Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 38-02

Flanged Connections

VERSION 1
REVISION 3

OCTOBER 2023

FOREWORD

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

Overview of Western Australia's Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Mechanical Advisory, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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Users should use and reference the current version of this document.

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Any interpretation of anything in the Standards/Specifications that deviates from specific Water Corporation Project requirements must be referred to, and resolved by, reference to and for determination by the Water Corporation's project manager and/or designer for that particular project.

REVISION STATUS

The revision status of this standard is shown section by section below:

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
1	1/0	11.10.13	All	New Version/Revision	MB	SE
All	1/2	25.05.23	n/a	Periodic Review, no changes required	SE	SE
2	1/0	11.10.13	All	New Version/Revision	MB	SE
	1/1	19.12.17	19, 22	Table 2.5 Wording updated for clarity and modified for elastomeric gasket cut off at PN16 DN500 in line with WSA109. Table 2.7 SS bolt sizing updated	MB	SE
	1/1	19.12.17	14	Section 2.3 references to Grade 4.6 bolts removed.	GD	SE
	1/1	19.12.17	15	Section 2.6 inc. tables 2.3 & 2.4 updated for SOB valve mating dimensions.	SM	SE
		29.09.21	18	Section 2.6 updated to include mating details for AFFCO valves.	BV	SE
	1/1	19.12.17	21-23	Section 2.9 updated to allow use of AS1252.1 bolting. Also, to clarify the use of threaded bar.	GD	SE
	1/1	19.12.17	24-25	Section 2.11 revised for mag flow meter and elastomeric insulating gasket requirements	GD	SE
	1/3	**23.10.23**	**25**	**Section 2.11.1 updated for mag flow meter gasket requirements**	**GD**	**SE**
	1/3	**23.10.23**	**18**	**Table 2.5 revised AFFCO mating flange values. Also, addition of DN1200 and DN1400 values**	**MW**	**SE**
	1/3	**23.10.23**	**26**	**Section 2.11.1 updated for mag flow meter insulating gasket requirements**	**GD**	**SE**
3	1/0	11.10.13	All	New Version/Revision	MB	SE
	1/3	**27.10.23**	**27,28**	**Section 3.2 Changed**	**SE**	**SE**
4	1/0	11.10.13	All	New Version/Revision	MB	SE
	1/1	19.12.17	30	Section 4.6.2 bolt torquing procedure updated to include provision for polyethylene pipe	GD	SE
5	1/0	11.10.13	All	New Version/Revision	MB	SE
	1/1	19.12.17	All	Section Revised to simplify bolt torque requirements.	MB	SE
	1/1	19.12.17	36	Grade 8.8 bolts assumed for all torques, Grade 4.6 removed. Section 5.3 Torques added for PE flanges.	GD	SE

REVISION STATUS						
SECT.	**VER./ REV.**	**DATE**	**PAGES REVISED**	**REVISION DESCRIPTION (Section, Clause, Sub-Clause)**	**RVWD.**	**APRV.**
	1/1	19.12.17	44-48	Sections 5.5, 5.6 & 5.7 added for Siemens / E&H mag flow meters, butterfly valves and older gray cast iron valve torques respectively.	GD	SE
	1/3	**23.10.23**	**44-45**	**Notes for MFM gaskets / torques updated. E&H PN21 & PN35 bolt torques added.**	**GD**	**SE**
	1/3	**23.10.23**	**46**	**EBRO F012A Bolting Torques updated.**	**GD**	**SE**
	1/3	**23.10.23**	**49**	**AFFCO S460 Series**	**GD**	**SE**
6	1/1	19.12.17	49-51	Section Added	MB	SE
	1/3	**23.10.23**	**49-51**	**Gasket ID's removed**	**GD**	**SE**

DESIGN STANDARD DS 38-02
Flanged Connections

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Preface

Water utilities throughout Australia have standardised on flange pressure ratings PN 14/16, 21 and 35 (formerly referred to as Class) in accordance with the water industry flange standard AS 4087. These represent pressure ratings of 1400/1600 kPa, 2100 kPa and 3500 kPa respectively. The pressure ratings were based on flange tables C, F and H of the original process industry flange standard AS 2129 for pressure ratings of 1200 kPa, 2100 kPa and 3500 kPa respectively.

In the early 1990's Standards Australia WS-022 Committee was requested to re-rate the pressure capacity of Table C flanges to 1600 kPa. The Committee investigated and established that grey cast iron could be rated no higher than 1400 kPa because of bolt spacing limitations - hence the PN 14 rating for grey cast iron flanges in AS 4087. Ductile cast iron flanges were rated up to 1600 kPa - hence the PN 16 flange pressure rating for ductile cast iron in AS 4087 arising from the higher tensile strength of ductile cast iron as compared with grey cast iron.

