not exceed the yield strength of the bolts.
9. If the checks in 7. or 8. are not satisfied revise the specified bolt torque or the lubrication procedure or chose a new lubricant and repeat the same procedure using new bolts and nuts until satisfied.

5.14.11.2.4 Lubrication procedure

The purpose of this lubrication procedure is to apply bolt lubrication as consistently as possible without contaminating the lubricant. Apply lubricant in a manner that can easily be repeated giving a consistent amount of lubricant. To achieve this it is recommended that the threads shall be filled with lubricant.

5.14.11.3 Hydraulic tension preloading

5.14.11.3.1 Background

Any bolt tensioner exhibits a load transfer loss as the bolt load is transferred from the bolt tensioner to the nuts. The bolt load loss is a direct loss of stud elongation, this due to many different factors, such as thread deflections, radial expansion of the nut and ‘Bedding in’ of the nut into the flange. Extra load must be applied so the bolt will relax down to the required load on load transfer. The load transfer loss can be calculated as:

$$\Delta = 0{,}9\ d/l$$

where Δ = fraction of the initially applied prestress lost in transfer
d = nominal bolt diameter
l = clear bolt length between engaged threads

If the bearing surface is flexible this must be allowed for by calculating the equivalent effective bolt length. The d/l ratio should not exceed 0,222, which corresponds to a load transfer loss of 0,20. The bolt length may have to be increased by using washers for some flanges. Refer to tables in Annex C for details.

5.14.11.3.2 Equipment

The following equipment is required:

- A hydraulic tensioner.
- An electronic load cell with a valid calibration from an accredited laboratory traceable to a recognised national standard.
- Two solid steel backing plates.
- Five bolts with nuts.

5.14.11.3.3 Qualification and calibration

The following procedure shall be followed:

1. Place the load cell between the reaction plates, insert bolt and attach nuts.
2. Install bolt tensioner and apply estimated initial tensile load.
3. Make transfer and record achieved pre-load.
4. Repeat steps 1. to 3. for all five bolts.
5. Calculate the mean tensile load achieved.
6. Calculate the standard deviation of the tensile load achieved.
7. Calculate the minimum bolt tension as the mean value less one standard deviation and check to see that this exceeds the minimum bolt load specified.
8. Calculate the maximum bolt tension as the mean value plus one standard deviation and check to see that this is lower than the maximum bolt load specified.

Annex A
(Normative)
Flange dimensions and weights

A.1 Symbols

A	=	outside diameter of neck
A_{max}	=	the maximum outer diameter to accommodate standard hydraulic wrenches
B	=	bore diameter, the bore should not exceed the maximum listed bore in this NORSOK standard
B_{min}	=	the minimum bore diameter for which the face angles are valid
Da1	=	ID of groove
Da3	=	OD of groove
d_B	=	bolt size
BCD	=	bolt circle diameter
DW1	=	inner recess diameter
DW2	=	outer recess diameter
DW3	=	outside diameter of flange
DW4	=	flange to neck fillet OD
E1	=	depth of groove
E2	=	depth of recess
E3	=	depth of recess for gasket
HC2	=	swivel collar thickness
HP1	=	thickness of PB and PS
HW3	=	flange thickness
HW5	=	overall length
L	=	bolt hole diameter
L1,L2,L3	=	bolt hole depths
n_B	=	number of bolts
R1	=	radius
R2	=	radius
R3	=	radius (maximum value tabulated)
RV1	=	neck to flange ring radius on integral flanges
t	=	pipe wall thickness
X	=	half major ellipse axis
Y	=	half minor ellipse axis
αA2	=	groove angle
αB1	=	flange face bevel angle
αB2	=	effective face angle/rear face bevel angle

A.2 Weld neck (WN) flanges

Dimensions of WN flanges are defined in Figure A.1. Given variations of wall thickness of connected pipe (t) in Table A.1 to Table A.6 are according to standard wall thicknesses in ASME B36.10M, ASME B36.19M and ISO 4200.

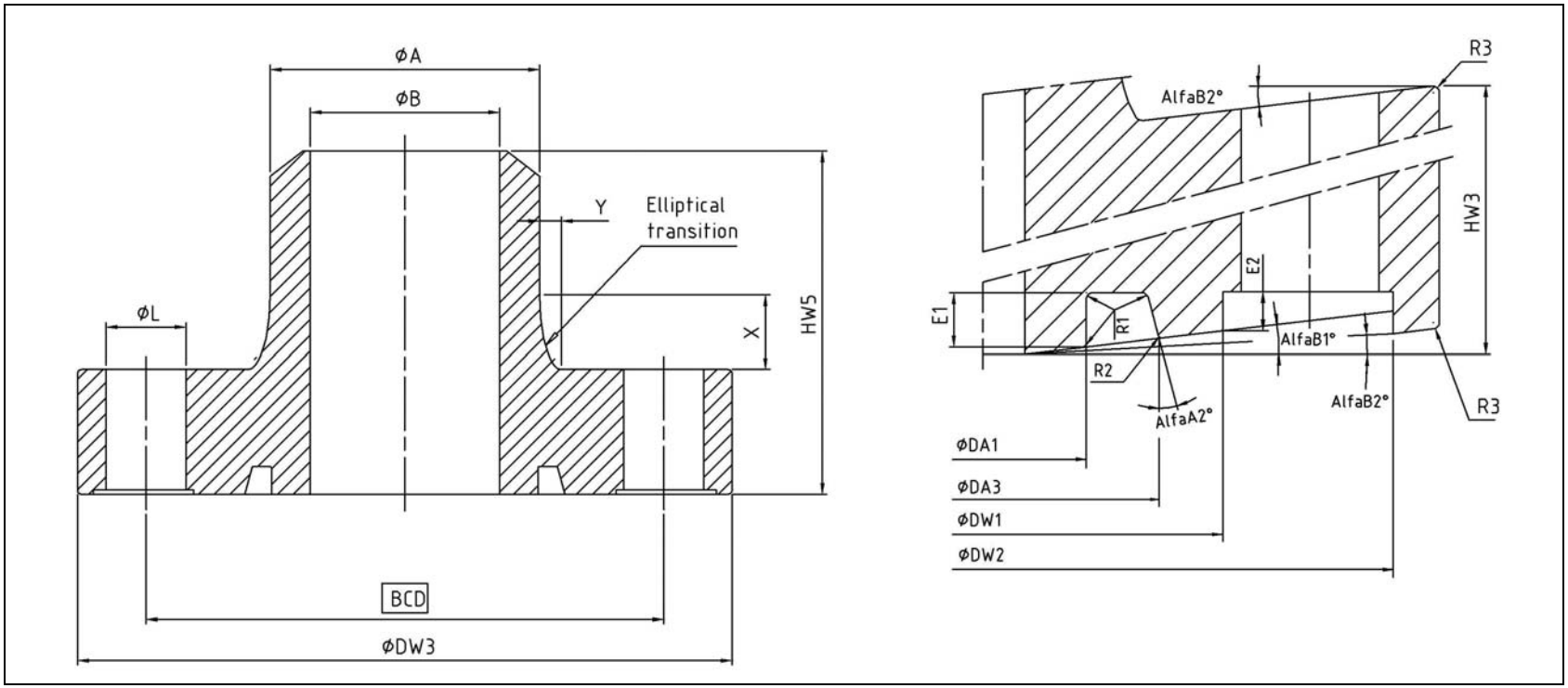

Figure A.1 – Nomenclatures for weld neck (WN) flanges

Table A.1 - Dimensions of CL 150 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	DW1 mm	DW2 mm	DW3 mm	BCD mm	DA1 mm	DA3 mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	HW3 mm	HW5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L mm	n	d_B in
15	½	2.11-4.78	21.3	17.1-11.7	49.1	87.0	93.0	67.3	20.8	30.88	15.2	5.30	1.0	0.27	0.18	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.11-5.56	26.7	22.5-15.6	54.4	92.0	98.0	72.7	25.8	35.88	15.2	5.30	1.0	0.30	0.20	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	2.77-6.35	33.4	27.9-20.7	61.2	99.0	105.0	79.4	32.8	42.87	15.2	5.30	1.0	0.32	0.22	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	2.77-5.08	48.3	42.8-38.1	76.0	114.0	120.0	94.3	47.8	58.88	15.3	5.58	1.0	0.41	0.27	15.0	41.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
50	2	2.77-5.54	60.3	54.8-49.2	88.1	126.0	132.0	106.3	59.8	71.88	15.3	6.19	1.0	0.45	0.30	15.0	42.0	10.5	3.0	0.4	0.6	1.0	15.0	4	½
65	2½	3.05-5.16	73.0	66.9-62.7	100.8	139.0	145.0	119.0	72.8	85.86	15.3	6.79	1.0	0.41	0.27	16.0	43.0	10.5	3.0	0.4	0.6	1.0	15.0	4	½
80	3	3.05-5.49	88.9	82.8-77.9	116.7	155.0	161.0	134.9	87.8	101.96	15.6	7.42	1.0	0.88	0.59	18.0	46.0	10.5	3.0	0.4	0.7	1.0	15.0	8	½
100	4	3.05-6.02	114.3	108.2-102.3	141.7	180.0	186.0	160.3	113.8	129.91	15.4	8.40	1.0	0.59	0.40	22.0	51.0	10.5	3.0	0.5	0.8	1.0	15.0	8	½
125	5	3.40-6.55	141.3	134.5-128.2	168.7	207.0	213.0	187.3	139.8	157.90	15.5	9.27	1.0	0.76	0.50	25.0	55.0	10.5	3.0	0.5	0.9	1.0	15.0	12	½
150	6	3.40-7.11	168.3	161.5-154.1	195.7	234.0	240.0	214.3	167.7	187.86	15.4	10.12	1.0	0.62	0.41	28.0	60.0	10.5	3.0	0.6	1.0	1.0	15.0	12	½
200	8	3.76-6.35	219.1	211.6-206.4	249.4	288.0	294.0	268.1	217.7	239.91	15.6	11.48	1.0	0.94	0.63	26.0	53.0	10.5	3.0	0.7	1.1	1.5	15.0	12	½
250	10	4.19-6.35	273.1	264.7-260.4	310.6	349.0	355.0	329.3	271.7	299.92	15.6	12.90	1.0	0.93	0.62	32.0	60.0	10.5	3.0	0.8	1.3	1.5	15.0	16	½
300	12	4.57-6.35	323.9	314.8-311.2	358.1	397.0	403.0	376.7	321.7	348.95	15.7	13.97	1.0	1.01	0.67	35.0	64.0	10.5	3.0	0.8	1.4	1.5	15.0	20	½
350	14	4.78-7.92	355.6	346.0-339.8	392.3	431.0	437.0	411.5	353.7	381.89	15.6	14.63	1.0	0.85	0.57	38.0	67.0	10.5	3.0	0.8	1.4	1.5	15.0	20	½
400	16	4.78-7.92	406.4	396.8-390.6	451.2	497.0	505.0	473.4	405.7	436.06	15.8	15.63	1.0	1.20	0.80	42.0	73.0	10.5	3.0	0.9	1.5	2.0	18.0	20	⅝
450	18	4.78-7.92	457.2	447.6-441.4	498.7	545.0	552.0	520.9	455.7	487.97	15.7	16.54	1.0	1.01	0.67	46.0	77.0	10.5	3.0	1.0	1.6	2.0	18.0	20	⅝
500	20	5.54-9.53	508.0	496.9-488.9	552.5	599.0	606.0	574.7	507.7	540.99	15.7	17.63	1.0	1.02	0.68	50.0	82.0	10.5	3.0	1.0	1.7	2.0	18.0	24	⅝
550	22	5.54-9.53	558.8	547.7-539.7	606.9	653.0	661.0	629.1	557.7	593.03	15.7	18.45	1.0	1.08	0.72	54.0	87.0	10.5	3.0	1.1	1.8	2.0	18.0	28	⅝
600	24	6.35-9.53	609.6	596.9-590.5	666.3	722.0	730.0	693.0	607.7	644.13	15.8	19.23	1.0	1.19	0.79	59.0	93.0	10.5	3.0	1.1	1.9	3.0	22.0	24	¾
650	26	7.92-9.53	660.4	644.6-641.3	720.2	776.0	784.0	746.8	659.5	696.97	15.7	20.00	1.0	1.00	0.67	64.0	98.0	10.5	3.0	1.1	1.9	3.0	22.0	24	¾
700	28	7.92-9.53	711.2	695.4-692.1	774.5	830.0	839.0	801.2	709.5	749.04	15.7	20.92	1.0	1.08	0.72	68.0	103.0	10.5	3.0	1.2	2.0	3.0	22.0	28	¾
750	30	7.92-12.70	762.0	746.2-736.6	828.9	884.0	893.0	855.5	761.5	802.05	15.7	21.65	1.0	1.08	0.72	72.0	108.0	10.9	3.1	1.3	2.1	3.0	22.0	32	¾
800	32	7.92-12.70	812.8	797.0-787.4	881.3	937.0	945.0	908.0	811.5	853.02	15.7	22.32	1.0	1.03	0.69	76.0	113.0	11.3	3.2	1.3	2.2	3.0	22.0	36	¾
850	34	7.92-12.70	863.6	847.8-838.2	933.9	989.0	998.0	960.5	861.5	904.16	15.8	22.97	1.0	1.18	0.79	79.0	118.0	11.8	3.4	1.3	2.2	3.0	22.0	40	¾
900	36	7.92-12.70	914.4	898.6-889.0	986.1	1050.0	1059.0	1016.6	913.5	958.16	15.8	23.82	1.0	1.15	0.77	84.0	123.0	12.3	3.5	1.4	2.3	3.0	25.0	32	⅞
950	38	9.53-12.70	965.2	946.1-939.8	1041.2	1105.0	1114.0	1071.6	963.5	1009.22	15.8	24.44	1.0	1.20	0.80	88.0	128.0	12.7	3.6	1.4	2.3	3.0	25.0	36	⅞
1000	40	9.53-12.70	1016.0	996.9-990.6	1098.7	1162.0	1172.0	1129.2	1015.5	1062.30	15.8	25.06	1.0	1.26	0.84	92.0	133.0	13.2	3.8	1.4	2.4	3.0	25.0	40	⅞
1050	42	9.53-12.70	1066.8	1047.7-1041.4	1145.8	1209.0	1219.0	1176.2	1065.5	1113.36	15.9	25.65	1.0	1.31	0.87	95.0	137.0	13.8	3.9	1.5	2.5	3.0	25.0	44	⅞
1100	44	9.53-12.70	1117.6	1098.5-1092.2	1197.8	1261.0	1271.0	1228.3	1115.5	1164.28	15.8	26.42	1.0	1.22	0.81	99.0	141.0	14.2	4.1	1.5	2.5	3.0	25.0	44	⅞
1150	46	9.53-12.70	1168.4	1149.3-1143.0	1249.9	1313.0	1323.0	1280.3	1167.5	1217.35	15.9	27.00	1.0	1.28	0.85	102.0	146.0	14.7	4.2	1.6	2.6	3.0	25.0	48	⅞
1200	48	9.53-12.70	1219.2	1200.1-1193.8	1302.4	1366.0	1376.0	1332.9	1217.5	1268.39	15.9	27.54	1.0	1.30	0.87	106.0	150.0	15.2	4.3	1.6	2.6	3.0	25.0	52	⅞

Table A.2 – Dimensions of CL 300 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	Dw1 mm	Dw2 mm	Dw3 mm	BCD mm	DA1 mm	DA3 mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	Hw3 mm	Hw5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L mm	n	d_b in
15	½	2.11-4.78	21.3	17.1-11.7	49.1	87.0	93.0	67.3	20.8	30.88	15.2	5.30	1.0	0.27	0.18	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.11-5.56	26.7	22.5-15.6	54.4	92.0	98.0	72.7	25.8	35.88	15.2	5.30	1.0	0.30	0.20	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	2.77-6.35	33.4	27.9-20.7	61.2	99.0	105.0	79.4	32.8	42.87	15.2	5.30	1.0	0.32	0.22	15.0	40.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	2.77-5.08	48.3	42.8-38.1	76.0	114.0	120.0	94.3	47.8	58.88	15.3	5.58	1.0	0.41	0.27	15.0	41.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
50	2	2.77-5.54	60.3	54.8-49.2	88.1	126.0	132.0	106.3	59.8	71.88	15.3	6.19	1.0	0.45	0.30	15.0	42.0	10.5	3.0	0.4	0.6	1.0	15.0	4	½
65	2½	3.05-5.16	73.0	66.9-62.7	100.8	139.0	145.0	119.0	72.8	85.86	15.3	6.79	1.0	0.41	0.27	16.0	43.0	10.5	3.0	0.4	0.6	1.0	15.0	4	½
80	3	3.05-5.49	88.9	82.8-77.9	116.7	155.0	161.0	134.9	87.8	101.96	15.6	7.42	1.0	0.88	0.59	18.0	46.0	10.5	3.0	0.4	0.7	1.0	15.0	8	½
100	4	3.05-6.02	114.3	108.2-102.3	141.7	180.0	186.0	160.3	113.8	129.91	15.4	8.40	1.0	0.59	0.40	22.0	51.0	10.5	3.0	0.5	0.8	1.0	15.0	8	½
125	5	3.40-6.55	141.3	134.5-128.2	168.7	207.0	213.0	187.3	139.8	157.90	15.5	9.27	1.0	0.76	0.50	25.0	55.0	10.5	3.0	0.5	0.9	1.0	15.0	12	½
150	6	3.40-7.11	168.3	161.5-154.1	195.7	234.0	240.0	214.3	167.7	187.86	15.4	10.12	1.0	0.62	0.41	28.0	60.0	10.5	3.0	0.6	1.0	1.0	15.0	12	½
200	8	3.76-8.18	219.1	211.6-202.7	252.9	299.0	306.0	274.6	217.7	239.89	15.4	11.48	1.0	0.66	0.44	35.0	69.0	10.5	3.0	0.7	1.1	1.5	18.0	12	⅝
250	10	4.19-9.27	273.1	264.7-254.6	307.8	353.0	361.0	329.4	271.7	299.97	15.5	12.90	1.0	0.80	0.54	42.0	78.0	10.5	3.0	0.8	1.3	1.5	18.0	20	⅝
300	12	4.57-10.31	323.9	314.8-303.3	361.6	407.0	415.0	383.2	321.7	348.91	15.4	13.97	1.0	0.67	0.45	47.0	85.0	11.4	3.3	0.8	1.4	1.5	18.0	20	⅝
350	14	4.78-11.13	355.6	346.0-333.3	395.8	442.0	450.0	418.0	353.7	381.94	15.5	14.63	1.0	0.74	0.49	50.0	90.0	12.3	3.5	0.8	1.4	1.5	18.0	24	⅝
400	16	4.78-12.70	406.4	396.8-381.0	455.8	511.0	519.0	482.4	405.7	436.04	15.6	15.63	1.0	0.84	0.56	58.0	100.0	13.5	3.9	0.9	1.5	2.0	22.0	24	¾
450	18	6.35-14.27	457.2	444.5-428.7	503.3	559.0	567.0	529.9	455.7	488.03	15.5	16.54	1.0	0.81	0.54	63.0	107.0	14.7	4.2	1.0	1.6	2.0	22.0	28	¾
500	20	6.35-15.09	508.0	495.3-477.8	558.1	621.0	631.0	587.7	507.7	541.04	15.5	17.63	1.0	0.81	0.54	69.0	116.0	16.0	4.6	1.0	1.7	2.0	25.0	24	⅞
550	22	9.53-22.23	558.8	539.7-514.3	612.5	675.0	685.0	642.1	557.7	593.00	15.5	18.45	1.0	0.75	0.50	74.0	121.0	17.3	4.9	1.1	1.8	2.0	25.0	28	⅞
600	24	9.53-17.48	609.6	590.5-574.6	668.3	740.0	750.0	702.0	607.7	644.18	15.6	19.23	1.5	0.91	0.61	81.0	128.0	18.4	5.3	1.1	1.9	3.0	29.0	28	1
650	26	7.92-16.00	660.4	644.6-628.4	722.2	794.0	804.0	755.8	659.5	697.22	15.7	20.00	1.5	0.99	0.66	86.0	134.0	19.7	5.6	1.1	1.9	3.0	29.0	32	1
700	28	7.92-15.88	711.2	695.4-679.4	776.5	848.0	859.0	810.2	709.5	749.16	15.6	20.92	1.5	0.92	0.61	91.0	140.0	21.0	6.0	1.2	2.0	3.0	29.0	32	1
750	30	7.92-17.50	762.0	746.2-727.0	837.9	917.0	928.0	874.5	761.5	802.35	15.7	21.65	1.5	1.06	0.71	98.0	147.0	22.2	6.3	1.3	2.1	3.0	32.0	32	1⅛
800	32	9.53-17.48	812.8	793.7-777.8	890.3	969.0	981.0	927.0	811.5	853.26	15.6	22.32	1.5	0.97	0.64	103.0	152.0	23.5	6.7	1.3	2.2	3.0	32.0	32	1⅛
850	34	9.53-20.00	863.6	844.5-823.6	945.9	1032.0	1045.0	985.5	861.5	904.45	15.7	22.97	1.5	1.09	0.72	109.0	159.0	24.7	7.1	1.3	2.2	3.0	35.0	32	1¼
900	36	9.53-22.20	914.4	895.3-870.0	997.1	1084.0	1097.0	1037.6	913.5	958.34	15.7	23.82	1.5	0.99	0.66	114.0	164.0	25.9	7.4	1.4	2.3	3.0	35.0	32	1¼
950	38	12.70-20.00	965.2	939.8-925.2	1052.2	1139.0	1152.0	1092.6	963.5	1009.45	15.7	24.44	1.5	1.05	0.70	119.0	170.0	27.2	7.8	1.4	2.3	3.0	35.0	36	1¼
1000	40	12.70-22.20	1016.0	990.6-971.6	1109.7	1196.0	1210.0	1150.2	1015.5	1062.48	15.7	25.06	1.5	1.05	0.70	126.0	177.0	28.5	8.1	1.4	2.4	3.0	35.0	40	1¼
1050	42	12.70-22.20	1066.8	1041.4-1022.4	1162.8	1257.0	1271.0	1206.2	1065.5	1113.57	15.7	25.65	1.5	1.09	0.73	131.0	184.0	29.6	8.5	1.5	2.5	3.0	38.0	36	1⅜
1100	44	12.70-25.00	1117.6	1092.2-1067.6	1214.8	1309.0	1323.0	1258.3	1115.5	1164.66	15.8	26.42	1.5	1.14	0.76	135.0	190.0	30.9	8.8	1.5	2.5	3.0	38.0	40	1⅜
1150	46	12.70-25.0	1168.4	1143.0-1118.4	1266.9	1370.0	1385.0	1314.3	1167.5	1217.68	15.7	27.00	1.5	1.12	0.74	142.0	198.0	32.2	9.2	1.6	2.6	3.0	42.0	36	1½
1200	48	12.70-25.0	1219.2	1193.8-1169.2	1319.4	1422.0	1437.0	1366.9	1217.5	1268.63	15.7	27.54	1.5	1.08	0.72	146.0	204.0	33.5	9.6	1.6	2.6	3.0	42.0	36	1½

Table A.3 – Dimensions of CL 600 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	Dw1 mm	Dw2 mm	Dw3 mm	BCD mm	DA1 mm	DA3 mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	Hw3 mm	Hw5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L mm	n	d_b in
15	½	2.77-4.78	21.3	15.8-11.7	49.1	87.0	93.0	67.3	20.8	30.86	15.1	5.30	1.0	0.15	0.10	20.0	51.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.87-5.56	26.7	21.0-15.6	54.4	92.0	98.0	72.7	25.8	35.86	15.1	5.30	1.0	0.15	0.10	20.0	53.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	2.77-6.35	33.4	27.9-20.7	61.2	99.0	105.0	79.4	32.8	42.85	15.1	5.30	1.0	0.15	0.10	20.0	56.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	2.77-7.14	48.3	42.8-34.0	77.1	115.0	121.0	95.3	47.8	58.88	15.2	5.58	1.0	0.29	0.19	23.0	64.0	12.4	3.5	0.3	0.5	1.0	15.0	8	½
50	2	2.77-8.74	60.3	54.8-42.8	91.7	130.0	136.0	110.0	59.8	71.89	15.2	6.19	1.0	0.33	0.22	23.0	60.0	10.5	3.0	0.4	0.6	1.0	15.0	8	½
65	2½	3.05-7.01	73.0	66.9-59.0	104.8	143.0	149.0	123.1	72.8	85.92	15.3	6.79	1.0	0.44	0.29	26.0	66.0	12.0	3.4	0.4	0.6	1.0	15.0	12	½
80	3	3.05-7.62	88.9	82.8-73.7	116.7	155.0	161.0	134.9	87.8	101.93	15.4	7.42	1.0	0.53	0.35	25.0	61.0	10.5	3.0	0.4	0.7	1.0	15.0	12	½
100	4	3.05-8.56	114.3	108.2-97.2	150.0	196.0	203.0	171.7	113.8	129.97	15.4	8.40	1.0	0.59	0.39	31.0	70.0	11.7	3.3	0.5	0.8	1.0	18.0	12	⅝
125	5	3.40-9.53	141.3	134.5-122.2	177.0	223.0	230.0	198.6	139.8	157.88	15.3	9.27	1.0	0.48	0.32	35.0	78.0	13.7	3.9	0.5	0.9	1.0	18.0	12	⅝
150	6	7.11-10.97	168.3	154.1-146.4	205.2	251.0	258.0	226.8	167.7	187.85	15.3	10.12	1.0	0.46	0.31	36.0	75.0	11.7	3.3	0.6	1.0	1.0	18.0	12	⅝
200	8	6.35-12.70	219.1	206.4-193.7	258.7	304.0	312.0	280.4	217.7	239.92	15.4	11.48	1.0	0.60	0.40	43.0	87.0	14.1	4.0	0.7	1.1	1.5	18.0	20	⅝
250	10	6.35-15.09	273.1	260.4-242.9	318.7	374.0	382.0	344.8	271.7	299.95	15.4	12.90	1.0	0.61	0.40	53.0	102.0	16.7	4.8	0.8	1.3	1.5	22.0	20	¾
300	12	8.38-17.48	323.9	307.1-288.9	378.0	441.0	450.0	407.7	321.7	349.01	15.5	13.97	1.0	0.68	0.45	60.0	108.0	19.1	5.5	0.8	1.4	1.5	25.0	20	⅞
350	14	7.92-19.05	355.6	339.8-317.5	409.5	472.0	482.0	439.2	353.7	382.05	15.5	14.63	1.0	0.72	0.48	64.0	113.0	20.7	5.9	0.8	1.4	1.5	25.0	24	⅞
400	16	9.53-21.44	406.4	387.3-363.5	465.4	537.0	547.0	499.0	405.7	436.09	15.5	15.63	1.5	0.72	0.48	73.0	122.0	23.2	6.6	0.9	1.5	2.0	29.0	24	1
450	18	9.53-23.83	457.2	438.1-409.5	523.4	602.0	614.0	560.1	455.7	488.19	15.5	16.54	1.5	0.81	0.54	80.0	131.0	25.7	7.3	1.0	1.6	2.0	32.0	24	1⅛
500	20	12.70-26.19	508.0	482.6-455.6	574.0	653.0	664.0	610.6	507.7	541.20	15.5	17.63	1.5	0.81	0.54	86.0	139.0	28.1	8.0	1.0	1.7	2.0	32.0	28	1⅛
550	22	12.70-28.58	558.8	533.4-501.6	631.1	717.0	730.0	670.7	557.7	593.17	15.5	18.45	1.5	0.75	0.50	94.0	149.0	30.6	8.7	1.1	1.8	2.0	35.0	24	1¼
600	24	12.70-30.96	609.6	584.2-547.7	685.9	772.0	785.0	725.6	607.7	644.23	15.5	19.23	1.5	0.79	0.52	100.0	158.0	33.0	9.4	1.1	1.9	3.0	35.0	28	1¼
650	26	14.2-28.00	660.4	632.0-604.4	736.0	822.0	835.0	775.6	659.5	697.27	15.6	20.00	1.5	0.85	0.57	105.0	166.0	35.5	10.1	1.1	1.9	3.0	35.0	32	1¼
700	28	15.88-28.00	711.2	679.4-655.2	792.5	886.0	900.0	835.2	709.5	749.42	15.6	20.92	1.5	0.95	0.63	112.0	176.0	37.9	10.8	1.2	2.0	3.0	38.0	32	1⅜
750	30	15.88-30.00	762.0	730.2-702.0	847.1	940.0	955.0	889.8	761.5	802.49	15.7	21.65	1.5	0.98	0.65	118.0	185.0	40.4	11.5	1.3	2.1	3.0	38.0	36	1⅜
800	32	17.48-30.00	812.8	777.8-752.8	899.0	1001.0	1016.0	945.7	811.5	853.46	15.6	22.32	1.5	0.92	0.62	126.0	195.0	42.8	12.2	1.3	2.2	3.0	42.0	32	1½
850	34	17.48-32.00	863.6	828.6-799.6	954.3	1064.0	1081.0	1004.8	861.5	904.61	15.7	22.97	1.5	1.00	0.67	133.0	205.0	45.3	12.9	1.3	2.2	3.0	45.0	32	1⅝
900	36	19.05-36.00	914.4	876.3-842.4	1007.9	1118.0	1134.0	1058.4	913.5	958.39	15.5	23.82	1.5	0.81	0.54	145.0	214.0	47.3	13.5	1.4	2.3	3.0	45.0	32	1⅝
950	38	20.00-36.00	965.2	925.2-893.2	1060.5	1179.0	1196.0	1115.0	963.5	1009.62	15.6	24.44	1.5	0.95	0.64	147.0	223.0	49.0	14.0	1.4	2.3	3.0	49.0	32	1¾
1000	40	20.00-40.00	1016.0	976.0-936.0	1115.1	1234.0	1251.0	1169.6	1015.5	1062.71	15.7	25.06	1.5	0.99	0.66	153.0	232.0	50.8	14.5	1.4	2.4	3.0	49.0	36	1¾
1050	42	22.20-40.00	1066.8	1022.4-986.8	1167.7	1294.0	1312.0	1225.2	1065.5	1113.56	15.6	25.65	1.5	0.86	0.57	165.0	241.0	52.5	15.0	1.5	2.5	3.0	52.0	32	1⅞
1100	44	22.20-45.00	1117.6	1073.2-1027.6	1221.0	1347.0	1365.0	1278.5	1115.5	1164.67	15.6	26.42	1.5	0.91	0.60	170.0	249.0	54.3	15.5	1.5	2.5	3.0	52.0	36	1⅞
1150	46	22.20-45.00	1168.4	1124.0-1078.4	1285.4	1419.0	1438.0	1345.9	1167.5	1217.95	15.7	27.00	2.0	1.05	0.70	174.0	262.0	56.0	16.0	1.6	2.6	3.0	55.0	36	2
1200	48	25.0-45.00	1219.2	1169.2-1129.2	1337.0	1470.0	1490.0	1397.4	1217.5	1268.69	15.6	27.54	2.0	0.86	0.57	189.0	270.0	57.8	16.5	1.6	2.6	3.0	55.0	36	2

Table A.4 – Dimensions of CL 900 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	Dw1 mm	Dw2 mm	Dw3 mm	BCD Mm	DA1 mm	DA3 mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	Hw3 mm	Hw5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L mm	n	d_b in
15	½	2.77-4.78	21.3	15.8-11.7	49.1	87.0	93.0	67.3	20.8	30.86	15.1	5.30	1.0	0.15	0.10	20.0	51.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.87-5.56	26.7	21.0-15.6	54.4	92.0	98.0	72.7	25.8	35.86	15.1	5.30	1.0	0.15	0.10	20.0	53.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	3.38-6.35	33.4	26.6-20.7	61.2	99.0	105.0	79.4	32.8	42.85	15.1	5.30	1.0	0.15	0.10	20.0	56.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	2.77-7.14	48.3	42.8-34.0	77.1	115.0	121.0	95.3	47.8	58.88	15.2	5.58	1.0	0.29	0.19	23.0	64.0	12.4	3.5	0.3	0.5	1.0	15.0	8	½
50	2	2.77-8.74	60.3	54.8-42.8	91.7	130.0	136.0	110.0	59.8	71.89	15.2	6.19	1.0	0.33	0.22	23.0	60.0	10.5	3.0	0.4	0.6	1.0	15.0	8	½
65	2½	3.05-9.53	73.0	66.9-53.9	104.8	143.0	149.0	123.1	72.8	85.91	15.3	6.79	1.0	0.41	0.28	26.0	66.0	12.0	3.4	0.4	0.6	1.0	15.0	12	½
80	3	3.05-11.13	88.9	82.8-66.6	116.7	155.0	161.0	134.9	87.8	101.91	15.3	7.42	1.0	0.48	0.32	25.0	61.0	10.5	3.0	0.4	0.7	1.0	15.0	12	½
100	4	3.05-11.13	114.3	108.2-92.0	150.0	196.0	203.0	171.7	113.8	129.96	15.4	8.40	1.0	0.56	0.37	31.0	70.0	11.7	3.3	0.5	0.8	1.0	18.0	12	⅝
125	5	6.55-12.70	141.3	128.2-115.9	177.0	223.0	230.0	198.6	139.8	157.86	15.3	9.27	1.0	0.43	0.29	35.0	78.0	13.7	3.9	0.5	0.9	1.0	18.0	12	⅝
150	6	7.11-14.27	168.3	154.1-139.8	210.0	256.0	263.0	231.6	167.7	187.88	15.3	10.12	1.0	0.47	0.31	40.0	87.0	15.5	4.4	0.6	1.0	1.0	18.0	16	⅝
200	8	6.35-18.26	219.1	206.4-182.6	267.2	322.0	330.0	293.2	217.7	239.96	15.4	11.48	1.0	0.58	0.39	50.0	98.0	19.1	5.5	0.7	1.1	1.5	22.0	20	¾
250	10	7.80-21.44	273.1	257.5-230.2	325.8	388.0	397.0	354.8	271.7	299.97	15.4	12.90	1.0	0.56	0.38	60.0	110.0	23.1	6.6	0.8	1.3	1.5	25.0	20	⅞
300	12	8.38-25.4	323.9	307.1-273.1	380.3	452.0	462.0	413.9	321.7	349.00	15.4	13.97	1.5	0.58	0.39	68.0	119.0	26.7	7.6	0.8	1.4	1.5	29.0	20	1
350	14	9.53-27.79	355.6	336.5-300.0	415.6	487.0	497.0	449.3	353.7	382.03	15.4	14.63	1.5	0.61	0.41	73.0	127.0	28.9	8.3	0.8	1.4	1.5	29.0	24	1
400	16	12.70-30.96	406.4	381.0-344.5	477.2	556.0	567.0	513.8	405.7	436.09	15.4	15.63	1.5	0.65	0.43	82.0	140.0	32.6	9.3	0.9	1.5	2.0	32.0	24	1⅛
450	18	11.13-29.36	457.2	434.9-398.5	534.3	620.0	633.0	574.0	455.7	488.21	15.5	16.54	1.5	0.74	0.49	90.0	153.0	36.3	10.4	1.0	1.6	2.0	35.0	24	1¼
500	20	12.70-32.54	508.0	482.6-442.9	592.9	686.0	700.0	635.5	507.7	541.27	15.5	17.63	1.5	0.76	0.51	99.0	166.0	39.9	11.4	1.0	1.7	2.0	38.0	24	1⅜
550	22	22.23-34.93	558.8	514.3-488.9	647.0	749.0	764.0	693.6	557.7	593.28	15.5	18.45	1.5	0.75	0.50	107.0	179.0	43.5	12.4	1.1	1.8	2.0	42.0	24	1½
600	24	14.27-38.89	609.6	581.1-531.8	704.6	814.0	830.0	754.2	607.7	644.42	15.5	19.23	1.5	0.82	0.55	115.0	191.0	47.1	13.5	1.1	1.9	3.0	45.0	24	1⅝
650	26	20.00-36.0	660.4	620.4-588.4	759.2	877.0	894.0	812.8	659.5	697.44	15.6	20.00	1.5	0.84	0.56	124.0	204.0	50.8	14.5	1.1	1.9	3.0	49.0	24	1¾
700	28	22.20-40.00	711.2	666.8-631.2	812.8	931.0	948.0	866.4	709.5	749.20	15.4	20.92	1.5	0.62	0.41	141.0	214.0	52.5	15.0	1.2	2.0	3.0	49.0	24	1¾
750	30	17.50-45.00	762.0	727.0-672.0	870.2	995.0	1014.0	926.9	761.5	802.29	15.4	21.65	1.5	0.66	0.44	149.0	227.0	56.0	16.0	1.3	2.1	3.0	52.0	24	1⅞
800	32	25.00-45.00	812.8	762.8-722.8	928.8	1061.0	1081.0	988.4	811.5	853.35	15.5	22.32	2.0	0.68	0.45	157.0	239.0	59.5	17.0	1.3	2.2	3.0	55.0	24	2
850	34	25.00-50.00	863.6	813.6-763.6	989.0	1139.0	1160.0	1057.1	861.5	904.71	15.6	22.97	2.0	0.89	0.60	158.0	254.0	63.0	18.0	1.3	2.2	3.0	62.0	24	2¼
900	36	22.20-50.00	914.4	870.0-814.4	1042.7	1193.0	1214.0	1110.7	913.5	958.50	15.5	23.82	2.0	0.72	0.48	176.0	265.0	64.8	18.5	1.4	2.3	3.0	62.0	24	2¼
950	38	30.00-55.00	965.2	905.2-855.2	1102.8	1267.0	1291.0	1176.8	963.5	1009.85	15.6	24.44	2.0	0.92	0.61	174.0	279.0	66.5	19.0	1.4	2.3	3.0	68.0	24	2½
1000	40	30.00-55.00	1016.0	956.0-906.0	1155.9	1320.0	1344.0	1230.0	1015.5	1062.64	15.5	25.06	2.0	0.77	0.51	190.0	290.0	68.3	19.5	1.4	2.4	3.0	68.0	24	2½
1050	42	25.00-60.00	1066.8	1016.8-946.8	1208.1	1372.0	1396.0	1282.1	1065.5	1113.93	15.6	25.65	2.0	0.90	0.60	192.0	300.0	70.0	20.0	1.5	2.5	3.0	68.0	28	2½
1100	44	32.00-60.00	1117.6	1053.6-997.6	1262.7	1427.0	1451.0	1336.8	1115.5	1164.64	15.5	26.42	2.0	0.72	0.48	211.0	310.0	71.8	20.5	1.5	2.5	3.0	68.0	28	2½
1150	46	36.00-65.00	1168.4	1096.4-1038.4	1321.3	1501.0	1527.0	1401.9	1167.5	1217.69	15.5	27.00	2.0	0.73	0.49	219.0	324.0	73.5	21.0	1.6	2.6	3.0	74.0	28	2¾
1200	48	36.00-65.00	1219.2	1147.2-1089.2	1394.4	1590.0	1618.0	1482.0	1217.5	1269.20	15.6	27.54	2.5	0.95	0.63	218.0	342.0	75.3	21.5	1.6	2.6	3.0	81.0	28	3