Accordingly, the originally under rated AS 2129 Table C flange pressure rating of 1200 kPa was confirmed as 1400 kPa (PN 14) for grey cast iron and 1600 kPa (PN 16) for ductile iron in AS 4087.

More recently, internationally sourced proprietary mechanical equipment supplied with EN 1092 flange ratings has also been used PN 25 resilient seated valves in various sizes are now commonly available.

EN 1092 has been adopted by the Corporation in lieu of the now out of date flange standard AS/NS 4331.

Revision 2 is the second significant revision of DS 38-02 and incorporates comments and lessons learned from project design and construction over the past few years. It is still a relatively new standard for which user feedback and comment is not only welcome but essential to the quality and integrity of this standard.

1 SCOPE AND GENERAL

1.1 Scope

This Standard covers the design, manufacture and installation of flanged joints for pipework used in Corporation infrastructure. The Standard is based on AS 4087, EN 1092 and Corporation-designed flange standards, for pressure ratings PN 6 to PN 40 in the size range DN 50 to DN 2000. The scope of the Standard precludes the use of O-ring and flat segmented flange sealing gaskets.

Where proprietary equipment and fittings are unobtainable to meet the Water Corporation's nominated requirements, the flange Supplier's designated flange standard and joining requirements shall apply.

NOTES:

1. Reference should be made to AS 4087 for copper-alloy flange requirements which are not addressed in this Standard.
2. O-rings required for replacement in existing joints, should be either NBR or EPDM, in accordance with AS 4087 and WSA 109.

1.2 Purpose

The Corporation's mechanical design requirements are documented in its DS 30 Standards series.

Designers shall comply with these standards for the design and specification of mechanical components of Corporation assets.

The purpose of the DS 30 Standards series is to provide specific standards and explanatory guidelines applicable to the design of Corporation assets.

1.3 Design Process

The mechanical design process to be followed by Designers is documented in the Corporation's Engineering Design Manual and DS 30.

1.4 Standards

All materials and workmanship shall comply with latest revisions of the relevant codes and standards.

Water Corporation Strategic Product Specifications (SPS), or in their absence the latest editions of Australian Standards, or Water Services Association of Australia (WSAA) Code, shall be referenced for design and specification. In the absence of relevant Australian Standards or WSAA Codes relevant international or industry standards shall be referenced.

1.5 Referenced Documents

Corporation Standards and Specifications and Australian and International Standards referred to in the DS 30 Standard series are listed in full in Appendices A and B of DS 30-01.

1.6 Notation

Statements governed by the use of the word 'shall' are mandatory or 'normative' requirements of the Standard. Statements expressed by the use of the words 'should' or 'may' are 'informative' but not mandatory and are provided for information and guidance. Notes in Standard text are informative. Notes that form part of the Standard Tables are normative. An Appendix to the Standard that is designated 'normative' contains mandatory requirements. An Appendix that is designated 'informative' is provided for information and guidance. The term 'specified' includes requirements of the Standard and requirements stated or referenced in other project documentation.

1.7 Nomenclature

For definitions of the terminology and relationships referred to in this Standard the reader is referred to the Engineering Definitions and Relationship section of DS 30-01 and the following:

1.7.1 Flange Types

The various flange attachment configurations designated in AS 4087 and EN1092.
NOTE: The flange type numbers assigned for ease of identification are as defined in EN 1092.

1.7.2 Plate Flange for Welding (Type 01)

A flange where the inside diameter matches the outside diameter of the pipe, which slips over the pipe and is typically welded in place externally.

NOTE: This configuration is intended to produce a strong leak-free flanged assembly which is relatively low cost and low precision in terms of cut pipe length tolerances. Plate flanges for welding may be plain, bossed or may incorporate a hub and can be used for tube or pipe. Consideration of potential pipe distortion must be made when attaching to large bore pipes.

1.7.3 Loose Plate Flange (Type 02)

A backing ring-shaped flange that loosely fits behind a socket or stub flange that forms part of a pipe or pipe fitting.

NOTE: Typically, a loose plate flange is designed to enable the pipe or pipe fitting to be easily aligned with and mechanically connected, by means of flange fasteners, to a mating flange and enable the pipe or pipe fitting socket or stub flange to seal by virtue of contact with the mating flange. Loose plate flange material selection should be based on flanged joint mechanical and structural life requirements, as it not required to be in contact with the pipeline fluid.

1.7.4 Blind Flange (Type 05)

An unbored plate that is intended to seal a flanged pipework end or a flanged access hole in a pipe or pressure vessel; also commonly referred to as a blank flange or dead plate.

1.7.5 Weld-Neck Flange (Type 11)

A flange that incorporates a long-tapered neck, which is designed to be butt welded to a pipe and to produce a high strength connection with a mating flange.