Table A.5 – Dimensions of CL 1500 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	Dw1 mm	Dw2 mm	Dw3 mm	BCD mm	DA1 mm	DA3 Mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	Hw3 mm	Hw5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L Mm	n	d_b in
15	½	2.77-7.47	21.3	15.8-6.4	49.1	87.0	93.0	67.3	20.8	30.86	15.1	5.30	1.0	0.15	0.10	20.0	51.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.87-7.82	26.7	21.0-11.1	54.4	92.0	98.0	72.7	25.8	35.86	15.1	5.30	1.0	0.15	0.10	20.0	53.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	3.38-9.09	33.4	26.6-15.2	61.2	99.0	105.0	79.4	32.8	42.85	15.1	5.30	1.0	0.15	0.10	20.0	56.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	3.68-10.15	48.3	40.9-28.0	77.1	115.0	121.0	95.3	47.8	58.89	15.2	5.58	1.0	0.30	0.20	23.0	64.0	12.4	3.5	0.3	0.5	1.0	15.0	8	½
50	2	3.91-11.07	60.3	52.5-38.2	91.7	130.0	136.0	110.0	59.8	71.88	15.2	6.19	1.0	0.30	0.20	23.0	60.0	10.5	3.0	0.4	0.6	1.0	15.0	8	½
65	2½	5.16-14.02	73.0	62.7-45.0	104.8	143.0	149.0	123.1	72.8	85.92	15.3	6.79	1.0	0.45	0.30	26.0	66.0	12.0	3.4	0.4	0.6	1.0	15.0	12	½
80	3	5.49-15.24	88.9	77.9-58.4	126.7	172.0	180.0	148.3	87.8	101.93	15.3	7.42	1.0	0.45	0.30	30.0	73.0	13.8	3.9	0.4	0.7	1.0	18.0	12	⅝
100	4	6.02-17.12	114.3	102.3-80.1	161.0	216.0	224.0	187.0	113.8	129.96	15.3	8.40	1.0	0.49	0.33	37.0	86.0	16.8	4.8	0.5	0.8	1.0	22.0	12	¾
125	5	9.53-19.05	141.3	122.2-103.2	189.6	252.0	261.0	218.6	139.8	157.93	15.3	9.27	1.0	0.49	0.33	43.0	92.0	19.8	5.7	0.5	0.9	1.0	25.0	12	⅞
150	6	10.97-21.95	168.3	146.4-124.4	225.7	297.0	307.0	258.8	167.7	187.94	15.3	10.12	1.5	0.49	0.33	50.0	101.0	23.0	6.6	0.6	1.0	1.0	29.0	12	1
200	8	12.70-25.00	219.1	193.7-169.1	284.4	355.0	365.0	317.4	217.7	239.96	15.3	11.48	1.5	0.49	0.33	60.0	115.0	28.9	8.3	0.7	1.1	1.5	29.0	16	1
250	10	12.70-28.58	273.1	247.7-215.9	354.6	440.0	453.0	393.6	271.7	300.06	15.4	12.90	1.5	0.55	0.37	75.0	136.0	35.1	10.0	0.8	1.3	1.5	35.0	16	1¼
300	12	14.27-33.32	323.9	295.4-257.3	409.3	495.0	508.0	449.0	321.7	349.10	15.4	13.97	1.5	0.58	0.38	83.0	151.0	41.1	11.7	0.8	1.4	1.5	35.0	20	1¼
350	14	19.05-35.71	355.6	317.5-284.2	450.4	544.0	558.0	493.1	353.7	382.15	15.4	14.63	1.5	0.62	0.41	89.0	162.0	44.7	12.8	0.8	1.4	1.5	38.0	20	1⅜
400	16	21.44-40.49	406.4	363.5-325.4	508.6	611.0	626.0	555.2	405.7	436.12	15.4	15.63	1.5	0.53	0.35	105.0	180.0	50.6	14.5	0.9	1.5	2.0	42.0	20	1½
450	18	23.83-45.24	457.2	409.5-366.7	568.6	687.0	704.0	622.3	455.7	488.31	15.5	16.54	1.5	0.68	0.45	111.0	198.0	56.5	16.1	1.0	1.6	2.0	49.0	20	1¾
500	20	26.19-50.01	508.0	455.6-408.0	634.1	759.0	778.0.	690.7	507.7	541.29	15.4	17.63	1.5	0.61	0.41	126.0	217.0	62.4	17.8	1.0	1.7	2.0	52.0	20	1⅞
550	22	34.93-53.98	558.8	488.9-450.8	698.3	831.0	850.0	757.9	557.7	593.24	15.4	18.45	2.0	0.53	0.36	142.0	234.0	68.3	19.5	1.1	1.8	2.0	55.0	20	2
600	24	30.96-59.54	609.6	547.7-490.5	762.1	911.0	933.0	829.3	607.7	644.50	15.5	19.23	2.0	0.69	0.46	146.0	253.0	74.2	21.2	1.1	1.9	3.0	62.0	20	2¼
650	26	32.00-60.00	660.4	596.4-540.4	819.7	969.0	990.0	887.0	659.5	697.20	15.3	20.00	2.0	0.49	0.33	172.0	269.0	75.2	21.5	1.1	1.9	3.0	62.0	20	2¼
700	28	36.00-60.00	711.2	639.2-591.2	879.9	1029.0	1051.0	947.2	709.5	749.32	15.4	20.92	2.0	0.54	0.36	182.0	285.0	78.8	22.5	1.2	2.0	3.0	62.0	24	2¼
750	30	36.00-65.00	762.0	690.0-632.0	943.5	1108.0	1132.0	1017.5	761.5	802.59	15.4	21.65	2.0	0.67	0.44	186.0	304.0	82.3	23.5	1.3	2.1	3.0	68.0	24	2½
800	32	40.00-70.00	812.8	732.8-672.8	966.8	1131.0	1155.0	1040.8	811.5	853.32	15.3	22.32	2.0	0.52	0.35	202.0	311.0	85.8	24.5	1.3	2.2	3.0	68.0	24	2½
850	34	40.00-75.00	863.6	783.6-713.6	1026.4	1206.0	1232.0	1107.1	861.5	904.35	15.3	22.97	2.0	0.51	0.34	214.0	328.0	89.3	25.5	1.3	2.2	3.0	74.0	24	2¾
900	36	45.00-80.00	914.4	824.4-754.4	1096.6	1308.0	1339.0	1191.3	913.5	958.50	15.4	23.82	2.5	0.57	0.38	222.0	352.0	92.8	26.5	1.4	2.3	3.0	88.0	20	3¼
950	38	50.00-80.00	965.2	865.2-805.2	1156.9	1383.0	1416.0	1257.5	963.5	1009.72	15.4	24.44	2.5	0.66	0.44	226.0	369.0	96.3	27.5	1.4	2.3	3.0	94.0	20	3½
1000	40	50.00-85.00	1016.0	916.0-846.0	1210.4	1422.0	1452.0	1305.0	1015.5	1062.52	15.4	25.06	2.5	0.54	0.36	250.0	382.0	99.8	28.5	1.4	2.4	3.0	88.0	24	3¼
1050	42	50.00-90.00	1066.8	966.8-886.8	1271.9	1514.0	1549.0	1379.5	1065.5	1113.65	15.4	25.65	2.5	0.58	0.39	257.0	402.0	103.3	29.5	1.5	2.5	3.0	101.0	20	3¾
1100	44	55.00-95.00	1117.6	1007.6-927.6	1323.6	1550.0	1583.0	1424.2	1115.5	1164.52	15.3	26.42	2.5	0.51	0.34	275.0	413.0	106.8	30.5	1.5	2.5	3.0	94.0	24	3½
1150	46	60.00-110.0	1168.4	1048.4-948.4	1388.9	1631.0	1666.0	1496.5	1167.5	1217.65	15.4	27.00	2.5	0.56	0.37	281.0	433.0	110.3	31.5	1.6	2.6	3.0	101.0	24	3¾
1200	48	60.00-115.0	1219.2	1099.2-989.2	1437.0	1679.0	1714.0	1544.7	1217.5	1268.44	15.3	27.54	2.5	0.47	0.31	303.0	445.0	110.3	31.5	1.6	2.6	3.0	101.0	24	3¾

Table A.6 – Dimensions of CL 2500 weld neck (WN) flanges

DN	NPS	t mm	A mm	B mm	Dw1 mm	Dw2 mm	Dw3 mm	BCD mm	DA1 mm	DA3 mm	αA2 °	E1 mm	E2 mm	αB1 °	αB2 °	Hw3 mm	Hw5 mm	X mm	Y mm	R1 mm	R2 mm	R3 mm	L mm	n	d_b In
15	½	2.77-7.47	21.3	15.8-6.4	49.1	87.0	93.0	67.3	20.8	30.86	15.1	5.30	1.0	0.15	0.10	20.0	51.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
20	¾	2.87-7.82	26.7	21.0-11.1	54.4	92.0	98.0	72.7	25.8	35.86	15.1	5.30	1.0	0.15	0.10	20.0	53.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
25	1	3.38-9.09	33.4	26.6-15.2	61.2	99.0	105.0	79.4	32.8	42.85	15.1	5.30	1.0	0.15	0.10	20.0	56.0	10.5	3.0	0.3	0.5	1.0	15.0	4	½
40	1½	3.68-12.50	48.3	40.9-23.3	77.1	115.0	121.0	95.3	47.8	58.87	15.2	5.58	1.0	0.25	0.17	23.0	64.0	12.4	3.5	0.3	0.5	1.0	15.0	8	½
50	2	3.91-14.20	60.3	52.5-31.9	94.9	140.0	147.0	116.2	59.8	71.89	15.2	6.19	1.0	0.31	0.21	27.0	72.0	14.7	4.2	0.4	0.6	1.0	18.0	8	⅝
65	2½	7.01-16.00	73.0	59.0-41.0	115.9	170.0	179.0	141.6	72.8	85.91	15.2	6.79	1.0	0.33	0.22	32.0	81.0	17.0	4.9	0.4	0.6	1.0	22.0	8	¾
80	3	5.49-17.50	88.9	77.9-53.9	137.3	199.0	209.0	166.3	87.8	101.94	15.3	7.42	1.0	0.40	0.27	36.0	85.0	20.0	5.7	0.4	0.7	1.0	25.0	8	⅞
100	4	8.56-22.20	114.3	97.2-69.9	167.3	238.0	248.0	200.4	113.8	129.93	15.2	8.40	1.5	0.34	0.23	44.0	95.0	24.6	7.0	0.5	0.8	1.0	29.0	8	1
125	5	15.88-25.0	141.3	109.5-91.3	197.2	268.0	278.0	230.2	139.8	157.91	15.3	9.27	1.5	0.39	0.26	50.0	106.0	29.6	8.5	0.5	0.9	1.0	29.0	12	1
150	6	10.97-30.0	168.3	146.4-108.3	232.7	311.0	322.0	268.8	167.7	187.94	15.3	10.12	1.5	0.41	0.28	58.0	120.0	34.5	9.9	0.6	1.0	1.0	32.0	12	1⅛
200	8	15.09-36.0	219.1	188.9-147.1	301.6	394.0	408.0	343.7	217.7	239.99	15.3	11.48	1.5	0.44	0.29	72.0	145.0	44.0	12.6	0.7	1.1	1.5	38.0	12	1⅜
250	10	15.09-45.0	273.1	242.9-183.1	368.4	470.0	485.0	415.0	271.7	300.08	15.3	12.90	1.5	0.49	0.33	88.0	172.0	53.9	15.4	0.8	1.3	1.5	42.0	16	1½
300	12	17.48-55.0	323.9	288.9-213.9	429.6	548.0	564.0	483.2	321.7	349.17	15.4	13.97	1.5	0.55	0.37	99.0	195.0	63.4	18.1	0.8	1.4	1.5	49.0	16	1¾
350	14	19.05-55.0	355.6	317.5-245.6	474.6	600.0	618.0	531.2	353.7	382.22	15.4	14.63	1.5	0.56	0.37	108.0	211.0	69.2	19.8	0.8	1.4	1.5	52.0	16	1⅞
400	16	21.44-65.0	406.4	363.5-276.4	547.8	697.0	718.0	615.1	405.7	436.37	15.4	15.63	2.0	0.62	0.41	125.0	238.0	78.5	22.4	0.9	1.5	2.0	62.0	16	2¼
450	18	23.88-70.0	457.2	409.4-317.2	609.0	758.0	780.0	676.3	455.7	488.28	15.4	16.54	2.0	0.53	0.36	136.0	260.0	88.0	25.1	1.0	1.6	2.0	62.0	16	2¼
500	20	26.19-80.0	508.0	455.6-348.0	661.8	825.0	849.0	735.0	507.7	541.35	15.4	17.63	2.0	0.56	0.37	147.0	282.0	97.3	27.8	1.0	1.7	2.0	68.0	16	2½
550	22	53.98-85.0	558.8	450.8-388.8	735.0	930.0	958.0	821.8	557.7	593.39	15.4	18.45	2.5	0.54	0.36	163.0	310.0	106.8	30.5	1.1	1.8	2.0	81.0	16	3
600	24	52.37-95.0	609.6	504.9-419.6	797.4	1008.0	1039.0	891.3	607.7	644.47	15.4	19.23	2.5	0.56	0.38	176.0	334.0	116.1	33.2	1.1	1.9	3.0	88.0	16	3¼

A.3 Blind flanges

Blind flanges do not have a flange face angle. The dimensions of blind flanges given in this clause are defined in the drawing. All face dimensions can be found from the rigid interface dimensions, overall dimensions are found in Table A.1 to Table A.6 for the WN flanges.

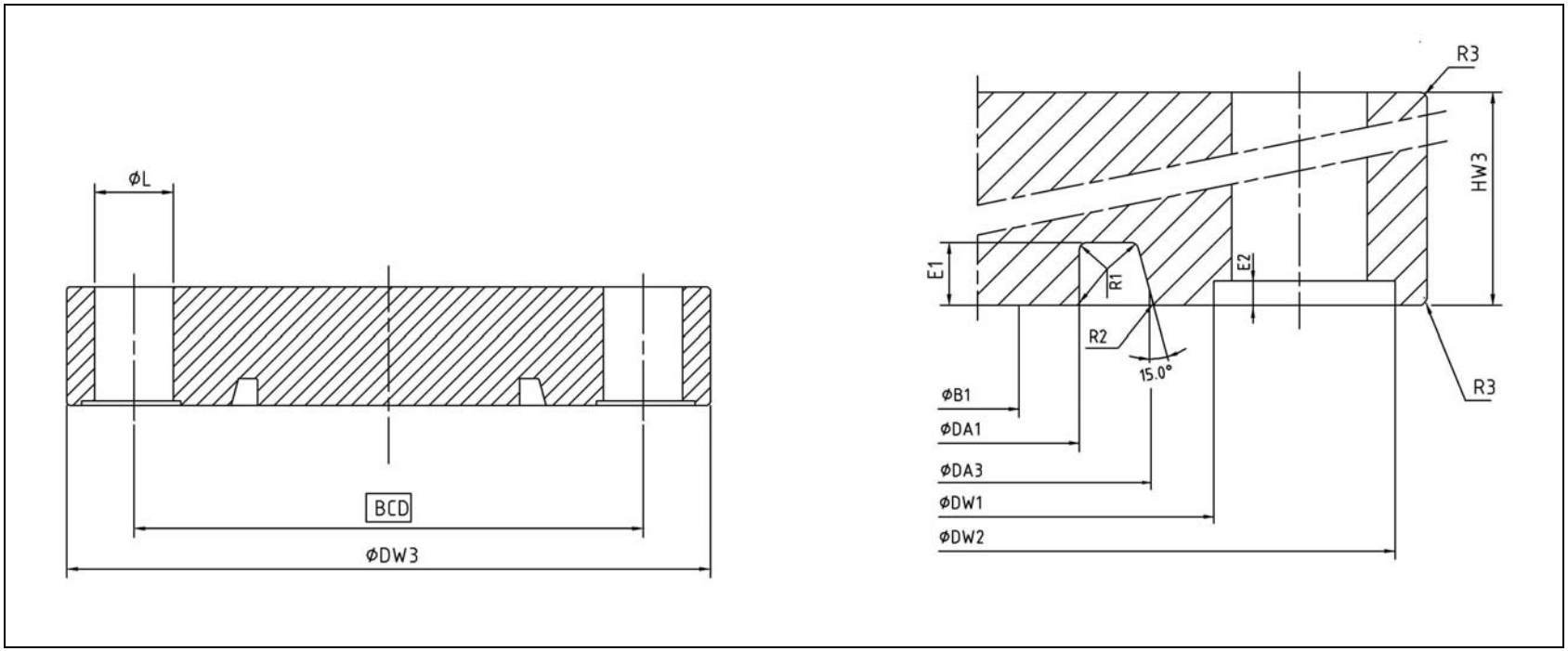

Figure A.2 – Nomenclatures for BLs

A.4 Integral flanges

Dimensions specific to the integral flanges are given in this clause and are defined in the drawing below. All other dimensions are found in Tables A.1 to A.6 for WN flanges. Dimensions comply with requirements in ASME B16.34 and API 6D. The face angle for the integral flanges are based on the stiffness from a flange neck of diameter equal to A_{max}. For WN flanges, the face angles are based on the listed standard pipe outer diameters. For integral flanges with smaller neck diameter than Amax, the face dimensions can be interpolated between the values listed for WN and the values listed for integral flanges. The heel seal functionality is improved with an optimised flange face angle.

Standard bore diameter within a pressure class may be used if accepted by the purchaser. The standard bore should be selected within the given bore range for the actual size and pressure class. Smaller bore diameters may be accepted if the flange face angle is adjusted according to the actual flange warping stiffness. The flange functionality will not be affected by a bore diameter step at the mating faces between an integral flange and another flange component to this NORSOK standard. Note that other functional requirements such as effect on flow patterns, and pigging requirements may limit the step change at the mating faces.

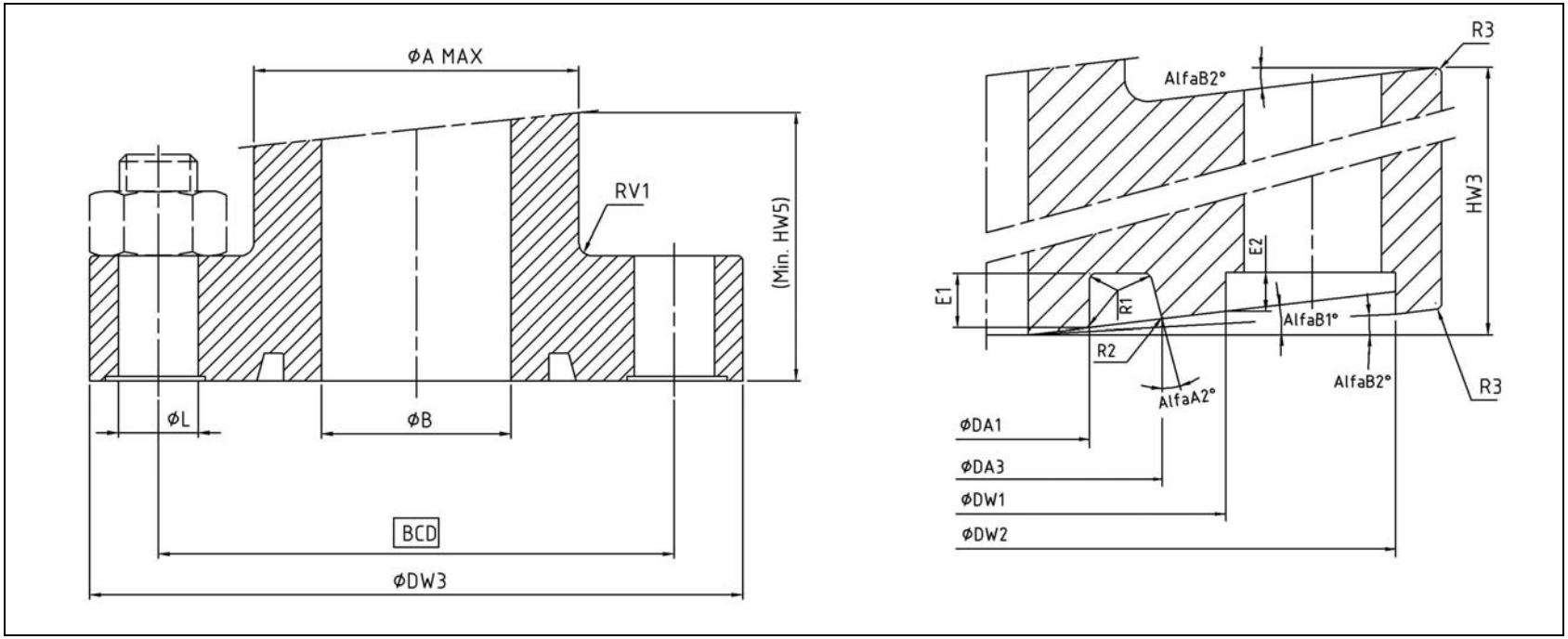

Figure A.3 – Nomenclatures for integral flanges

Table A.7 – Dimensions for CL 150 and CL 300 integral flanges

CL 150								
DN	**NPS**	**A_{max}** mm	**B** mm	**DA3** mm	**αA2** °	**αB1** °	**αB2** °	**RV1** mm
15	½	22.0	17.1-11.7	30.87	15.2	0.25	0.17	3.0
20	¾	31.0	22.5-15.6	35.87	15.2	0.25	0.17	3.0
25	1	39.0	27.9-20.7	42.86	15.2	0.25	0.17	3.0
40	1½	52.0	42.8-38.1	58.87	15.2	0.34	0.23	3.0
50	2	67.0	54.8-49.2	71.85	15.2	0.30	0.20	3.0
65	2½	80.0	66.9-62.7	85.84	15.2	0.26	0.17	4.0
80	3	94.0	82.8-77.9	101.91	15.4	0.66	0.44	4.0
100	4	122.0	108.2-102.3	129.86	15.3	0.41	0.27	4.0
125	5	149.0	134.5-128.2	157.84	15.4	0.53	0.35	4.0
150	6	178.0	161.5-154.1	187.79	15.3	0.41	0.28	4.0
200	8	232.0	211.6-206.4	239.75	15.3	0.44	0.30	4.0
250	10	293.0	264.7-260.4	299.70	15.2	0.33	0.22	6.0
300	12	340.0	314.8-311.2	348.72	15.3	0.44	0.29	6.0
350	14	375.0	346.0-339.8	381.66	15.2	0.32	0.22	6.0
400	16	430.0	396.8-390.6	435.68	15.3	0.42	0.28	6.0
450	18	478.0	447.6-441.4	487.66	15.3	0.43	0.28	6.0
500	20	532.0	496.9-488.9	540.62	15.3	0.39	0.26	6.0
550	22	586.0	547.7-539.7	592.59	15.3	0.38	0.25	6.0
600	24	641.0	596.9-590.5	643.60	15.3	0.41	0.27	6.0
650	26	695.0	644.6-641.3	696.47	15.2	0.33	0.22	6.0
700	28	749.0	695.4-692.1	748.45	15.2	0.33	0.22	6.0
750	30	804.0	746.2-736.6	801.40	15.2	0.30	0.20	6.0
800	32	856.0	797.0-787.4	852.39	15.2	0.31	0.21	6.0
850	34	909.0	847.8-838.2	903.37	15.2	0.32	0.22	6.0
900	36	955.0	898.6-889.0	957.42	15.3	0.40	0.27	6.0
950	38	1010.0	946.1-939.8	1008.38	15.3	0.38	0.25	6.0
1000	40	1067.0	996.9-990.6	1061.33	15.2	0.35	0.24	6.0
1050	42	1114.0	1047.7-1041.4	1112.36	15.3	0.41	0.27	6.0
1100	44	1166.0	1098.5-1092.2	1163.31	15.3	0.38	0.25	8.0
1150	46	1218.0	1149.3-1143.0	1216.30	15.3	0.39	0.26	8.0
1200	48	1271.0	1200.1-1193.8	1267.28	15.3	0.40	0.27	8.0

CL 300								
DN	NPS	**A_{max}** mm	**B** mm	**DA3** Mm	**αA2** °	**αB1** °	**αB2** °	**RV1** mm
15	½	22.0	17.1-11.7	30.87	15.2	0.25	0.17	3.0
20	¾	31.0	22.5-15.6	35.87	15.2	0.25	0.17	3.0
25	1	39.0	27.9-20.7	42.86	15.2	0.25	0.17	3.0
40	1½	52.0	42.8-38.1	58.87	15.2	0.34	0.23	3.0
50	2	67.0	54.8-49.2	71.85	15.2	0.30	0.20	3.0
65	2½	80.0	66.9-62.7	85.84	15.2	0.26	0.17	4.0
80	3	94.0	82.8-77.9	101.91	15.4	0.66	0.44	4.0
100	4	122.0	108.2-102.3	129.86	15.3	0.41	0.27	4.0
125	5	149.0	134.5-128.2	157.84	15.4	0.53	0.35	4.0
150	6	178.0	161.5-154.1	187.79	15.3	0.41	0.28	4.0
200	8	232.0	211.6-202.7	239.79	15.3	0.43	0.28	4.0
250	10	286.0	264.7-254.6	299.83	15.4	0.53	0.35	6.0
300	12	340.0	314.8-303.3	348.76	15.3	0.40	0.27	6.0
350	14	375.0	346.0-333.3	381.75	15.3	0.41	0.27	6.0
400	16	430.0	396.8-381.0	435.78	15.3	0.46	0.30	6.0
450	18	478.0	444.5-428.7	487.79	15.3	0.48	0.32	6.0
500	20	526.0	496.9-477.8	540.84	15.4	0.56	0.37	6.0
550	22	580.0	539.7-514.3	592.75	15.3	0.46	0.31	6.0
600	24	634.0	590.5-574.6	643.83	15.4	0.55	0.37	6.0
650	26	688.0	644.6-628.4	696.81	15.4	0.58	0.39	6.0
700	28	743.0	695.4-679.4	748.73	15.3	0.51	0.34	6.0
750	30	801.0	746.2-727.0	801.76	15.4	0.54	0.36	6.0
800	32	854.0	793.7-777.8	852.68	15.3	0.48	0.32	6.0
850	34	907.0	844.5-823.6	903.76	15.4	0.54	0.36	6.0
900	36	959.0	895.3-870.0	957.68	15.3	0.49	0.33	6.0
950	38	1014.0	939.8-925.2	1008.66	15.3	0.49	0.32	6.0
1000	40	1071.0	990.6-971.6	1061.61	15.3	0.45	0.30	6.0
1050	42	1116.0	1041.4-1022.4	1112.75	15.4	0.55	0.37	6.0
1100	44	1168.0	1092.2-1067.6	1163.76	15.4	0.56	0.38	8.0
1150	46	1218.0	1143.0-1118.4	1216.80	15.4	0.59	0.39	8.0
1200	48	1271.0	1193.8-1169.2	1267.74	15.4	0.56	0.37	8.0

Table A.8 – Dimensions for CL 600 and CL 900 integral flanges

CL 600								
DN	NPS	A_{max} mm	B mm	DA3 mm	αA2 °	αB1 °	αB2 °	RV1 mm
15	½	27.0	15.8-11.7	30.86	15.1	0.15	0.10	3.0
20	¾	33.0	21.0-15.6	35.86	15.1	0.15	0.10	3.0
25	1	41.0	27.9-20.7	42.85	15.1	0.15	0.10	3.0
40	1½	58.0	42.8-34.0	58.87	15.1	0.22	0.15	3.0
50	2	73.0	54.8-42.8	71.85	15.1	0.22	0.15	3.0
65	2½	87.0	66.9-59.0	85.88	15.2	0.29	0.20	4.0
80	3	98.0	82.8-73.7	101.89	15.3	0.40	0.26	4.0
100	4	129.0	108.2-97.2	129.90	15.3	0.39	0.26	4.0
125	5	156.0	134.5-122.2	157.81	15.2	0.33	0.22	4.0
150	6	184.0	154.1-146.4	187.78	15.2	0.28	0.18	4.0
200	8	237.0	206.4-193.7	239.80	15.2	0.35	0.23	4.0
250	10	293.0	260.4-242.9	299.81	15.3	0.38	0.26	6.0
300	12	346.0	307.1-288.9	348.83	15.3	0.42	0.28	6.0
350	14	377.0	339.8-317.5	381.86	15.3	0.46	0.31	6.0
400	16	431.0	387.3-363.5	435.86	15.3	0.46	0.30	6.0
450	18	487.0	438.1-409.5	487.89	15.3	0.49	0.33	6.0
500	20	538.0	482.6-455.6	540.88	15.3	0.49	0.32	6.0
550	22	592.0	533.4-501.6	592.84	15.3	0.44	0.30	8.0
600	24	647.0	584.2-547.7	643.84	15.3	0.45	0.30	8.0
650	26	697.0	632.0-603.3	696.82	15.3	0.49	0.33	8.0
700	28	745.0	679.4-655.2	748.96	15.4	0.60	0.40	8.0
750	30	799.0	730.2-702.0	801.96	15.4	0.59	0.39	8.0
800	32	850.0	777.8-752.8	852.96	15.4	0.58	0.39	8.0
850	34	903.0	828.6-799.6	904.03	15.4	0.62	0.42	9.0
900	36	957.0	876.3-842.4	957.88	15.3	0.50	0.34	9.0
950	38	1008.0	925.2-893.2	1009.01	15.4	0.59	0.40	9.0
1000	40	1062.0	976.0-936.0	1062.01	15.4	0.60	0.40	9.0
1050	42	1106.0	1022.4-986.8	1113.03	15.4	0.58	0.39	9.0
1100	44	1160.0	1073.2-1027.6	1164.07	15.4	0.60	0.40	10.0
1150	46	1221.0	1124.0-1078.4	1217.11	15.4	0.63	0.42	10.0
1200	48	1273.0	1169.2-1129.2	1267.97	15.4	0.54	0.36	10.0

CL 900								
DN	NPS	A_{max} mm	B mm	DA3 mm	αA2 °	αB1 °	αB2 °	RV1 mm
15	½	27.0	15.8-11.7	30.86	15.1	0.15	0.10	3.0
20	¾	33.0	21.0-15.6	35.86	15.1	0.15	0.10	3.0
25	1	41.0	26.6-20.7	42.85	15.1	0.15	0.10	3.0
40	1½	58.0	42.8-34.0	58.87	15.1	0.22	0.15	3.0
50	2	73.0	54.8-42.8	71.85	15.1	0.22	0.14	3.0
65	2½	87.0	66.9-53.9	85.87	15.2	0.27	0.18	4.0
80	3	98.0	82.8-66.6	101.88	15.2	0.36	0.24	4.0
100	4	129.0	108.2-92.0	129.89	15.2	0.37	0.25	4.0
125	5	156.0	128.2-115.9	157.79	15.2	0.28	0.18	4.0
150	6	189.0	154.1-139.8	187.78	15.2	0.26	0.17	4.0
200	8	241.0	206.4-182.6	239.87	15.3	0.42	0.28	6.0
250	10	293.0	257.5-230.2	299.85	15.3	0.39	0.26	6.0
300	12	346.0	307.1-273.1	348.85	15.3	0.40	0.26	7.0
350	14	388.0	336.5-300.0	381.81	15.2	0.34	0.23	7.0
400	16	441.0	381.0-344.5	435.83	15.2	0.37	0.25	7.0
450	18	495.0	434.9-398.5	487.88	15.3	0.43	0.29	7.0
500	20	545.0	482.6-442.9	540.95	15.3	0.48	0.32	8.0
550	22	598.0	514.3-488.9	592.95	15.3	0.48	0.32	8.0
600	24	653.0	581.1-531.8	643.99	15.3	0.50	0.34	10.0
650	26	706.0	632.0-588.4	697.00	15.4	0.54	0.36	10.0
700	28	759.0	666.8-631.2	748.82	15.3	0.38	0.26	10.0
750	30	808.0	727.0-672.0	801.91	15.3	0.44	0.29	11.0
800	32	864.0	762.8-722.8	852.89	15.3	0.43	0.29	11.0
850	34	915.0	813.6-763.6	904.11	15.4	0.57	0.38	12.0
900	36	969.0	870.0-814.4	958.00	15.3	0.47	0.32	12.0
950	38	1023.0	905.2-855.2	1009.14	15.4	0.57	0.38	13.0
1000	40	1077.0	956.0-906.0	1062.03	15.3	0.49	0.32	14.0
1050	42	1129.0	1016.8-946.8	1113.19	15.4	0.57	0.38	14.0
1100	44	1183.0	1053.6-997.6	1163.99	15.3	0.46	0.30	15.0
1150	46	1225.0	1096.4-1038.4	1217.12	15.3	0.50	0.34	15.0
1200	48	1294.0	1147.2-1089.2	1268.26	15.4	0.58	0.39	16.0

Table A.9 – Dimensions for CL 1500 and CL 2500 integral flanges

CL 1500								
DN	NPS	A_{max} mm	B mm	DA3 Mm	αA2 °	αB1 °	αB2 °	RV1 mm
15	½	27.0	15.8-6.4	30.86	15.1	0.15	0.1	3.0
20	¾	33.0	21.0-11.1	35.86	15.1	0.15	0.1	3.0
25	1	41.0	26.6-15.2	42.85	15.1	0.15	0.1	3.0
40	1 ½	58.0	40.9-28.0	58.86	15.1	0.20	0.13	3.0
50	2	73.0	52.5-38.2	71.85	15.1	0.19	0.13	3.0
65	2 ½	87.0	62.7-45.0	85.85	15.2	0.23	0.15	4.0
80	3	105.0	77.9-58.4	101.87	15.2	0.28	0.19	4.0
100	4	135.0	102.3-80.1	129.87	15.2	0.28	0.18	4.0
125	5	157.0	122.2-103.2	157.86	15.2	0.35	0.23	4.0
150	6	191.0	146.4-124.4	187.84	15.2	0.31	0.21	5.0
200	8	250.0	193.7-169.1	239.82	15.2	0.28	0.19	6.0
250	10	315.0	247.7-215.9	299.84	15.2	0.30	0.20	7.0
300	12	370.0	295.4-257.3	348.83	15.2	0.30	0.20	8.0
350	14	403.0	317.5-284.2	381.86	15.2	0.33	0.22	9.0
400	16	459.0	363.5-325.4	435.83	15.2	0.29	0.19	10.0
450	18	515.0	409.5-366.7	487.90	15.2	0.36	0.24	11.0
500	20	572.0	455.6-408.0	540.88	15.2	0.33	0.22	12.0
550	22	634.0	488.9-450.8	592.82	15.2	0.28	0.19	13.0
600	24	688.0	547.7-490.5	643.93	15.2	0.36	0.24	14.0
650	26	745.0	596.4-540.4	696.77	15.2	0.27	0.18	14.0
700	28	805.0	639.2-584.2	748.78	15.2	0.28	0.19	15.0
750	30	864.0	690.0-625.3	801.86	15.2	0.33	0.22	16.0
800	32	887.0	732.8-672.8	852.87	15.2	0.32	0.22	16.0
850	34	930.0	773.6-703.6	903.91	15.2	0.34	0.22	17.0
900	36	992.0	824.4-754.4	957.99	15.2	0.37	0.25	18.0
950	38	1050.0	865.2-805.2	1009.07	15.3	0.41	0.27	19.0
1000	40	1105.0	916.0-846.0	1061.96	15.2	0.35	0.23	20.0
1050	42	1144.0	966.8-886.8	1113.12	15.3	0.41	0.27	20.0
1100	44	1216.0	1007.6-927.6	1163.91	15.2	0.32	0.22	22.0
1150	46	1261.0	1048.4-948.4	1217.25	15.3	0.43	0.29	24.0
1200	48	1309.0	1099.2-989.2	1267.93	15.2	0.32	0.21	26.0

CL 2500								
DN	NPS	A_{max} mm	B mm	DA3 mm	αA2 °	αB1 °	AB2 °	RV1 mm
15	½	27.0	15.8-6.4	30.86	15.1	0.15	0.10	3.0
20	¾	33.0	21.0-11.1	35.86	15.1	0.15	0.10	3.0
25	1	41.0	26.6-13.4	42.85	15.1	0.15	0.10	3.0
40	1 ½	58.0	40.9-23.3	58.86	15.1	0.18	0.12	3.0
50	2	73.0	52.5-31.9	71.87	15.1	0.22	0.15	3.0
65	2 ½	90.0	59.0-41.0	85.87	15.1	0.22	0.15	4.0
80	3	104.0	77.7-53.9	101.90	15.2	0.29	0.19	4.0
100	4	133.0	97.2-69.9	129.88	15.2	0.24	0.16	5.0
125	5	163.0	109.5-91.3	157.83	15.2	0.26	0.17	6.0
150	6	196.0	146.4-108.3	187.84	15.2	0.27	0.18	7.0
200	8	253.0	188.9-146.1	239.86	15.2	0.28	0.19	8.0
250	10	319.0	242.9-183.1	299.88	15.2	0.30	0.20	11.0
300	12	376.0	288.9-213.9	348.92	15.2	0.33	0.22	13.0
350	14	412.0	317.5-241.3	381.93	15.2	0.33	0.22	15.0
400	16	473.0	363.5-276.1	436.01	15.2	0.37	0.25	18.0
450	18	535.0	409.4-311.2	487.90	15.2	0.29	0.20	20.0
500	20	582.0	455.6-348.0	540.97	15.2	0.33	0.22	22.0
550	22	633.0	450.8-388.8	592.98	15.2	0.33	0.22	24.0
600	24	692.0	504.9-412.8	644.00	15.2	0.33	0.22	26.0

A.5 Rigid interfaces (RIs)

RI flanges shall be made with seal grooves as specified in Annex B. The threaded bolt holes shall be made with minimum free hole depths and minimum thread engagement lengths as shown in Annex B. Flange bore shall not exceed the maximum bore listed for WN flanges. Diameters Di1 and Di2 shall be the same as diameters DW1 and DW2 respectively, and as given in Table A.1 to Table A.6 for WN flanges.