NOTE: The long weld neck is intended to transfer stress to the pipe rather than concentrating it at the base of the flange. The flange bore matches the pipe bore, which minimises fluid turbulence. Significant additional welding is required to attach this flange, however it limits pipe distortion on large diameter pipes during welding and the jointing method is better for higher pressure applications.

1.7.6 Screwed Flange (Type 13)

A flange that has a threaded bore designed for direct connection to a threaded pipe or pipe fitting. Screwed flange jointing shall be permissible only on Class 2 and Class 3 piping as defined in AS 4041.

NOTE: Threaded connections should be used only for relatively low pressure applications, given their lower pressure rating as compared with welded flange connections.

1.7.7 Integral Flange (Type 21)

A flange manufactured as an integral part of equipment (e.g. flanged pump, pipe or valve) that may be configured as a flat or raised face flange.

1.7.8 Flat Face Flange

A flange where the entire face is machined flat.

1.7.9 Raised Face Flange

A machined annulus with an outer diameter less than bolt PCD and an inner opening diameter corresponding to the nominal flanged pipe bore. The raised face is intended to separate the un-raised part of a flange face from its mating flange face in order to increase gasket compression (by minimising flange-to-flange face contact area) to achieve an effective seal.

A raised face flange enables higher gasket sealing pressures for a given fastener force as compared with a flat face flange that has a full face gasket.

1.7.10 Full Face Gasket

A gasket with an outside diameter equal to the flange outside diameter.

1.7.11 Narrow Face Gasket

A gasket with an outside diameter equal to the diameter of the raised flange face (or inside of the bolt circle).

1.7.12 O-ring Gasket

An elastomeric ring which fits into a machined groove in the flange face.

NOTE: O-rings flange gaskets are not permissible arising from past operational experience of corrosion in the vicinity of the wetted side of O-ring grooves and from field joint preparation/assembly quality. The use of narrow face compressed fibre gaskets is preferred in applications where O-ring gaskets have been used in the past.

1.7.13 Segmented Gasket

A flat gasket that comprises an assembly of interlocking gasket segments rather than a single integral sheet of gasket material.

NOTE: Segmented flange gaskets are not permissible except where expressly authorised in writing on the basis of demonstrated project justification including consideration of service longevity and failure risks.

1.7.14 Flange Fasteners

Bolts, nuts and washers used in the assembly of flanged pressure retaining components (pipes).

1.7.15 Structural Fasteners

Bolts, nuts and washers used in the assembly of structural components (non-pressure retaining components).

NOTE: The selection and use of structural fasteners shall be in accordance with requirements and guidance provided in the "Fasteners and Washers" section of DS 30-02 and in the "Bolting Structural Joints" section of DS 38-01.

1.7.16 Galling

The adhesive wear and propagation of damage between the bearing surface of a nut or bolt head, and its mating surface in a fastener application. This can cause a significant increase in resistance during tightening resulting in a lower induced tension in the fastener, a lower clamping force on the gasket and consequently a greater chance of joint leakage.

1.8 Acronyms and Symbols

For acronyms and symbols referred to in this Standard the reader is referred to that section contained in DS 30-01.

1.9 Standard Units and Relationships

The units and relationships used for mechanical designs shall be in accordance with those specified in the SI Units, Relationships, and Prefixes section of DS 30-01.

1.10 Drawing Symbols

A comprehensive list of mechanical drawing symbols is referenced in DS 80.

2 DESIGN

2.1 Pressure Ratings

The flange connection pressure rating shall typically equal or exceed the pressure rating of a flanged piping system. Where equipment is procured of higher pressure rating, the equipment and pipe work flanges shall match the equipment pressure rating. Flange pressure ratings shall be selected from the following subject to the conditions outlined below:

Pressure classes: *PN 6, PN 10*, **PN 16**, **PN 21**, *PN 25*, **PN 35**, *PN 40*

NOTE: Corporation non-preferred pressure ratings are shown in italics. PN25 is however common on European sourced equipment and where required has be modified to AS4087 PN21 drilling pattern (e.g. valves).

Subject to Corporation acceptance, pressure ratings PN 6, PN 10, PN 25 and PN 40 shall be limited to the following applications:

(a) PN 6 rated flanges may be used on nominal low or non-pressure (usually large diameter) applications e.g. typical of wastewater inlets, treatment plants and storage tank inlets.

(b) PN 10 rated flanges may be used in special low pressure applications e.g. water and wastewater treatment plants.

(c) PN 25 and PN 40 rated flanges may need to be considered for special pressures in certain circumstances and for proprietary equipment.

2.2 Designation of Flange Standards

Flange specifications, within the applicable sizes and pressure ratings, shall comply with AS 4087 except as stated below:

(a) Flange diameters and/or pressures beyond the scope of AS 4087 shall comply with the requirements of EN 1092 or Corporation independently verified flange specifications (based on EN 1092). Refer to Table 2.1 for an outline of the available complete flange designs and specifications (drill pattern and thickness) of the relevant flange standards.

(b) Where proprietary equipment is not available with AS 4087 flanges, the mating flange shall match the equipment flange specification.

(c) European sourced valves with EN1092 PN25 flanges may be de-rated and drilled to AS4087 PN21 where required to mate with existing PN21 flanges, otherwise PN25 flanges are preferred.

(d) The selection and use of AS 2129 Table E flange specifications shall be limited to the following applications:

- General purpose tapped lugged butterfly valves
- General purpose valves and appurtenances of sizes less than DN 80

NOTE: EN 1092 and AS 4087 flanges are not compatible.

Table 2.1 –Flange Specification Selection Synoptic Table – Steel Flanges

Flange Description	Type	Relevant Standard	DN / PN	50	65	80	100	150	200	250	300	350	400	450	500	600	700	750	800	900	1000	1200	1400	1600	1800	2000
Plate (Preferred except where demonstrably unavailable)	01	EN 1092	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		EN 1092	10	↓16	↓16	↓16	↓16	↓16	x	x	x	x	x	x	x	x	x		x	x	x	x				
		EN 1092	16	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		AS 4087	**16**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		AS 4087	**21**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	25	↓40	↓40	↓40	↓40	↓40	x	x	x	x	x	x	x	x	x		x	w	w	w	w			
		AS 4087	**35**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	40	x	x	x	x	x	x	x	x	x	x													
Blank (Dead Plate)	05	EN 1092	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		EN 1092	10	↓16	↓16	↓16	↓16	↓16	x	x	x	x	x	x	x	x	x		x	x	x	x				
		AS 4087	**16**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		AS 4087	**21**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	25	↓40	↓40	↓40	↓40	↓40	x	x	x	x	x	x	x	x	x									
		AS 4087	**35**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	40	x	x	x	x	x	x	x	x	x	x	x	x	x										
Weld Neck (Use where plate demonstrably unavailable or impracticable, e.g. Clause 2.6)	11	EN 1092	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		EN 1092	10	↓16	↓16	↓16	↓16	↓16	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		EN 1092	16	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		AS 4087	**16**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		AS 4087	**21**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	25	↓40	↓40	↓40	↓40	↓40	x	x	x	x	x	x	x	x	x		x	x	x	w	w			
		AS 4087	**35**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	40	x	x	x	x	x	x	x	x	x	x	x	x	x	w		w	w	w	w	w			
Integral	21	EN 1092	6	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		EN 1092	10	↓16	↓16	↓16	↓16	↓16	x	x	x	x	x	x	x	x										
		EN 1092	16	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x
		AS 4087	**16**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		AS 4087	**21**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	25	↓40	↓40	↓40	↓40	↓40	x	x	x	x	x	x	x	x										
		AS 4087	**35**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**				
		EN 1092	40	x	x	x	x	x	x	x	x	x	x	x	x	x										

LEGEND: Flange sizes in **bold** are preferred x – Drill pattern and thickness specification available in standard w – See Corporation flange specification for thickness details – refer Clause 2.5	$\downarrow^{16}$ – Use PN16 EN1092 flange dimensions $\downarrow^{40}$ – Use PN40 EN1092 flange dimensions

2.3 Flange Types

The following flange types (as designated in EN 1092) are acceptable to the Corporation:

Type 01	Plate flange for welding
Type 02	Loose plate flange
Type 05	Blind flange
Type 11	Weld-neck flange
Type 13	Screwed Flange
Type 21	Integral flange

The type of flange to be used shall be specified and designed by the *Designer.* The flange design shall be cost effective, shall be constructible; and shall be compatible with the mating equipment and pipework.

2.4 Flange Facing

The facing requirements for each flange shall be specified and designed by the *Designer* to ensure mating flange compatibility and to achieve the required compression joint type (flat face or narrow face joint).

The following limitations on flange face types shall be take into consideration by the *Designer*:

2.4.1 Flat Face Flanges

Grey cast iron flanges shall be flat faced in accordance with AS 4087 and shall be mated only with other flat faced flanges. Grey cast iron flanges in accordance with EN 1092.2 shall not be permissible[1].

Mating flanges shall be flat faced where either flange is of a brittle material (e.g. grey cast iron, PVC-U, ABS) in order to mitigate the potential for bolting couples due to rotation and consequent cracking of the brittle material during flange fastener tightening, where flange faces are raised.

NOTES:

1. Raised face configuration of grey cast iron flanges EN 1092.2 Clauses 5.3 and 5.7.1 renders them unsuitable for Corporation flange applications.
2. PVC-M, PVC-U and ABS flange connections are non-preferred but, where required and justified, shall be fitted with hot dip galvanised steel or Gr 316 stainless steel backing flanges with pre-drilled holes complying with AS 4087.