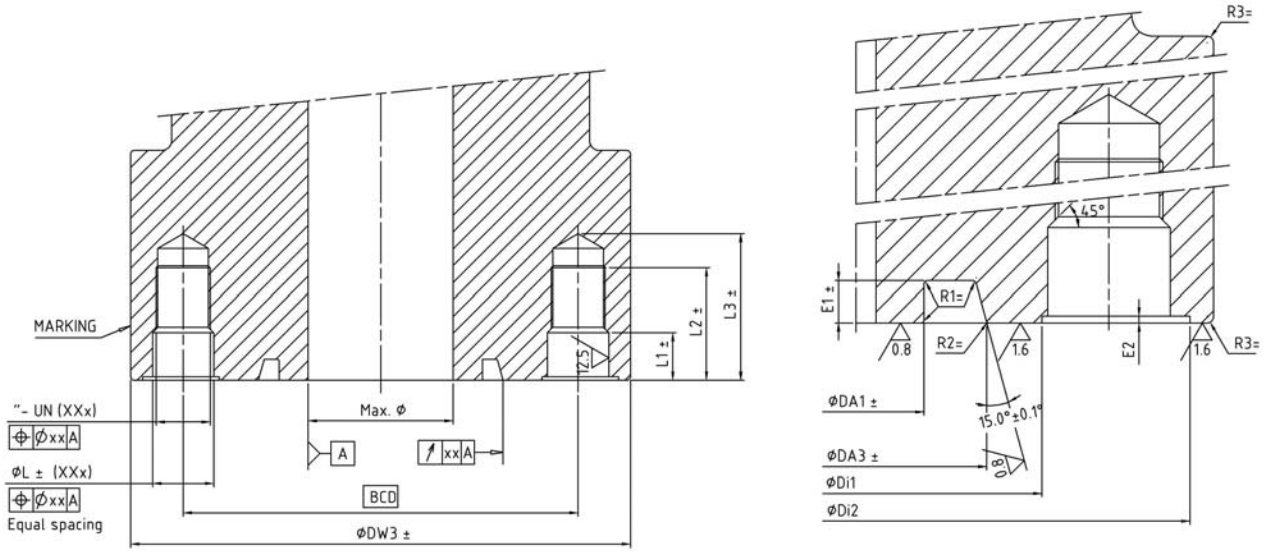

Figure A.4 – Nomenclatures for rigid interface flanges

Table A.10 – Bolt related flange data

Nominal bolt size	Free hole depth	Free hole plus thread engagement	Total depth	Bolt hole diameter	Recess
	L1 ± 1	L2 ± 1	L3 ± 1	L	E2
in	mm	mm	mm	mm	mm
½	13	28	36	15.00	1.0
⅝	15	34	44	18.00	1.0
¾	18	41	52	22.00	1.0
⅞	21	48	61	25.00	1.0
1	24	55	69	29.00	1.5
1 ⅛	27	63	78	32.00	1.5
1 ¼	31	71	87	35.00	1.5
1 ⅜	34	80	97	38.00	1.5
1 ½	37	87	106 ± 2	42.00	1.5
1 ⅝	41	95	116	45.00	1.5
1 ¾	44	105 ± 2	125	49.00	1.5
1 ⅞	47	113	134	52.00	1.5
2	50	121	143	55.00	2.0
2 ¼	57	137	160	62.00	2.0
2 ½	63	153	177	68.00	2.0
2 ¾	69	168	195	74.00	2.0
3	76	185	214	81.00	2.5
3 ¼	83	201	232	88.00	2.5
3 ½	89	217	250	94.00	2.5
3 ¾	96	233	267	101.00	2.5
4	102	249	285	107.00	2.5

NOTE Thread engagement meets requirements in ASME VIII Div.2. AD-730.

A.6 Paddle spacer (PS)/paddle blank (PB)

PS flanges and PB flanges shall be made with seal grooves as specified in Annex B. Table A.11 lists the minimum thickness of PS flanges and PB flanges. For PS flanges the bore shall not exceed the maximum bore listed for WN flanges, see Table A.1 to Table A.6. For PB flanges the bore B1 of no sealing surface shall not exceed the minimum bore listed for WN flanges, see Table A.1 to Table A.6.

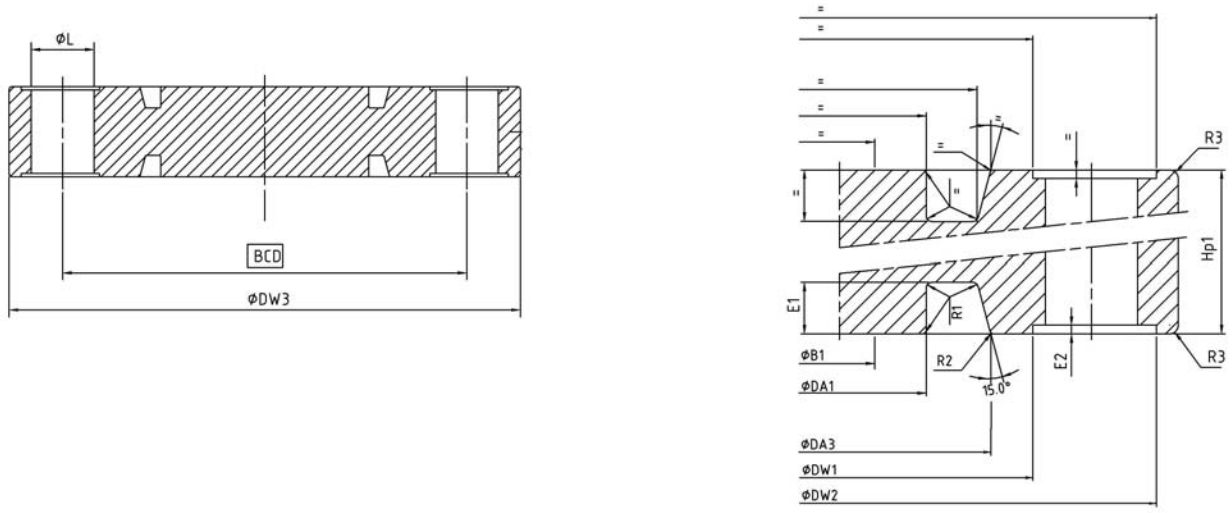

Figure A.5 – Nomenclatures for paddle blank (PB) flange

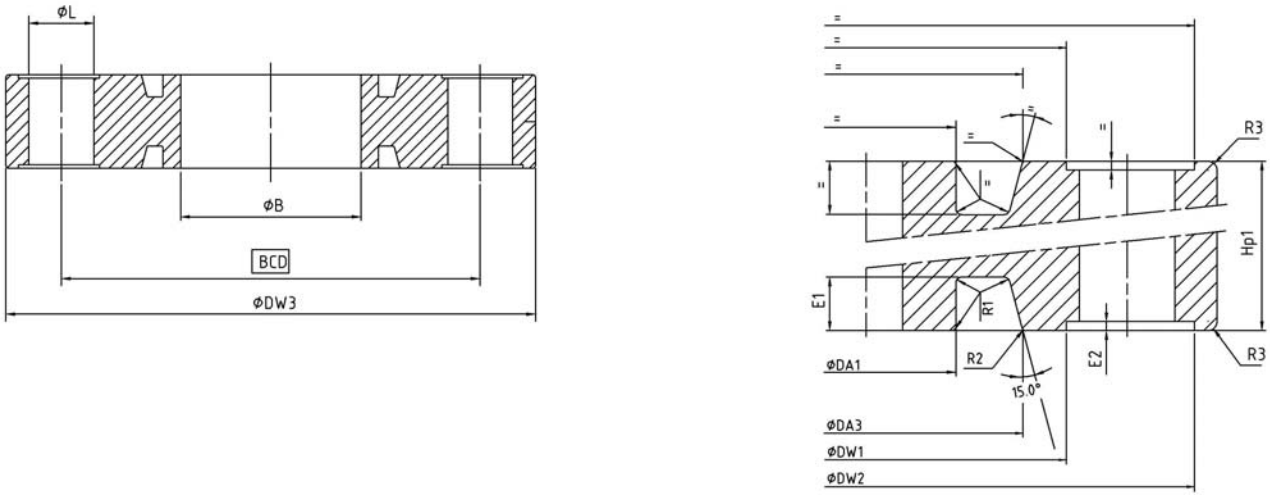

Figure A.6 – Nomenclatures for paddle spacer (PS) flange

Table A.11 – Flange thickness, HP1 (mm), for PS flanges and PB flanges

DN	NPS	CL 150	CL 300	CL 600	CL 900	CL 1500	CL 2500
15	½	17.0	17.0	17.0	17.0	17.0	17.0
20	¾	18.0	18.0	18.0	18.0	18.0	18.0
25	1	19.0	19.0	19.0	19.0	19.0	19.0
40	1½	22.0	22.0	22.0	22.0	22.0	22.0
50	2	23.0	23.0	23.0	23.0	23.0	25.0
65	2½	23.0	23.0	26.0	26.0	26.0	29.0
80	3	24.0	24.0	26.0	26.0	29.0	33.0
100	4	25.0	25.0	31.0	31.0	35.0	39.0
125	5	29.0	29.0	35.0	35.0	40.0	45.0
150	6	32.0	32.0	37.0	40.0	45.0	52.0
200	8	33.0	38.0	44.0	48.0	54.0	63.0
250	10	38.0	44.0	51.0	56.0	65.0	76.0
300	12	42.0	49.0	57.0	64.0	73.0	86.0
350	14	44.0	52.0	61.0	68.0	79.0	92.0
400	16	48.0	57.0	68.0	75.0	87.0	103.0
450	18	52.0	62.0	74.0	82.0	96.0	113.0
500	20	56.0	67.0	80.0	89.0	104.0	126.0
550	22	59.0	72.0	85.0	96.0	112.0	137.0
600	24	63.0	76.0	91.0	102.0	120.0	149.0
650	26	66.0	81.0	97.0	109.0	129.0	
700	28	70.0	85.0	102.0	116.0	137.0	
750	30	73.0	90.0	108.0	123.0	145.0	
800	32	76.0	94.0	113.0	129.0	153.0	
850	34	79.0	98.0	119.0	135.0	162.0	
900	36	82.0	102.0	125.0	142.0	172.0	
950	38	85.0	107.0	131.0	148.0	181.0	
1000	40	88.0	111.0	136.0	155.0	190.0	
1050	42	91.0	115.0	141.0	161.0	199.0	
1100	44	95.0	119.0	147.0	167.0	208.0	
1150	46	98.0	124.0	152.0	173.0	217.0	
1200	48	100.0	128.0	157.0	179.0	226.0	

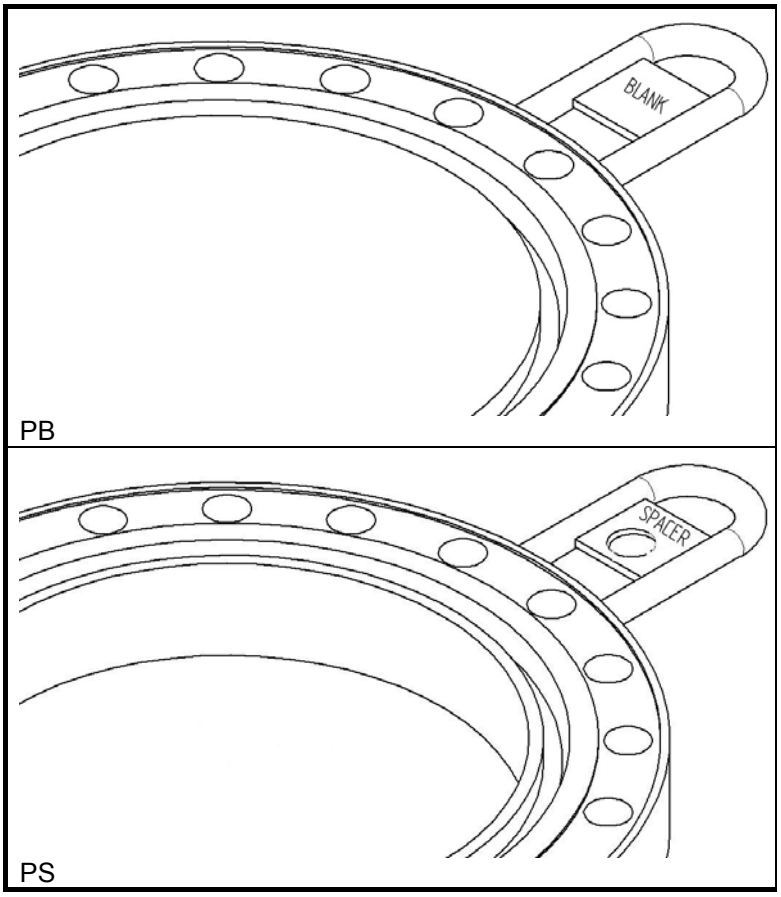

Figure A.7 – Handles and lifting lugs for paddle blanks (PBs) and paddle spacers (PSs)

Handle and lifting lugs
The handles for spades and spacers shall follow the design as shown in Figure A.7.

Handles shall be made of a rod with circular cross section and with a plate welded to the handle and die-stamped as appropriate with "BLANK" or "SPACER" on both sides with a minimum letter size of 10 mm. The handles for PSs shall be provided with a Ø12 mm hole as shown in Figure A.7. This hole serves as a remote visual indicator.

CAUTION: PB handles shall not be supplied with any holes for any purpose to avoid misinterpretation.

The welds of the handles to the flange shall be capable of carrying the weight of the paddle flange. The handle shall also tolerate lifting the paddle flange from the floor in horizontal position to vertical position without being bent. Welding shall meet the visual inspection requirements of the appropriate piping design code.

A.7 Flange tolerances

Table A.12 – Flange dimensional tolerances

Dimension	Flange type	Size range	Tolerance mm
Outside diameter at weld end (A)	WN	≤ DN 100 > DN 100 ≤ DN 350 > DN 350 ≤ DN 600 > DN 600	–0+0.6 –0+1.0 –0+1.6 –0+2.4
Bore diameter (B)	WN, IF, PS	≤ DN 100 > DN 100 ≤ DN 350 > DN 350 ≤ DN 600 > DN 600	–0.6+0 –1.0+0 –1.6+0 –2.4+0
Outside diameter of flange (DW3)	WN, BL,IF, PB, PS	≤ 150 mm OD > 150 mm ≤ 620 mm OD > 620 mm OD	±0.5 ±0.8 ±1.2
Overall length of flange (HW5)	WN	< 120 mm length ≥ 120 mm ≤ 400 mm length > 400 mm length	±0.8 ±1.2 ±2.0
Flange thickness HW3 (HP1)	WN, BL, IF,PS, PB	≤ 30 mm thickness > 30 mm ≤ 60 mm thickness > 60 mm ≤ 120 mm thickness > 120 mm thickness	±0.5 ±0.8 ±1.2 ±2.0
Groove OD run out	WN, BL, IF, PS, PB	≤ DN 125 > DN 125 ≤ DN 600 > DN 600	-0+0.10 -0+0.15 -0+0.20
ID of groove (DA1)	WN, BL, IF, PS, PB	≤ DN 125 > DN 125 ≤ DN 600 > DN 600	±0.2 ±0.3 ±0.5
OD of groove (DA3)	WN, BL, IF, PS, PB	≤ DN 80 > DN 80 ≤ DN 550 > DN 550	±0.05 ±0.1 ±0.15
Groove angle (αA2)	WN, IF	≤ DN 500 > DN 500	±0.1° ±0.15°
Face angle (α B1)	WN, IF	all sizes	±7.5%
Effective face angle (α B2)	WN, IF	all sizes	±7.5%
Rear face angle (α B2)	WN, IF	all sizes	±15%
IX seal groove depth (E1)	WN, BL, IF, RI, PS, PB	≤ DN 250 > DN 250 ≤ DN 450 > DN 450 ≤ DN 650 > DN 650 ≤ DN 850 > DN 850 ≤ DN 1050 > DN 1050	±0.15 ±0.20 ±0.30 ±0.40 ±0.50 ±0.60
RG seal groove depth (E3)	WN, BL, IF, RI, PS, PB	all	-0.0/+0.05
Bolt hole diameter (L)	WN, BL, IF	Bolt sizes to ¾” Bolt sizes ⅞” to 2 ½” Bolt sizes 2¾” to 4”	±0.3 ±0.5 ±0.8
Bolt hole position tolerance	WN, BL, IF	Bolt size to ¾” Bolt sizes ⅞” to 2 ½” Bolt sizes 2¾” to 4”	-0+0.3 -0+0.5 -0+0.8

A.8 Flange weights

Table A.13 – Weights of CL 150 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
NPS	DN	Sch.	mm	Weld neck (WN) kg	Blind kg	Paddle blank (PB) kg	Paddle space (PS) kg
½	15	10S	2.11	0.7	0.7	0.8	0.8
½	15	160	4.78	0.7			0.8
¾	20	10S	2.11	0.7	0.8	0.9	0.9
¾	20	160	5.56	0.8			0.9
1	25	10S	2.77	0.9	0.9	1.1	1.1
1	25	160	6.35	1.0			1.1
1½	40	10S	2.77	1.1	1.2	1.8	1.5
1½	40	80	5.08	1.2			1.6
2	50	10S	2.77	1.3	1.4	2.2	1.8
2	50	80	5.54	1.4			1.9
2½	65	10S	3.05	1.6	1.9	2.7	2.1
2½	65	40	5.16	1.7			2.1
3	80	10S	3.05	1.9	2.5	3.4	2.3
3	80	40	5.49	2.1			2.5
4	100	10S	3.05	2.9	4.2	4.7	2.9
4	100	40	6.02	3.3			3.1
5	125	10S	3.40	3.8	6.2	7.1	3.9
5	125	40	6.55	4.4			4.1
6	150	10S	3.40	5.0	9.0	10	4.9
6	150	40	7.11	5.9			5.4
8	200	10S	3.76	6.1	13	16	6.7
8	200	20	6.35	6.8			7.1
10	250	10S	4.19	9.8	23	26	10
10	250	20	6.35	11			11
12	300	10S	4.57	12	33	38	13
12	300	20	6.35	13			13
14	350	10S	4.78	15	42	47	15
14	350	20	7.92	17			16
16	400	10S	4.78	23	62	69	23
16	400	20	7.92	25			24
18	450	10S	4.78	27	82	90	26
18	450	20	7.92	29			28
20	500	10S	5.54	34	107	118	32
20	500	20	9.53	38			35
22	550	10S	5.54	41	138	148	38
22	550	20	9.53	46			42
24	600	10	6.35	58	185	193	55
24	600	20	9.53	62			58
26	650	10	7.92	73	232	235	65
26	650	STD	9.53	76			67
28	700	10	7.92	85	283	286	76
28	700	STD	9.53	88			78
30	750	10	7.92	98	339	338	86
30	750	20	12.70	107			93
32	800	10	7.92	110	402	394	96
32	800	20	12.70	121			103
34	850	10	7.92	123	466	458	107
34	850	20	12.70	135			115
36	900	10	7.92	148	559	537	127
36	900	20	12.70	161			136
38	950	STD	9.53	172	649	616	146
38	950	XS	12.70	182			152
40	1000	STD	9.53	197	751	707	166
40	1000	XS	12.70	208			173
42	1050	STD	9.53	207	839	791	174
42	1050	ISO	16.00	230			181
44	1100	STD	9.53	227	953	900	192
44	1100	XS	12.70	240			200
46	1150	STD	9.53	245	1064	1007	207
46	1150	XS	12.70	259			216
48	1200	STD	9.53	268	1197	1112	222
48	1200	XS	12.70	282			232