2.4.2 Raised Face Flanges

Where a raised face flange is used, both mating flanges shall be comprised of a ductile material (e.g. steel, ductile cast iron).

The raised faces of mating flanges shall be restricted to ductile materials for reasons outlined in Section 2.4.1.

2.5 Corporation Designed Flanges

The Corporation has undertaken design in accordance with EN 1951-1:2001 to establish flange thickness requirements for particular large diameter high pressure flanges to EN 1092 specification. Refer to Table 2.2 below for a summary of available Corporation designed flanges.

In the event of an overlap or conflict between EN 1092 and Corporation designed flange specifications, the Corporation designed flange specification shall prevail.

Table 2.2 – Corporation Designed Flanges

Flange Type	Size (DN)	Material[2]	Drg Number
PN 25 Raised face slip-on	900 – 1400	AS/NZS 3678 Gr250	JZ39-91-4
PN 25 Flat face slip-on	700 – 1400	AS/NZS 3678 Gr250	JZ39-91-5
PN 25 Raised face weld neck	1200 – 1400	ASTM A350 LF3 (Carbon Steel Forging) AS 1448 GrK5 (equivalent)	JZ39-91-6
PN 25 Flat face weld neck	700 – 1400	ASTM A350 LF3 (Carbon Steel Forging) AS 1448 GrK5 (equivalent)	JZ39-91-7
PN 40 Raised face weld neck	700 – 1400	ASTM A350 LF3 (Carbon Steel Forging) AS 1448 GrK5 (equivalent)	JZ39-91-9

NOTE: The above flange specifications have been derived on the basis of carbon steel of material grade 250 MPa or higher. Flanges to AS and EN specifications are based on the use of lower grade (typically grade 200 MPa) material. This has resulted in relatively lower thickness flange specifications in Corporation designed flanges.

2.6 Seal on Body Butterfly Valve Joint Sealing

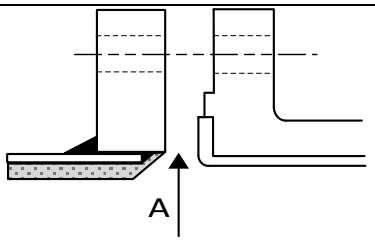
The *Designer* shall consider the required sealing internal diameter (ID) for the purpose of specifying requirements for seal on body butterfly valve mating flange and associated weld details.

The mating flange requirements for Wouter Witzel, Ebro and AFFCO Series S460 seal on body butterfly valves are respectively shown in Table 2.3, Table 2.4 and Table 2.5. Each table indicates the maximum permissible internal diameter of the mating flanges (to ensure sealing of the flange face) and minimum permissible pipeline internal diameter (to avoid disc fouling), as specified by the valve manufacturer.

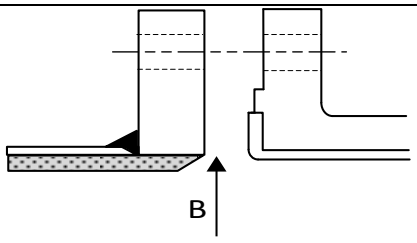
Where a valve requires the mating pipe flange ID to match that of the adjoining pipework, either a weld neck flange or standard alternative plate flange butt weld preparation shall be used.

The use of gaskets for the purpose of flange joint sealing is not recommended by Manufacturers of seal on body valves as the supplied valve is intended to provide the seal.

Figure 2.1. Typical pipe flange to seal on body butterfly valve sealing arrangements.



Slip-on flange to butterfly valve typical arrangement.



Butt welded plate flange to butterfly valve typical arrangement.

Table 2.3 Seal on Body Butterfly Valve Mating Flange Requirements – Wouter Witzel Series 75 (EVFS)

** Non compatible HDPE pipe, including all PN16 pipe, requires a proprietary butterfly valve spacer to avoid disc interference.*