Table A.14 – Weights of CL 300 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
				Weld neck (WN) kg	Blind kg	Paddle blank (PB) kg	Paddle spacer (PS) kg
NPS	DN	Sch.	mm				
½	15	10S	2.11	0.7	0.7	0.8	0.8
½	15	160	4.78	0.7			0.8
¾	20	10S	2.11	0.7	0.8	0.9	0.9
¾	20	160	5.56	0.8			0.9
1	25	10S	2.77	0.9	0.9	1.1	1.1
1	25	160	6.35	1.0			1.1
1½	40	10S	2.77	1.1	1.2	1.8	1.5
1½	40	80	5.08	1.2			1.6
2	50	10S	2.77	1.3	1.4	2.2	1.8
2	50	80	5.54	1.4			1.9
2½	65	10S	3.05	1.6	1.9	2.7	2.1
2½	65	40	5.16	1.7			2.1
3	80	10S	3.05	1.9	2.5	3.4	2.3
3	80	40	5.49	2.1			2.5
4	100	10S	3.05	2.9	4.2	4.7	2.9
4	100	40	6.02	3.3			3.1
5	125	10S	3.40	3.8	6.2	7.1	3.9
5	125	40	6.55	4.4			4.1
6	150	10S	3.40	5.0	9.0	10	4.9
6	150	40	7.11	5.9			5.4
8	200	10S	3.76	9.7	19	20	9.3
8	200	40	8.18	11			10
10	250	10S	4.19	14	31	31	12
10	250	40	9.27	16			14
12	300	10S	4.57	19	47	47	17
12	300	40	10.31	23			20
14	350	10S	4.78	23	58	59	21
14	350	40	11.13	28			24
16	400	10S	4.78	36	90	86	31
16	400	40	12.70	43			35
18	450	10	6.35	43	117	112	37
18	450	40	14.27	53			42
20	500	10	6.35	59	159	152	50
20	500	40	15.09	71			57
22	550	20	9.53	75	202	193	63
22	550	60	22.23	95			75
24	600	20	9.53	96	264	244	80
24	600	40	17.48	111			88
26	650	10	7.92	109	322	299	91
26	650	ISO	16.00	126			101
28	700	10	7.92	128	392	360	106
28	700	30	15.88	147			117
30	750	10	7.92	163	492	446	136
30	750	ISO	17.50	189			151
32	800	STD	9.53	191	581	523	157
32	800	40	17.48	214			171
34	850	STD	9.53	228	697	618	186
34	850	ISO	20.00	262			207
36	900	STD	9.53	254	806	712	206
36	900	ISO	22.20	300			234
38	950	XS	12.70	296	928	824	240
38	950	ISO	20.00	324			258
40	1000	XS	12.70	339	1085	944	270
40	1000	ISO	22.20	380			296
42	1050	XS	12.70	388	1247	1081	311
42	1050	ISO	22.20	433			339
44	1100	XS	12.70	417	1391	1212	335
44	1100	ISO	25.00	480			374
46	1150	XS	12.70	480	1605	1385	385
46	1150	ISO	25.00	549			427
48	1200	XS	12.70	520	1781	1544	417
48	1200	ISO	25.00	594			463

Table A.15 – Weights of CL 600 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
				Weld neck (WN)	Blind	Paddle blank (PB)	Paddle spacer (PS)
NPS	DN	Sch.	mm	kg	kg	kg	kg
½	15	40	2.77	0.9	0.9	0.8	0.8
½	15	160	4.78	1.0			0.8
¾	20	40	2.87	1.0	1.0	0.9	0.9
¾	20	160	5.56	1.1			0.9
1	25	10S	2.77	1.2	1.2	1.1	1.1
1	25	160	6.35	1.3			1.1
1 ½	40	10S	2.77	1.6	1.7	1.7	1.4
1 ½	40	160	7.14	1.9			1.5
2	50	10S	2.77	2.0	2.3	2.3	1.8
2	50	160	8.74	2.4			2.0
2 ½	65	10S	3.05	2.5	3.0	3.0	2.3
2 ½	65	80	7.01	2.9			2.4
3	80	10S	3.05	2.6	3.4	3.5	2.4
3	80	80	7.62	3.1			2.6
4	100	10S	3.05	4.9	6.9	6.8	4.5
4	100	80	8.56	5.9			5.0
5	125	10S	3.40	6.8	10	10	6.1
5	125	80	9.53	8.3			6.8
6	150	40	7.11	9.2	13	14	8.1
6	150	80	10.97	10			8.6
8	200	10S	3.76	12	23	23	11
8	200	80	12.70	16			13
10	250	20	6.35	23	43	41	19
10	250	100	18.26	31			23
12	300	30	8.38	37	69	64	31
12	300	80	17.48	44			35
14	350	20	7.92	41	84	79	35
14	350	80	19.05	52			41
16	400	30	9.53	60	123	113	50
16	400	80	21.44	73			57
18	450	STD	9.53	81	170	156	68
18	450	80	23.83	100			79
20	500	30	12.70	99	214	197	82
20	500	80	26.19	121			94
22	550	30	12.70	131	287	256	107
22	550	80	28.58	161			124
24	600	XS	12.70	153	353	317	125
24	600	80	30.96	194			149
26	650	ISO	14.20	174	419	383	143
26	650	ISO	28.00	210			164
28	700	30	15.88	218	520	468	177
28	700	ISO	28.00	253			197
30	750	30	15.88	248	617	559	202
30	750	ISO	30.00	295			229
32	800	40	17.48	301	748	664	241
32	800	ISO	30.00	348			268
34	850	40	17.48	356	894	792	287
34	850	ISO	32.00	417			322
36	900	40	19.05	422	1078	921	327
36	900	ISO	36.00	499			372
38	950	ISO	20.00	472	1112	1071	378
38	950	ISO	36.00	552			425
40	1000	ISO	20.00	519	1379	1215	414
40	1000	ISO	40.00	629			479
42	1050	ISO	22.20	626	1645	1394	483
42	1050	ISO	40.00	733			545
44	1100	ISO	22.20	672	1832	1571	524
44	1100	ISO	45.00	820			611
46	1150	ISO	22.20	778	2079	1803	617
46	1150	ISO	45.00	942			711
48	1200	ISO	25.00	904	2436	2008	682
48	1200	ISO	45.00	1058			771

Table A.16 – Weights of CL 900 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
NPS	DN	Sch.	mm	Weld nek (WN) kg	Blind kg	Paddle blank (PB) kg	Paddle spacer (PS) kg
½	15	40	2.77	0.92	0.91	0.8	0.8
½	15	160	4.78	0.96			0.8
¾	20	40	2.87	1.0	1.0	0.9	0.9
¾	20	160	5.56	1.1			0.9
1	25	40	3.38	1.2	1.2	1.1	1.1
1	25	160	6.35	1.3			1.1
1 ½	40	10S	2.77	1.6	1.7	1.7	1.4
1 ½	40	160	7.14	1.9			1.5
2	50	10S	2.77	2.0	2.3	2.3	1.8
2	50	160	8.74	2.4			2.0
2 ½	65	10S	3.05	2.5	3.0	3.0	2.3
2 ½	65	160	9.53	3.1			2.5
3	80	10S	3.05	2.6	3.4	3.5	2.4
3	80	160	11.13	3.5			2.8
4	100	10S	3.05	4.9	6.9	6.8	4.5
4	100	120	11.13	6.4			5.2
5	125	40	6.55	7.7	10.2	10	6.5
5	125	120	12.70	9.1			7.1
6	150	40	7.11	10.8	15.3	15	9.1
6	150	120	14.27	13.1			10
8	200	20	6.35	18.3	29.8	28	15
8	200	120	18.26	24.0			18
10	250	30	7.80	30.5	52.3	48	25
10	250	120	21.44	39.6			30
12	300	30	8.38	44.5	80.5	75	38
12	300	120	25.40	59.1			45
14	350	30	9.53	53.6	99.9	92	44
14	350	120	27.79	71.9			54
16	400	40	12.70	81.5	147	133	66
16	400	120	30.96	105			78
18	450	30	11.13	106	202	182	86
18	450	100	29.36	135			102
20	500	30	12.70	142	274	244	115
20	500	100	32.54	180			135
22	550	60	22.23	199	352	313	156
22	550	100	34.93	228			171
24	600	30	14.27	225	448	394	181
24	600	100	38.89	290			215
26	650	ISO	20.00	292	560	488	228
26	650	ISO	36.00	342			254
28	700	ISO	22.20	346	671	589	270
28	700	ISO	40.00	407			303
30	750	ISO	17.50	394	816	716	314
30	750	ISO	45.00	503			373
32	800	ISO	25.00	502	982	856	392
32	800	ISO	45.00	591			439
34	850	ISO	25.00	614	1208	1026	473
34	850	ISO	50.00	739			539
36	900	ISO	25.00	688	1391	1189	533
36	900	ISO	50.00	827			607
38	950	ISO	30.00	847	1653	1397	647
38	950	ISO	55.00	1001			728
40	1000	ISO	30.00	937	1874	1595	720
40	1000	ISO	55.00	1106			809
42	1050	ISO	32.00	1010	2067	1779	778
42	1050	ISO	60.00	1215			887
44	1100	ISO	32.00	1110	2318	2005	859
44	1100	ISO	60.00	1332			977
46	1150	ISO	36.00	1320	2690	2291	1006
46	1150	ISO	65.00	1571			1138
48	1200	ISO	36.00	1595	3215	2651	1196
48	1200	ISO	65.00	1873			1339

Table A.17 – Weights of CL 1500 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
				Weld neck (WN)	Blind	Paddle blank (PB)	Paddle spacer (PS)
NPS	DN	Sch.	mm	kg	kg	kg	kg
½	15	40	2.77	0.92	0.91	0.8	0.8
½	15	XXS	7.47	0.99			0.8
¾	20	40	2.87	1.0	1.0	0.9	0.9
¾	20	XXS	7.82	1.1			0.9
1	25	40	3.38	1.2	1.2	1.1	1.1
1	25	XXS	9.09	1.4			1.1
1½	40	40	3.68	1.7	1.7	1.7	1.4
1½	40	XXS	10.15	2.0			1.6
2	50	40	3.91	2.1	2.3	2.3	1.9
2	50	XXS	11.07	2.6			2.1
2 ½	65	40	5.16	2.7	3.0	3.0	2.3
2 ½	65	XXS	14.02	3.5			2.7
3	80	40	5.49	4.4	5.1	4.9	3.8
3	80	XXS	15.24	5.6			4.3
4	100	40	6.02	8.2	9.8	9.2	7.0
4	100	XXS	17.12	10			7.8
5	125	80	9.53	13	15.6	14	11
5	125	XXS	19.05	16			12
6	150	80	10.97	21	25.2	23	17
6	150	XXS	21.95	25			18
8	200	80	12.70	33	43.3	39	26
8	200	ISO	25.00	39			29
10	250	60	12.70	61	84.1	72	47
10	250	160	28.58	73			53
12	300	60	14.27	81	117	102	63
12	300	160	33.32	100			73
14	350	80	19.05	109	152	134	85
14	350	160	35.71	129			95
16	400	80	21.44	158	228	187	116
16	400	160	40.49	187			130
18	450	80	23.83	210	302	260	160
18	450	160	45.24	251			180
20	500	80	26.19	291	423	347	214
20	500	160	50.01	347			240
22	550	100	34.93	407	573	449	284
22	550	160	53.98	459			309
24	600	80	30.96	485	706	578	356
24	600	160	59.54	578			400
26	650	ISO	32.00	623	949	708	424
26	650	ISO	60.00	729			475
28	700	ISO	36.00	732	1126	843	496
28	700	ISO	60.00	837			546
30	750	ISO	36.00	862	1330	1032	605
30	750	ISO	65.00	1007			674
32	800	ISO	40.00	930	1510	1138	630
32	800	ISO	70.00	1092			709
34	850	ISO	40.00	1103	1815	1367	752
34	850	ISO	75.00	1316			857
36	900	ISO	45.00	1422	2223	1717	994
36	900	ISO	80.00	1664			1111
38	950	ISO	50.00	1647	2526	2018	1180
38	950	ISO	80.00	1877			1292
40	1000	ISO	50.00	1812	2941	2227	1242
40	1000	ISO	85.00	2104			1386
42	1050	ISO	50.00	2159	3453	2666	1517
42	1050	ISO	90.00	2529			1699
44	1100	ISO	55.00	2350	3863	2912	1607
44	1100	ISO	95.00	2746			1805
46	1150	ISO	60.00	2708	4355	3353	1879
46	1150	ISO	110.00	3244			2147
48	1200	ISO	60.00	2997	5000	3717	2030
48	1200	ISO	115.00	3630			2350

Table A.18 – Weights of CL 2500 flanges

Nominal size		Neck wall thickness		Approximate weights (each)			
				Weld neck (WN)	Blind	Paddle blank (PB)	Paddle spacer (PS)
NPS	DN	Sch.	mm	kg	kg	kg	kg
½	15	40	2.77	0.9	0.9	0.8	0.8
½	15	XXS	7.47	1.0			0.8
¾	20	40	2.87	1.0	1.0	0.9	0.9
¾	20	XXS	7.82	1.1			0.9
1	25	40	3.38	1.2	1.2	1.1	1.1
1	25	XXS	9.09	1.4			1.1
1½	40	40	3.68	1.7	1.7	1.7	1.4
1½	40	ISO	12.50	2.1			1.6
2	50	40	3.91	2.9	3.0	2.8	2.4
2	50	ISO	14.20	3.6			2.7
2 ½	65	80	7.01	5.3	5.4	4.9	4.3
2 ½	65	ISO	16.00	6.2			4.6
3	80	40	5.59	7.6	8.4	7.7	6.4
3	80	ISO	17.50	9.2			7.1
4	100	80	8.56	13	14	13	11
4	100	ISO	22.20	16			12
5	125	160	15.88	19	20	18	15
5	125	ISO	25.00	22			16
6	150	80	10.97	27	32	29	22
6	150	ISO	30.00	34			25
8	200	100	15.09	55	65	57	43
8	200	ISO	36.00	68			48
10	250	80	15.09	87	110	95	67
10	250	ISO	45.00	115			79
12	300	80	17.48	131	168	146	101
12	300	ISO	55.00	177			121
14	350	80	19.05	173	223	189	132
14	350	ISO	55.00	226			155
16	400	80	21.44	268	346	284	200
16	400	ISO	65.00	351			235
18	450	80	23.88	348	453	376	259
18	450	ISO	70.00	457			305
20	500	80	26.19	439	580	496	334
20	500	ISO	80.00	591			402
22	550	160	53.98	708	808	679	506
22	550	ISO	85.00	809			551
24	600	140	52.37	870	1027	869	634
24	600	ISO	95.00	1035			707

Annex B
(Normative)
Seals dimensions and weights

B.1 IX seal ring grooves

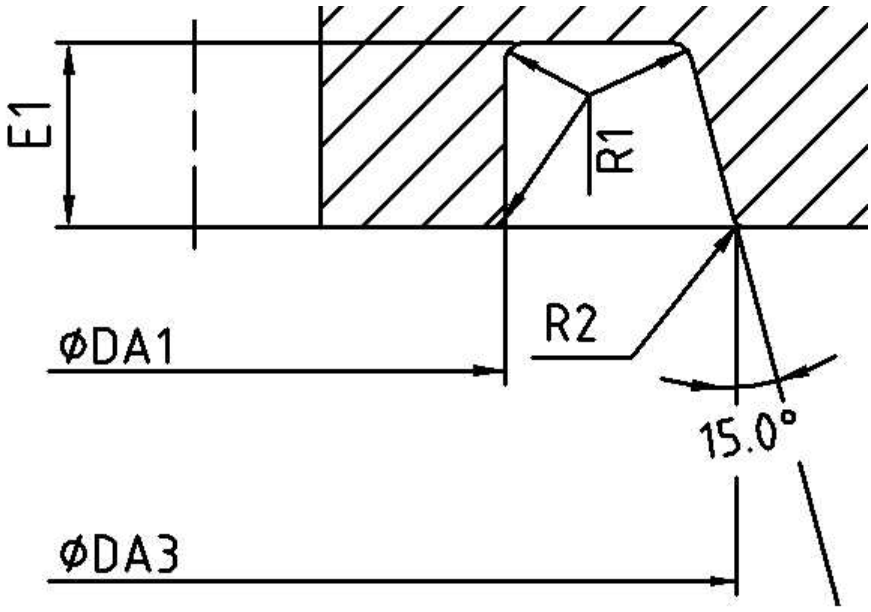

Figure B.1 – Nomenclature for IX seal grooves

The IX seal grooves are identical for all pressure classes and dimensions are hence given per DN in Annex A.

The outer diameter DA3 of the grooves and the groove angle αA2 are only valid for the flat face flanges. i.e RI, PS and PB flanges. For flanges with face bevel angle (WN and IF), these dimensions vary with the face angle.

Table B.1 – Dimensions of IX seal ring grooves

DN	NPS	IX size	DA1	DA3	E1	αA2
15	½	IX15	20.8	30.83	5.30	15.0
20	¾	IX20	25.8	35.82	5.30	15.0
25	1	IX25	32.8	42.82	5.30	15.0
40	1½	IX40	47.8	58.81	5.58	15.0
50	2	IX50	59.8	71.80	6.19	15.0
65	2½	IX65	72.8	85.79	6.79	15.0
80	3	IX80	87.8	101.77	7.42	15.0
100	4	IX100	113.8	129.75	8.40	15.0
125	5	IX125	139.8	157.68	9.27	15.0
150	6	IX150	167.7	187.66	10.12	15.0
200	8	IX200	217.7	239.62	11.48	15.0
250	10	IX250	271.7	299.58	12.90	15.0
300	12	IX300	321.7	348.54	13.97	15.0
350	14	IX350	353.7	381.51	14.63	15.0
400	16	IX400	405.7	435.47	15.63	15.0
450	18	IX450	455.7	487.43	16.54	15.0
500	20	IX500	507.7	540.39	17.63	15.0
550	22	IX550	557.7	592.35	18.45	15.0
600	24	IX600	607.7	643.32	19.23	15.0
650	26	IX650	659.5	696.23	20.00	15.0
700	28	IX700	709.5	748.19	20.92	15.0
750	30	IX750	761.5	801.15	21.65	15.0
800	32	IX800	811.5	852.11	22.32	15.0
850	34	IX850	861.5	903.07	22.97	15.0
900	36	IX900	913.5	957.03	23.82	15.0
950	38	IX950	963.5	1007.99	24.44	15.0
1000	40	IX1000	1015.5	1060.95	25.06	15.0
1050	42	IX1050	1065.5	1111.91	25.65	15.0
1100	44	IX1100	1115.5	1162.87	26.42	15.0
1150	46	IX1150	1167.5	1215.83	27.00	15.0
1200	48	IX1200	1217.5	1266.79	27.54	15.0