	Minimum mating flange or cement lining internal diameter to avoid disc interference							Maximum mating flange internal diameter to achieve a leak tight seal							
DN	Minimum allowable (as specified by Wouter Witzel)	MSCL Pipe (in accordance with DS 60)		MSCL welded flange AS 4087 PN16 and PN21		HDPE Pipe (PN12.5 SDR 13.5) with stub flange and backing ring.		Maximum allowable (as specified by Wouter Witzel)		MSCL butt welded/weldneck flange (sealing face ID "B" mm)		MSCL/SS slip on flange (sealing face ID "A" mm)		SS butt welded/weldneck flange Sch10 (sealing face ID "B" mm)	
	ID (PN16 and PN21)	ID (mm)	ID with cement lining (mm)	ID (mm)	Accept-table	ID (mm)	Accept-able	ID (PN16)	ID (PN21)	ID (mm)	Accept-able	ID (mm)	Accept-able	ID (mm)	Accept-able
400	320	396	372	372	OK	335	OK	420	420	396	OK	409	OK	396.84	OK
500	429	498	474	474	OK	418.8	NO*	529	529	498	OK	511	OK	496.92	OK
600	522	598	574	574	OK	527.8	OK	626	626	598	OK	613	OK	597.30	OK
700	621	699	675	675	OK	594.8	NO*	730	730	699	OK	714	OK	698.30	OK
800	719	799	767	767	OK	670.4	NO*	834	844	799	OK	816	OK	797.16	OK
900	823	900	868	868	OK	754	NO*	954	944	900	OK	917	OK	898.16	OK
1000	897	1000	968	968	OK	840	NO*	1035	1047	1000	OK	1019	OK	1000.16	OK
1200	1089	1201	1164	1164	OK	1005.6	NO*	1250	1266	1201	OK	1222	OK	1203.16	OK
1400	1281	1400	1360	1360	OK	1173.4	NO*	1460	1480	1400	OK	1425	OK	design check required	

Table 2.4 Seal on Body Butterfly Valve Mating Flange Requirements – EBRO F012-A

** Non compatible HDPE pipe, including all PN16 pipe, requires a proprietary butterfly valve spacer to avoid disc interference.*

	Minimum mating flange or cement lining internal diameter to avoid disc interference							Maximum mating flange internal diameter to achieve a leak tight seal						
DN	Minimum allowable (as specified by EBRO)	MSCL Pipe (in accordance with DS 60)		MSCL welded flange AS 4087 PN16 and PN21		HDPE Pipe (PN12.5 SDR 13.5) with stub flange and backing ring.		Maximum allowable (as specified by EBRO)	MSCL butt welded/weldneck flange (sealing face ID "B" mm)		MSCL/SS slip on flange (sealing face ID "A" mm)		SS butt welded/weldneck flange Sch10 (sealing face ID "B" mm)	
	ID (PN16 and PN21)	ID (mm)	ID with cement lining (mm)	ID (mm)	Accept-table	ID (mm)	Accept-able	ID (PN16 and PN21)	ID (mm)	Accept-able	ID (mm)	Accept-able	ID (mm)	Accept-able
400	332	396	372	372	OK	335	OK	412	396	OK	409	OK	396.84	OK
500	442	498	474	474	OK	418.8	NO*	514	498	OK	511	OK	496.92	OK
600	527	598	574	574	OK	527.8	OK	615	598	OK	613	OK	597.30	OK
700	618	699	675	675	OK	594.8	NO*	720	699	OK	714	OK	698.30	OK
800	723	799	767	767	OK	670.4	NO*	824	799	OK	816	OK	797.16	OK
900	829	900	868	868	OK	754	NO*	930	900	OK	917	OK	898.16	OK
1000	903	1000	968	968	OK	840	NO*	1030	1000	OK	1019	OK	1000.16	OK
1200	1093	1201	1164	1164	OK	1005.6	NO*	1230	1201	OK	1222	OK	1203.16	OK
1400	1283	1400	1360	1360	OK	1173.4	NO*	1430	1400	OK	1425	OK	design check required	

Table 2.5 Seal on Body Butterfly Valve Mating Flange Requirements – AFFCO Double Flanged S460 Series

** Non compatible HDPE pipe, including all PN16 pipe, requires a proprietary butterfly valve spacer to avoid disc interference.*

	Minimum mating flange or cement lining internal diameter to avoid disc interference							Maximum mating flange internal diameter to achieve a leak tight seal						
DN	Minimum allowable (as specified by AFFCO) ("M")	MSCL Pipe (in accordance with DS 60)		MSCL welded flange AS 4087 PN16 and PN21		HDPE Pipe (PN12.5 SDR 13.) with stub flange and backing ring.		Maximum allowable (as specified by AFFCO)	MSCL butt welded/weldneck flange (sealing face ID "B" mm)		MSCL/SS slip on flange (sealing face ID "A" mm)		SS butt welded/weldneck flange Sch10 (sealing face ID "B" mm)	
	ID (PN16 & PN21) (mm)	ID (mm)	ID with cement lining (mm)	ID (mm)	Accept-table	ID (mm)	Accept-able	ID (mm)	ID (mm)	Accept-able	ID (mm)	Accept-able	ID (mm)	Accept-able
400	332.86	396.00	372.00	372.00	OK	335.00	OK	431.50	396.00	OK	409.00	OK	396.84	OK
500	441.55	498.00	474.00	474.00	OK	418.80	NO*	534.60	498.00	OK	511.00	OK	496.92	OK
600	538.77	598.00	574.00	574.00	OK	527.80	NO*	637.10	598.00	OK	613.00	OK	597.30	OK
700	621.60	699.00	675.00	675.00	OK	594.80	NO*	733.50	699.00	OK	714.00	OK	698.30	OK
800	721.00	799.00	767.00	767.00	OK	670.40	NO*	833.50	799.00	OK	816.00	OK	797.16	OK
900	823.00	900.00	868.00	868.00	OK	754.00	NO*	932.50	900.00	OK	917.00	OK	898.16	OK
1000	894.40	1000.00	968.00	968.00	OK	840.00	NO*	1030.00	1000.00	OK	1019.00	OK	1000.16	OK
1200	1073.00	1201.00	1169.00	1169.00	OK	1002.00	NO*	1235.50	1201.00	OK	1219.00	OK	1203.16	OK
1400	1269.00	1400.00	1360.00	1360.00	OK	-	NO*	1456.00	1400.00	OK	design check required		design check required	

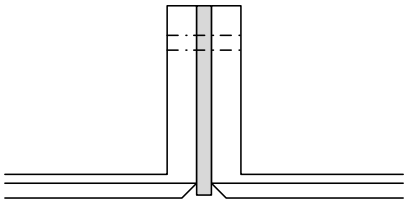
2.7 Flanged Joint Selection

The *Designer* shall nominate the required flange and gasket combination to achieve the necessary gasket compression joint type (full face or narrow face joint). Provision shall be made for:

- practicability and ease of installation;
- flange face limitations as given in Clause 2.4;
- size and pressure rating (PN) limitations as given below in Table 2.5 (based on AS 4087 Table C1).

The following flange and gasket combinations may apply as appropriate:

2.7.1 Full Face Joint



(a) Flat face to flat face with a full face gasket.

(b) Blank flange with a bonded full surface gasket[1].

2.7.2 Narrow Face Joint

(a) Flat face to raised face flange with a full face gasket.

(b) Raised face to raised face flange with a full face gasket.

(c) Flat face to flat face flange with a narrow face gasket[2, 3].

(d) Flat face flange to seal on body valve flange face with integral valve liner providing the seal.

NOTES:

1. The bonded full surface gasket of a blank flange is intended to prevent flange face corrosion.
2. Not a preferred joint due to gasket installation practicability.
3. Narrow face gaskets are not permissible where an isolating joint is required (refer Clause 2.11 of this Standard).

Table 2.5 – Flanged Joint size, Pressure Rating and Gasket Material.

DN	Pressure Class			DN
	PN 6/10	PN 14/16	PN 21/25/35/40	
2000				2000
1800				1800
1600				1600
1400				1400
1200				1200
1000				1000
900				900
800				800
700				700
600				600
500				500
400				400
300				300
250				250
200				200
100				100
80				80
65				65
50				50

NARROW FACE JOINT
COMPRESSED FIBRE GASKET

FULL-FACE JOINT
ELASTOMERIC GASKET

NOTES:

1. Flange size (DN) relates to the line above the numeric value e.g. PN14/16 full-face elastomeric gasket joint extends to DN 500.
2. The above table is intended to be applicable to MSCL or DI flanges, it is not intended to be applicable to plastic piping or proprietary equipment. For these the manufacturer should be consulted.

2.8 Gasket Material Selection

Gasket materials to be used for new flange connections within the Corporation shall be either:

(a) Elastomeric; or

(b) Compressed fibre.

Guidance on flange O-rings is included in this Standard as they exist in Corporation systems. It is not intended to modify existing flanged sealing arrangements retrospectively.

The *Designer* shall nominate the required gasket material with respect to flange size and pressure rating in accordance with Table 2.5 and the following material requirements.

When bolting to proprietary equipment the gasket material to be used shall be as specified by the equipment Manufacturer. In the case of magnetic flow meters, guidance on gasket material is provided at Section 2.11 and limited assembly information is provided in Section 5 Appendix A - Bolting Torques (Informative).

For problematic joints where low torque gaskets are required (e.g. Mag flow meters or PE pipe) the use of proprietary gaskets (eg. SURESEAL "Maxi") may be considered in consultation with the equipment manufacturer.

2.8.1 Elastomeric Gaskets

Elastomeric gaskets for applications that do not involve exposure to hydrocarbons shall be EPDM (UV stabilised)[1,] silicon gaskets may be used for isolated joint applications as indicated in Section 2.11.

Gaskets for contact with chemicals and gases shall be selected in accordance with the appropriate resistance characteristics for the particular process chemical, or gas. Gaskets likely to be exposed to gaseous chlorine or chlorine solution shall be FPM (fluoroelastomer polymer, e.g. Viton).

Natural rubber gasket shall not be used as it is known to be adversely affected by microbial growth.

NOTES:

1. EPDM can deteriorate from exposure to sewage or sludge with high levels of hydrocarbons, as the elastomer carbon content is unlikely to ensure appropriate isolation (especially when compressed).
2. The use of elastomeric rather than compressed fibre material for flange gaskets in smaller pipeline size and lower pressure applications offers advantages in terms of cost, availability and ease of field usage.
3. Further elastomer application requirements and guidance are given in DS 30-02, Section 33 'Materials - Elastomers'.