B.2 IX seal ring dimension

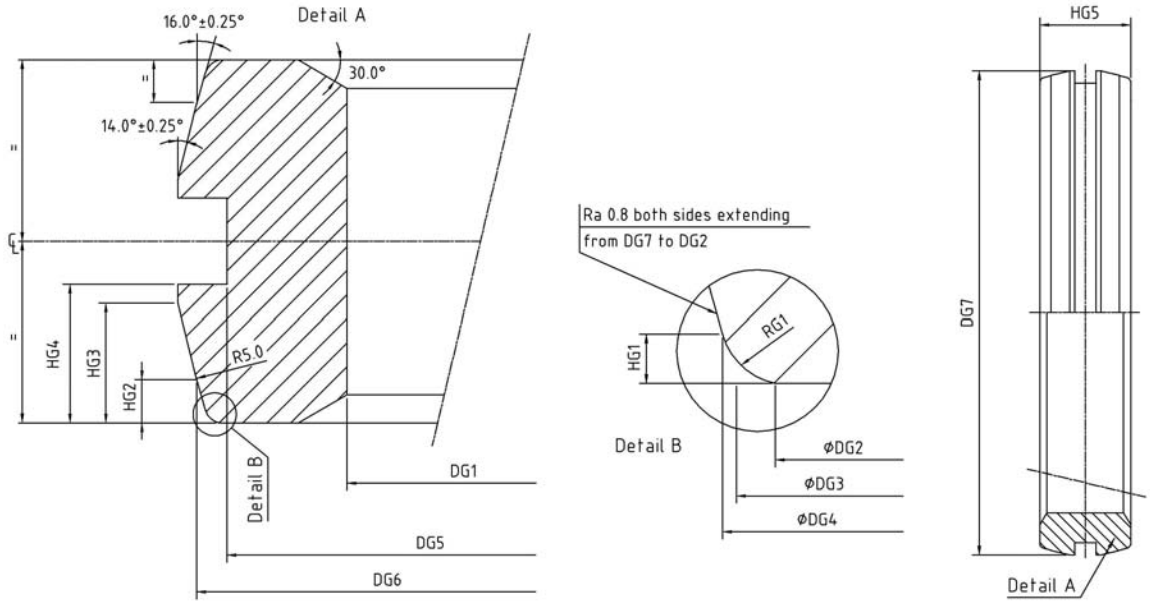

Figure B.2 – IX seal ring nomenclatures

Table B.2 – Dimensions of IX seal rings and their weights

DN	NPS	IX size	DG1 mm	DG2 mm	DG3 mm	DG4 mm	DG5 mm	DG6 mm	DG7 mm	HG1 mm	HG2 mm	HG3 mm	HG4 mm	HG5 mm	Weight kg
15	½	IX15	22.2	27.91	28.46	28.66	27.47	29.14	30.19	0.35	1.20	3.30	3.8	10.00	0.02
20	¾	IX20	27.2	32.93	33.47	33.67	32.48	34.16	35.20	0.35	1.20	3.30	3.8	10.00	0.03
25	1	IX25	34.2	39.95	40.49	40.69	39.50	41.18	42.22	0.35	1.20	3.30	3.8	10.00	0.03
40	1½	IX40	49.3	55.84	56.38	56.58	55.34	57.11	58.21	0.35	1.27	3.48	4.0	10.56	0.05
50	2	IX50	61.3	68.43	69.08	69.32	67.92	69.89	71.13	0.42	1.41	3.89	4.5	11.78	0.08
65	2½	IX65	74.4	82.14	82.79	83.03	81.52	83.69	85.05	0.42	1.56	4.28	4.9	12.98	0.12
80	3	IX80	89.5	97.74	98.49	98.77	97.09	99.47	100.96	0.49	1.71	4.70	5.4	14.24	0.17
100	4	IX100	115.7	125.17	126.04	126.36	124.44	127.15	128.85	0.56	1.94	5.34	6.2	16.19	0.28
125	5	IX125	142.0	152.66	153.64	154.00	151.87	154.87	156.75	0.63	2.15	5.92	6.8	17.94	0.42
150	6	IX150	170.2	182.17	183.25	183.66	181.32	184.61	186.66	0.70	2.36	6.48	7.5	19.64	0.62
200	8	IX200	220.5	233.46	234.66	235.10	232.45	236.19	238.54	0.77	2.68	7.38	8.5	22.36	0.99
250	10	IX250	274.9	292.64	294.05	294.57	291.57	295.78	298.42	0.91	3.02	8.31	9.6	25.20	1.85
300	12	IX300	325.0	341.13	342.65	343.21	339.97	344.52	347.36	0.98	3.26	8.96	10.4	27.15	2.18
350	14	IX350	357.1	373.87	375.38	375.94	372.58	377.34	380.32	0.98	3.42	9.39	11.0	28.46	2.60
400	16	IX400	409.3	427.36	428.98	429.58	425.98	431.08	434.27	1.05	3.66	10.05	11.9	30.47	3.43
450	18	IX450	459.4	478.90	480.63	481.27	477.45	482.85	486.23	1.12	3.87	10.65	12.7	32.28	4.38
500	20	IX500	511.6	531.45	533.29	533.97	529.93	535.63	539.20	1.19	4.09	11.24	13.5	34.06	5.27
550	22	IX550	561.7	583.04	584.99	585.71	581.62	587.44	591.18	1.26	4.28	11.78	14.3	35.69	6.48
600	24	IX600	611.9	633.64	635.70	636.46	632.40	638.26	642.16	1.33	4.47	12.29	15.0	37.25	7.55
650	26	IX650	664.0	686.37	688.42	689.18	685.19	691.09	695.16	1.33	4.66	12.81	15.7	38.81	8.74
700	28	IX700	714.1	738.01	740.17	740.97	737.01	742.94	747.16	1.40	4.83	13.28	16.3	40.25	10.4
750	30	IX750	766.3	790.65	792.92	793.77	789.83	795.79	800.16	1.47	5.00	13.76	17.0	41.69	11.8
800	32	IX800	816.4	841.32	843.70	844.58	840.67	846.66	851.16	1.54	5.16	14.20	17.6	43.03	13.3
850	34	IX850	866.6	892.10	894.48	895.36	891.52	897.53	902.18	1.54	5.32	14.63	18.2	44.34	14.8
900	36	IX900	918.7	945.78	948.27	949.19	945.38	951.41	956.19	1.61	5.48	15.06	18.8	45.65	17.1
950	38	IX950	968.8	996.59	999.08	1000.00	996.26	1002.30	1 007.21	1.61	5.63	15.47	19.3	46.88	18.9
1000	40	IX1000	1021.0	1049.28	1051.88	1052.85	1049.13	1055.19	1 060.23	1.68	5.77	15.88	19.9	48.12	20.9
1050	42	IX1050	1071.1	1100.00	1102.70	1103.71	1100.02	1106.10	1 111.26	1.75	5.92	16.27	20.4	49.29	23.0
1100	44	IX1100	1121.3	1150.83	1153.53	1154.54	1150.92	1157.00	1 162.28	1.75	6.05	16.64	21.0	50.43	25.1
1150	46	IX1150	1173.4	1203.55	1206.36	1207.40	1203.82	1209.91	1 215.31	1.82	6.19	17.03	21.5	51.59	27.5
1200	48	IX1200	1223.6	1254.39	1257.20	1258.25	1254.73	1260.83	1 266.35	1.82	6.32	17.39	22.0	52.68	29.9

Table B.3 – IX seal ring dimensional tolerances

Dimension	Size range	Tolerance mm
ID (DG1)	≤ IX80 > IX80 ≤ IX350 > IX350	±0.2 ±0.3 ±0.4
Diameter bottom recess (DG5)	≤ IX80 > IX80 ≤ IX350 > IX350	±0.1 ±0.2 ±0.4
Diameter, DG6	≤ IX150 > IX150	-0/+0.1 -0/+0.2
OD of ring (DG7)	≤ IX150 > IX150	-0/+0.1 -0/+0.2
Height, HG2	≤ IX40 > IX40 ≤ IX200 > IX200 ≤ IX400 > IX400 ≤ IX600 > IX600 ≤ IX800 > IX800 ≤ IX1000 > IX1000	±0.05 ±0.1 ±0.2 ±0.3 ±0.4 ±0.5 ±0.6
Height to end angle (HG3)	≤ IX40 > IX40 ≤ IX200 > IX200 ≤ IX400 > IX400 ≤ IX600 > IX600 ≤ IX800 > IX800 ≤ IX1000 > IX1000	±0.05 ±0.1 ±0.2 ±0.3 ±0.4 ±0.5 ±0.6
Height of ring (HG5)	≤ IX150 > IX150 ≤ IX350 > IX350 ≤ IX550 > IX550 ≤ IX700 > IX700 ≤ IX900 > IX900 ≤ IX1100 > IX1100	-0.1/+0 -0.2/+0 -0.3/+0 -0.4/+0 -0.5/+0 -0.6/+0 -0.7/+0

Annex C
(Normative)
Bolt dimensions and weights

Table C.1 – Length of stud bolts for CL 150

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	Nom. size NPS	Number	Nominal diameter in	Standard mm	Line blanks mm	Standard mm	Line blanks mm	WN/BL mm	LB/WN mm	OD/ID mm	Standard bolt set kg	Line blank bolt set kg	Standard bolt set kg	Line blank bolt set kg
15	½	4	½	70	85	110	110	28	10	26 / 14	0.5	0.5	0.6	0.6
20	¾	4	½	70	85	110	110	28	9	26 / 14	0.5	0.5	0.6	0.6
25	1	4	½	70	90	110	110	28	8	26 / 14	0.5	0.6	0.6	0.6
40	1½	4	½	70	90	110	110	28	5	26 / 14	0.5	0.6	0.6	0.6
50	2	4	½	70	90	110	110	28	4	26 / 14	0.5	0.6	0.6	0.6
65	2½	4	½	70	95	110	110	26	4	26 / 14	0.5	0.6	0.6	0.6
80	3	8	½	75	100	110	110	22		26 / 14	1.0	1.2	1.3	1.3
100	4	8	½	85	110	110	120	14		26 / 14	1.1	1.3	1.3	1.3
125	5	12	½	90	120	110	130	7		26 / 14	1.7	2.0	1.9	2.1
150	6	12	½	95	125	105	140				1.7	2.1	1.8	2.2
200	8	12	½	90	125	110	135	5		26 / 14	1.7	2.1	1.9	2.2
250	10	16	½	105	140	115	155				2.5	3.0	2.6	3.2
300	12	20	½	110	150	120	165				3.2	3.9	3.3	4.2
350	14	20	½	115	160	125	170				3.3	4.1	3.4	4.2
400	16	20	⅝	130	180	145	195				5.8	7.2	6.2	7.6
450	18	20	⅝	140	190	155	205				6.1	7.5	6.5	7.9
500	20	24	⅝	145	205	165	220				7.5	9.5	8.1	10.0
550	22	28	⅝	155	215	170	230				9.1	11.4	9.7	12.0
600	24	24	¾	170	235	190	255				12.4	15.6	13.4	16.5
650	26	24	¾	180	250	200	265				12.9	16.3	13.9	17.0
700	28	28	¾	190	260	210	280				15.6	19.6	16.8	20.7
750	30	32	¾	200	270	215	290				18.5	23.0	19.5	24.3
800	32	36	¾	205	280	225	300				21.2	26.6	22.6	28.1
850	34	40	¾	210	290	230	310				24.0	30.4	25.6	32.0
900	36	32	⅞	230	310	250	335				28.8	35.8	30.6	38.0
950	38	36	⅞	240	325	260	345				33.4	41.8	35.4	43.8
1000	40	40	⅞	245	335	270	355				37.7	47.5	40.4	49.7
1050	42	44	⅞	250	345	275	365				42.0	53.5	45.0	55.9
1100	44	44	⅞	260	355	280	375				43.2	54.7	45.6	57.1
1150	46	48	⅞	265	365	290	385				47.8	61.0	51.1	63.6
1200	48	52	⅞	275	375	295	395				53.2	67.5	56.1	70.3

Table C.2 – Length of stud bolts for CL 300

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	Nom. size NPS	Number	Nominal diameter in	Standard mm	Line blanks mm	Standard mm	Line blanks mm	WN/BL mm	LB/WN mm	OD/ID mm	Standard bolt set kg	Line blank bolt set kg	Standard bolt set kg	Line blank bolt set kg
15	½	4	½	70	85	110	110	28	10	26 / 14	0.5	0.5	0.6	0.6
20	¾	4	½	70	85	110	110	28	9	26 / 14	0.5	0.5	0.6	0.6
25	1	**4**	½	**70**	**90**	**110**	**110**	**28**	**8**	**26 / 14**	**0.5**	**0.6**	**0.6**	**0.6**
40	1½	**4**	½	**70**	**90**	**110**	**110**	**28**	**5**	**26 / 14**	**0.5**	**0.6**	**0.6**	**0.6**
50	2	**4**	½	**70**	**90**	**110**	**110**	**28**	**4**	**26 / 14**	**0.5**	**0.6**	**0.6**	**0.6**
65	2½	**4**	½	**70**	**95**	**110**	**110**	**26**	**4**	**26 / 14**	**0.5**	**0.6**	**0.6**	**0.6**
80	3	**8**	½	**75**	**100**	**110**	**110**	**22**		**26 / 14**	**1.0**	**1.2**	**1.3**	**1.3**
100	4	**8**	½	**85**	**110**	**110**	**120**	**14**		**26 / 14**	**1.1**	**1.3**	**1.3**	**1.3**
125	5	**12**	½	**90**	**120**	**110**	**130**	**7**		**26 / 14**	**1.7**	**2.0**	**1.9**	**2.1**
150	6	**12**	½	**95**	**125**	**105**	**140**				**1.7**	**2.1**	**1.8**	**2.2**
200	8	**12**	⅝	**115**	**155**	**135**	**170**				**3.2**	**3.9**	**3.6**	**4.1**
250	10	20	⅝	130	175	145	190				5.8	7.1	6.2	7.5
300	12	20	⅝	140	190	155	205				6.1	7.5	6.5	7.9
350	14	24	⅝	145	200	165	215				7.5	9.3	8.1	9.8
400	16	24	¾	170	225	190	245				12.4	15.1	13.4	16.1
450	18	28	¾	180	240	200	260				15.1	18.5	16.2	19.6
500	20	24	⅞	200	265	220	290				19.6	23.9	21.0	25.6
550	22	28	⅞	210	280	230	305				23.7	29.0	25.2	31.0
600	24	28	1	230	310	260	335				33.9	41.9	36.9	44.4
650	26	32	1	240	325	270	350				39.8	49.6	43.3	52.4
700	28	32	1	250	335	280	365				41.0	50.7	44.4	54.2
750	30	32	1 ⅛	275	365	300	390				57.1	70.1	60.7	73.8
800	32	32	1 ⅛	285	375	310	405				58.5	71.6	62.2	75.9
850	34	32	1¼	300	400	335	430				76.5	94.4	82.8	99.8
900	36	32	1¼	310	415	345	445				78.3	97.1	84.6	102.5
950	38	36	1¼	320	430	355	460				90.1	112.3	97.2	118.3
1000	40	40	1¼	335	445	365	480				103.5	128.1	110.2	136.0
1050	42	36	1⅜	350	465	385	500				118.6	146.6	127.1	155.2
1100	44	40	1⅜	360	480	395	515				134.5	167.0	144.0	176.5
1150	46	36	1 ½	380	505	420	540				153.0	189.3	164.6	199.4
1200	48	36	1 ½	390	515	425	555				155.9	192.2	166.1	203.8

Table C.3 – Length of stud bolts for CL 600

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	Nom. size NPS	Number	Nominal diameter in	Standard mm	Line blanks mm	Standard mm	Line blanks mm	WN/BL mm	LB/WN mm	OD/ID mm	Standard bolt set kg	Line blank bolt set kg	Standard bolt set kg	Line blank bolt set kg
15	½	4	½	80	95	110	110	18	4	26 / 14	0.5	0.6	0.6	0.6
20	¾	4	½	80	95	110	110	18	4	26 / 14	0.5	0.6	0.6	0.6
25	1	4	½	80	100	110	110	18		26 / 14	0.5	0.6	0.6	0.6
40	1½	8	½	85	105	110	120	12		26 / 14	1.1	1.2	1.3	1.3
50	2	8	½	85	110	110	120	12		26 / 14	1.1	1.3	1.3	1.3
65	2½	12	½	90	115	110	130	5		26 / 14	1.7	2.0	1.9	2.1
80	3	12	½	90	115	110	125	7		26 / 14	1.7	2.0	1.9	2.1
100	4	12	⅝	110	140	135	155	10		31 / 17	3.1	3.6	3.6	3.9
125	5	12	⅝	115	150	135	170				3.2	3.8	3.6	4.1
150	6	12	⅝	120	155	135	170				3.3	3.9	3.6	4.1
200	8	20	⅝	135	175	150	195				5.9	7.1	6.4	7.6
250	10	20	¾	160	210	180	230				10.0	12.0	10.8	12.8
300	12	20	⅞	180	240	205	260				15.3	18.6	16.6	19.7
350	14	24	⅞	190	250	210	275				19.0	22.9	20.3	24.6
400	16	24	1	215	285	240	310				27.7	33.8	29.9	35.9
450	18	24	1 ⅛	235	310	265	340				38.5	46.6	41.7	49.9
500	20	28	1 ⅛	250	330	275	355				46.8	56.9	50.0	60.1
550	22	24	1¼	270	355	305	390				53.4	64.8	58.1	69.5
600	24	28	1¼	285	375	315	405				64.6	78.7	69.3	83.4
650	26	32	1¼	295	390	325	420				75.7	92.7	81.0	98.0
700	28	32	1⅜	315	415	350	450				97.9	119.5	105.4	127.1
750	30	36	1⅜	325	435	360	470				112.5	139.3	121.1	147.9
800	32	32	1 ½	350	460	385	500				128.3	156.6	137.3	167.0
850	34	32	1 ⅝	370	485	410	530				159.0	193.8	171.1	207.4
900	36	32	1 ⅝	390	515	435	560				165.1	202.9	178.7	216.5
950	38	32	1 ¾	400	535	445	580				207.5	257.4	224.1	272.3
1000	40	36	1 ¾	415	550	460	595				239.6	295.9	258.4	314.6
1050	42	32	1 ⅞	445	585	490	63				259.3	318.8	278.4	344.3
1100	44	36	1 ⅞	455	600	500	650				296.4	365.8	318.0	389.7
1150	46	36	2	470	620	520	670				353.5	435.1	380.7	462.4
1200	48	36	2	500	655	550	705				369.8	454.2	397.1	481.9

Table C.4 – Length of stud bolts for CL 900

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	**Nom. size NPS**	**Number**	**Nominal diameter** in	**Standard** mm	**Line blanks** mm	**Standard** mm	**Line blanks** mm	**WN/BL** mm	**LB/WN** mm	**OD/ID** mm	**Standard bolt set** kg	**Line blank bolt set** kg	**Standard bolt set** kg	**Line blank bolt set** kg
15	½	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
20	¾	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
25	1	4	½	80	100	110	110	18		26 / 14	0.5	0.6	0.6	0.6
40	1½	8	½	85	105	110	120	12		26 / 14	1.1	1.2	1.3	1.3
50	2	8	½	85	110	110	120	12		26 / 14	1.1	1.3	1.3	1.3
65	2½	12	½	90	115	110	130	5		26 / 14	1.7	2.0	1.9	2.1
80	3	12	½	90	115	110	125	7		26 / 14	1.7	2.0	1.9	2.1
100	4	12	⅝	110	140	135	155	10		31 / 17	3.1	3.6	3.6	3.9
125	5	12	⅝	115	150	135	170				3.2	3.8	3.6	4.1
150	6	16	⅝	125	165	145	185				4.5	5.4	5.0	5.9
200	8	20	¾	155	200	175	220				9.8	11.6	10.6	12.4
250	10	20	⅞	180	240	205	260				15.3	18.6	16.6	19.7
300	12	20	1	205	270	230	295				22.4	27.1	24.2	28.8
350	14	24	1	215	285	240	310				27.7	33.8	29.9	35.9
400	16	24	1 ⅛	240	315	270	345				39.0	47.2	42.3	50.4
450	18	24	1¼	265	345	295	375				52.7	63.5	56.7	67.5
500	20	24	1⅜	285	375	320	410				68.5	83.1	74.2	88.8
550	22	24	1 ½	310	405	350	445				88.5	106.9	96.2	114.6
600	24	24	1 ⅝	330	435	375	475				110.2	134.0	120.4	143.1
650	26	24	1 ¾	355	465	400	510				143.1	173.6	155.6	186.1
700	28	24	1 ¾	390	505	435	550				152.8	184.8	165.3	197.3
750	30	24	1 ⅞	410	535	460	585				183.3	223.1	199.2	239.1
800	32	24	2	435	565	485	615				223.0	270.1	241.1	288.3
850	34	24	2 ¼	450	585	505	640				297.9	359.9	323.2	385.2
900	36	24	2 ¼	485	625	540	685				314.0	378.3	339.3	405.8
950	38	24	2 ½	495	640	555	705				403.5	485.6	437.5	522.5
1000	40	24	2 ½	525	680	590	745				420.5	508.3	457.3	545.2
1050	42	28	2 ½	530	690	595	755				493.8	599.6	536.8	642.6
1100	44	28	2 ½	570	735	630	800				520.3	629.4	560.0	672.4
1150	46	28	2 ¾	595	770	665	840				663.7	803.7	719.7	859.7
1200	48	28	3	605	785	685	860				818.0	989.4	894.2	1060.9

Table C.5 – Length of stud bolts for CL 1500

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	**Nom. size NPS**	**Number**	**Nominal diameter** in	**Standard** mm	**Line blanks** mm	**Standard** mm	**Line blanks** mm	**WN BL** mm	**LB/WN** mm	**OD/D** mm	**Standard bolt set** kg	**Line blank bolt set** kg	**Standard bolt set** kg	**Line blank bolt set** kg
15	½	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
20	¾	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
25	1	4	½	80	100	110	110	18		26 / 14	0.5	0.6	0.6	0.6
40	1½	8	½	85	105	110	120	12		26 / 14	1.1	1.2	1.3	1.3
50	2	8	½	85	110	110	120	12		26 / 14	1.1	1.3	1.3	1.3
65	2½	12	½	90	115	110	130	5		26 / 14	1.7	2.0	1.9	2.1
80	3	12	⅝	105	135	135	150	12		31 / 17	3.1	3.6	3.6	3.8
100	4	12	¾	130	165	160	180	12			5.3	6.1	6.0	6.5
125	5	12	⅞	150	190	185	210	14			8.2	9.5	9.3	10.1
150	6	12	1	170	215	210	240	14			11.9	13.9	13.7	14.9
200	8	16	1	190	245	215	270				17.1	20.2	18.5	21.6
250	10	16	1¼	235	300	265	330				32.5	38.3	35.1	41.0
300	12	20	1¼	250	320	280	355				42.2	50.1	45.6	54.0
350	14	20	1⅜	265	345	300	380				54.4	65.2	59.1	70.0
400	16	20	1 ½	305	390	345	430				72.9	86.6	79.4	93.1
450	18	20	1 ¾	330	425	375	470				113.5	135.4	123.9	145.9
500	20	20	1 ⅞	365	470	415	520				140.8	168.7	154.1	182.0
550	22	20	2	405	515	455	565				176.8	210.0	191.9	225.1
600	24	20	2 ¼	425	545	480	600				238.7	284.6	259.8	305.7
650	26	20	2 ¼	475	605	535	665				257.9	307.6	280.8	330.5
700	28	24	2 ¼	495	635	555	690				318.6	382.9	346.2	408.1
750	30	24	2 ½	520	665	580	725				417.6	499.8	451.6	533.8
800	32	24	2 ½	550	705	615	765				434.6	522.5	471.5	556.5
850	34	24	2 ¾	585	750	655	820				562.0	675.2	610.0	723.2
900	36	20	3 ¼	630	800	710	885				720.1	855.8	784.0	923.7
950	38	20	3 ½	650	830	740	920				882.5	1050.1	966.3	1133.8
1000	40	24	3 ¼	685	875	765	955				916.8	1098.8	993.4	1175.5
1050	42	20	3 ¾	725	920	820	1020				1108.2	1317.6	1210.3	1425.0
1100	44	24	3 ½	745	955	835	1045				1169.5	1405.3	1270.5	1506.3
1150	46	24	3 ¾	770	990	865	1085				1387.9	1671.4	1510.3	1793.8
1200	48	24	3 ¾	815	1040	910	1135				1445.9	1735.8	1568.3	1858.3

Table C.6 – Length of stud bolts for CL 2500

Bolting				Torque tool		Tension tool					Weight of stud bolts and nuts			
				Length of stud bolts		Length of stud bolts		"Washer" (thickness)		"Washer"	Torque tool		Tension tool	
DN	Nom. size NPS	Number	Nominal diameter in	Standard mm	Line blanks mm	Standard mm	Line blanks mm	WN/BL mm	LB/WN mm	OD/ID mm	Standard bolt set kg	Line blank bolt set kg	Standard bolt set kg	Line blank bolt set kg
15	½	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
20	¾	4	½	80	95	110	110	18		26 / 14	0.5	0.6	0.6	0.6
25	1	4	½	80	100	110	110	18		26 / 14	0.5	0.6	0.6	0.6
40	1½	8	½	85	105	110	120	12		26 / 14	1.1	1.2	1.3	1.3
50	2	8	⅝	100	125	135	140	18		31 / 17	2.0	2.3	2.4	2.4
65	2½	8	¾	120	145	160	165	22		37 / 21	3.3	3.7	4.0	4.1
80	3	8	⅞	135	165	185	190	28		42 / 24	5.1	5.8	6.2	6.3
100	4	8	1	160	195	210	225	26		48 / 28	7.7	8.7	9.1	9.5
125	5	12	1	170	215	210	240	14		48 / 28	11.9	13.9	13.7	14.9
150	6	12	1 ⅛	195	245	235	275	14		53 / 30	17.1	19.8	19.2	21.4
200	8	12	1⅜	235	295	280	330	14		64 / 36	30.2	35.1	33.9	37.9
250	10	16	1 ½	270	350	310	385				53.8	64.1	59.0	68.7
300	12	16	1 ¾	305	390	355	435	4		81 / 47	86.1	101.9	95.4	110.2
350	14	16	1 ⅞	330	425	380	470				105.2	125.4	115.8	134.9
400	16	16	2 ¼	385	485	450	545	7		103 / 60	178.7	209.3	198.6	227.7
450	18	16	2 ¼	405	520	465	575				184.9	220.1	203.2	236.9
500	20	16	2 ½	440	565	505	630				248.2	295.4	272.7	320.0
550	22	16	3	500	635	590	710	17		136 / 78	410.3	483.8	459.3	524.6
600	24	16	3 ¼	535	685	640	770	20		147 / 85	515.4	611.2	582.5	665.5

The tables above give all dimensional data for the bolts to be used with NCF5. In the columns for washers when using tension tools. the minimum washer thicknesses to achieve sufficient L/D ratio are listed. This minimum washer thickness is included in the bolt lengths listed for tension tools. If greater washer thickness is used, the bolt lengths must be increased accordingly

Annex D
(Normative)
Pressure temperature ratings

D.1 Flange structural capacity equations

The flange capacity can be calculated using the equations below. The strength terms in the warping moment limit load capacity is as follows: the first term is the flange ring capacity, second term is the support effect of the shear force from the pipe to the flange ring and the last term is the neck wall thickness warping resistance.

The reduction factors c_M and c_S take into account the reduction of the bending-carrying capacity and the shear force capacity of the neck cross section as a result of existing neck wall membrane stresses based on von Mises criterion by the factor δ_Q. The capacity equation is as given in a former revision of EN 1591-1, with a slight modification. The correction factor $d\delta_R$ accounting for axial tension force has been neglected and c_M has been simplified. Bolt interaction effects have been added. Comparison with elastic plastic finite element analysis has shown a good fit with the proposed simplified equations

The capacity method complies with the requirements of ASME VIII Div.2, Appendix 4 and 6, and to EN 13445-3.

Capacity

The axial load capacity of the flange can be calculated to be according to equation (D.1) for the flange only and equation (D.2) for flange and bolt interaction (bolt prying).

$$F_f = \frac{W_F}{e} \tag{D.1}$$

$$F_{fP} = \frac{W_F}{e_p} + F_{cB}\frac{e_B}{e_p} \tag{D.2}$$

The warping moment capacity of the flange including support from the neck is given by:

$$W_F = \frac{\pi}{4} \times f_y \times \left[2 \times b \times Hw3^2 + 2.2 \times c_S \times Hw3 \times t \times \sqrt{d_P \times t} + c_M \times d_p \times t^2\right] \tag{D.3}$$

where

$$\delta_Q = \frac{p \times d_P}{2 \times f_y \times t} \tag{D.4}$$

$$c_M = \sqrt{1 - 0.75 \times \delta_Q^2} \tag{D.5}$$

$$c_S = \sqrt{c_M \times \left(0.5 - 0.4 \times \delta_Q\right)} \tag{D.6}$$

$$b = \frac{\left(Dw3 - B\right)}{2} - L \tag{D.7}$$

$$e_B = \left[\frac{\left(Dw3 + Dw2\right)}{2} - BCD\right] \times 0.5 \tag{D.8}$$

$$e_p = \left[\frac{(Dw3 + Dw2)}{2} - d_p \right] \times 0.5 \quad \text{(D.9)}$$

Loads

$$F_{End} = \frac{\pi \times DG4^2}{4} \times p \quad \text{(D.10)}$$

$$F_R = F_A + \frac{4}{BCD} \times M_A \quad \text{(D.11)}$$

Flange utilisation ratio

$$\psi = \frac{F_{End} + F_R}{\min(F_{cB}, F_{fp})} \quad \text{(D.12)}$$

where

A	=	pipe/neck outer diameter, see Annex A
B	=	bore diameter, see Annex A
BCD	=	bolt circle diameter, see Annex A
F_A	=	applied axial force
F_{cB}	=	bolt total plastic capacity (root area x number of bolts x yield strength)
F_f	=	flange axial load capacity without effect of bolt prying
F_{fP}	=	flange axial load capacity including the effect of bolt prying
F_{End}	=	end cap force calculated to seal ring seal diameter
F_R	=	resulting force from external tension force F_A and external bending moment M_A
$Hw3$	=	flange ring thickness, see Annex A
$DG4$	=	seal ring seal diameter, see Annex B
$Dw2$	=	flange outer recess diameter, see Annex A
$Dw3$	=	flange outer diameter, see ANNEXA
L	=	bolt hole diameter, see Annex A
M_A	=	applied bending moment
d_p	=	average diameter of pipe/neck $= (A+B)/2$
e	=	radial distance between BCD and d_p
e_B	=	radial distance from flange outer rim to bolt circle diameter
e_p	=	radial distance from flange outer rim to pipe mean diameter
f_y	=	flange material yield strength at temperature
t	=	pipe/neck wall thickness
p	=	internal pressure in N/mm^2
ψ	=	flange utilisation ratio

Allowable utilisation ratios

ψ	< 2/3	Design condition for sustained loads
ψ	< 0.9	Design condition for sustained loads + displacement load amplitude
ψ	< 0.8	Design condition for sustained loads + occasional loads such as wind load, wave and current loads with annual probability of ≤ 10^{-2}
ψ	< 0.9	Hydrostatic pressure test
ψ	< 1.0	Accidental loads, annual probability of ≤ 10^{-4}

Annex E
(Informative)
Materials

Some typical materials are listed below.

Table E.1 – List of typical flange material specifications

Material group	Material group in NORSOK M-630	EN steel no.	Material specification (ASTM)		
			Forgings	Castings	Plates
CS 235	Carbon steel Type 235		A105	A216 Grade WCB	A516 Grade 60, 70
CS 235LT	Carbon steel Type 235LT impact tested		A350 Grade LF2	A352 Grade LCC	A516 Grade 70
CS 360LT	Carbon steel Type 360LT impact tested	1.0570 1.0571	A694 Grade F52	A352 Grade LCC	A516 Grade 70
SS 316	Stainless steel Type 316	1.4404	A182 Grade F316	A351 Grade CF8M or CF3M	A240 Grade 316
SS 22Cr	Stainless steel Type 22Cr Duplex	1.4462	A182 Grade F51	A890 UNS Grade 4 (J92205)	A240 UNS S31803
SS 25Cr	Stainless steel Type 25Cr Duplex	1.4507 1.4410 1.4501	A182 UNS S32550 F53 (UNS S32750) F55 (UNS S32760)	A890 UNS J93404 UNS J93380	A240 UNS S32550 UNS S32750 UNS S 32760
SS 6Mo	Stainless steel Type 6Mo	1.4547	A182 Grade F44 UNS N08367 UNS N08925 UNS N08926	A 351 CK-3MCuN CN-3MN	A 240 UNS S31254 UNS N08367 UNS N08925 UNS N08926
SS F49	Superaustenitic stainless steel. Not covered by NORSOK M-630	1.4565	A 182 Grade F49		A 240 UNS S 34565

The material groups contain materials of similar chemical/mechanical properties and corrosion resistance in order to facilitate an equivalent application of materials in a group depending on pressure, temperature and fluid.

Table E.2 – List of typical IX seal ring material specifications

Material group	Material group in NORSOK M-630	EN steel no.	Material specification		
			Forgings	Seamless pipe	Welded pipe
CS 360LT	Carbon steel Type 360LT impact tested	1.0570 1.0571	ASTM A694 Grade F52	API 5L X52	EN 10025 S355J2G3
SS 22Cr	Stainless steel Type 22Cr Duplex	1.4462	ASTM A182 Grade F51	ASTM A790 UNS S31803	A928 UNS S31803
17-4 PH	Martensitic stainless steel		ASTM A705 Grade 630		

Annex F
(Informative)
Metric bolting

If metric bolts shall be used, their size shall be selected based on the Table below. Metric bolts will then fit in the standard bolt holes. Washers shall always be used with metric bolts in order to achieve the standard bearing area between nut and bearing surface.

The target bolt pre-load is the same for imperial and metric bolts. In Table F.2 the bolt torque values for a friction coefficient of 0,12 are listed. The resulting loads as a fraction of bolt yield are also given for information.

Table F.1 – Metric bolt sizes for replacing the listed imperial bolts

ISO (DIN) METRIC			ANSI-INCH (UNC-8UN, ASME B18.2.2)		
Nominal size	**Diameter** mm	**Root area** mm^2	**Nominal size**	**Diameter** mm	**Root area** mm^2
M12x1.75	12	76.25	½-UNC	12.7	81.07
M16x2	16	144.12	⅝-UNC	15.875	130.16
M20x2.5	20	225.19	¾-UNC	19.05	194.78
M22x2.5	22	281.53	⅞-UNC	22.225	270.44
M24x3	24	324.27	1-UNC	25.4	355.41
M30x3.5	30	518.99	1 ⅛-8UN	28.575	469.42
M33x3.5	33	647.19	1 ¼-8UN	31.75	599.26
M36x4	36	759.28	1 ⅜-8UN	34.925	744.94
M39x4	39	912.87	1 ½-8UN	38.1	906.45
M42x4.5	42	1045.15	1 ⅝-8UN	41.275	1083.80
M45x4.5	45	1224.12	1 ¾-8UN	44.45	1276.99
M48x5	48	1376.59	1 ⅞-8UN	47.625	1486.00
M52x5	52	1652.21	2-8UN	50.8	1710.85
M60x5.5	60	2227.23	2 ¼-8UN	57.15	2208.06
M64x6	64	2519.52	2 ½-8UN	63.5	2768.61
M72x6	72	3281.53	2 ¾-8UN	69.85	3392.49
M76x6	76	3700.23	3-8UN	76.2	4079.72
M85x6	85	4734.21	3 ¼-8UN	82.55	4830.28
M90x6	90	5363.62	3 ½-8UN	88.9	5644.18
M95x6	95	6032.29	3 ¾-8UN	95.25	6521.42
M100x6	100	6740.24	4-8UN	101.6	7462.00

Table F.2 – Bolt torque values for metric bolts

Bolt torque values for NCF5 with metric bolts			
Stud size	**Target residual preload** kN	**Applied torque μ=0,12** kNm	**Fraction of bolt yield applied**
M12x1.75	44.0	92.6	0.80
M16x2	71.0	188.6	0.68
M20x2.5	106.0	350.4	0.65
M22x2.5	147.0	528.4	0.72
M24x3	193.0	780.7	0.82
M30x3.5	255.0	1255.0	0.68
M33x3.5	325.0	1736.0	0.69
M36x4	405.0	2374.0	0.74
M39x4	492.0	3119.0	0.69
M42x4.5	589.0	4040.0	0.78
M45x4.5	693.0	5084.0	0.78
M48x5	807.0	6340.0	0.81
M52x5	929.0	7779.0	0.78
M60x5.5	1199.0	11400.0	0.74
M64x6	1503.0	15310.0	0.82
M72x6	1667.0	18710.0	0.78
M76x6	2004.0	23770.0	0.83
M85x6	2373.0	30830.0	0.77
M90x6	2773.0	38320.0	0.79
M95x6	3204.0	46540.0	0.81
M100x6	3666.0	56280.0	0.83

Annex G
(Informative)
Statement of compliance

DET NORSKE VERITAS

STATEMENT OF CONFORMITY

Application of the Council Directive 97/23/EC of 29 May 1997 on Pressure Equipment, as amended.

STATEMENT NO.: 341.1-J-2586

This Statement consists of 1 page and plus 1 appendix

This is to certify that the design of

NORSOK COMPACT FLANGES

with type designation

NCF5

as specified in appendix to this document, is found to comply with the requirements applicable to it.

The design of the components has been assessed with respect to conformity with the relevant requirements of the Pressure Equipment Directive.

Further details of the product and conditions for the Statement of Conformity are given overleaf.

Place and date
Høvik, 15 September 2003
for DET NORSKE VERITAS AS

Carl-Morten Gjeldnes
Head of section, TNCNO750
Technical Services

Notified Body no.:
0575

DNV local office:
Oslo

Hans Dyrdal Rasmussen/Walther Storesund
Surveyor

Notice: The certificate is subject to terms and condition, if any, overleaf. Any significant changes in design or construction of the product, the quality system or amendments to the Directive or Standards referenced above may render this certificate invalid. The product liability rests with the manufacturer or his representative in accordance with the Council Directive, as amended.

APPENDIX, REV. 0

Covered products

Product	Designation
NORSOK Compact Flange L-005	NCF 5

Type of Flanges as given in NORSOK Standard L-005 Chapter 5.4.

Approach

The design evaluation is limited to the essential requirements given in the Pressure Equipment Directive, Annex I, Ch. 2. Design.

The design has been assessed for conformity with the relevant requirements, following the procedure laid down by the Pressure Equipment Directive Annex III Module B1.

The following main design aspects have been considered:

- Review of technical documentation as listed in Annex III Module B1 Ch. 3
- Review of FEM analyses to support the design calculations
- Performance of a test on a full scale specimen to support the validity of the design and the FEM analyses.

Design

The design approach was found to be relevant for NCF5 flanges to be installed on equipment covered by the Pressure Equipment Directive.

Tests

The test carried out showed that the component did not exhibit significant leaks or deformation exceeding the determined threshold.

Materials

The standard covers several material grades and temperature ranges. It is the responsibility of the manufacturer of the pressure equipment into which the components are integrated to ensure proper selection of materials for the applicable temperature ranges.

Particular material appraisal as required by PED annex 1 sec. 4.2 is the formal responsibility of the manufacturer of the pressure equipment into which the components are integrated and, when regarding pressure equipment in category III, the Notified Body responsible for conformity assessment of the equipment.

CE-mark of conformity

The components are not entitled to bear the CE-mark of conformity.

Comments

It is the responsibility of the manufacturer of the pressure equipment into which the components are integrated to analyse the hazards in line with the requirements of the third preliminary observation of Annex I

The following official guidelines have been considered: 4/9, 5/3, 8/4.

Place and date
Høvik, 15 September 2003

Walther Storesund
Surveyor