2.8.2 Reinforced Elastomeric Gaskets

The use of elastomeric gaskets incorporating a reinforcing fabric shall be limited to applications where fluid loss by means of 'wicking' is unlikely (i.e. full face gaskets on blank flanges or access covers).

NOTE: The use of annular reinforced fabric gaskets can lead to 'wicking' (i.e. leakage of water along paths provided by the fabric) through the inside cut edge to the outside environment'.

2.8.3 Compressed Fibre Gaskets

Compressed fibre gaskets shall be of material equivalent to Novus 30 or Klinger C4430.

Compressed fibre gaskets with a high elastomer content (e.g. Klinger C6327 or equivalent) may be used for blank flanges or access covers to assist gasket compression and sealing of the joint.

NOTES:

1. Compressed fibre gasket material has low compressibility at high load and is likely to minimise gasket seating area leakage potential that may arise due to gasket surface indentations.
2. The Corporation has adopted the use of compressed fibre gaskets to overcome previously unsatisfactory O-ring seal performance and has accordingly supported their inclusion in AS 4087–2004

2.8.4 Special Applications - Biogas

Gaskets for use on Biogas piping systems shall be Graphite steel spiral wound (Novus or equivalent).

2.9 Fasteners

Fastener materials to be used for flange connections shall be either:

(a) Hot dip galvanized carbon steel, or

(b) Stainless steel.

Fasteners are to be supplied in accordance with Table 2.6. For hot dip galvanized carbon steel bolting in sizes M12 to M36, AS1252.1 standard fasteners are preferred due to lower cost and higher availability. AS1110.1 bolting is only available as standard in plain finish and must be galvanized.

Note: Cost comparison AS110.1 vs AS1252.1 bolting may be found at Aqua #17333576.

Bolts, nuts and washers shall be of the same material type within the flanged joint. Where two or more materials are used, (e.g. one galvanised flange face bolted onto a stainless steel flange face), electrical isolation using isolation flange kits shall be provided. Particular attention shall be paid to ensure that there is no direct electrical contact between two dissimilar metals (e.g. mild steel washers used with stainless steel bolts).

The use of black bolts is not preferred due to susceptibility to corrosion over time and shall not be allowed except by permission of the Principal Engineer.

The use of threaded bar is not preferred and shall only be allowed by permission of the Principal Engineer where it is not physically possible to install bolts or where bolt availability will impact the project schedule. Where threaded bar is to be used, it shall be property class 8.8 and material certificates detailing the mechanical and chemical properties of the bar material shall be supplied. Cold galvanizing of threaded bar shall not be allowed, bar is to be procured black, cut to length and then hot dip galvanized. "8.8" shall be stamped on both ends of the bar for identification purposes prior to galvanizing. AS1252.1 nuts & washers shall be used with threaded bar.

The *Designer* shall nominate the required fastener material and property class for each flange connection. Relevant fastener standards are referenced below in Table 2.7 for carbon steel and stainless steel fastener components.

Table 2.6 – Typical fastener material applications

Application	**Fastener material**
Dry Internal, e.g. Pump Station	Hot Dipped Galvanised
Damp Internal	Stainless Steel Gr316
External – Non-coastal	Hot Dipped Galvanised
External – Coastal	Stainless Steel Gr316
High chloride atmospheres	Duplex 2205
Waste Water Treatment Plant – External	Hot Dipped Galvanised
Waste Water Treatment Plant – Open Channel	Stainless Steel Gr316
Buried	Hot Dipped Galvanised, wrapped
Process Plant - chemicals	Stainless Steel Gr316
Waste Water Pump Station – Wet Well	Stainless Steel Gr316

Table 2.7 – Fasteners Standard requirements

PC[1]	Dimensions		Mechanical Properties		HD Galvanized	
	Standard	**Size**	**Standard / Hardness**	**Size[2]**	**Standard**	**Size**
Bolt:						
8.8	AS 1252.1[7]	M12 to M36	AS 4291.1	M12 to M36	AS 1214	M12 to M36
8.8	AS 1110.1	≤ M64	AS 4291.1	≤ M64	AS 1214	≤ M64
A4-70 (316SS)	AS 1110.1	≤ M30	ISO 3506-1	≤ M30	N/A	N/A
A4-80 (316SS)		>M30≤M64		≤ M64	N/A	N/A
Nut:						
8	AS 1252.1[7]	M12 to M36	AS4291.2	M12 to M36	AS 1252.1	M12 to M36
8	AS 1112.1	≤ M64	AS/NZS 4291.2	≤ M64	AS 1214	≤ M64[3]
A4-70 (316SS)	AS 1112.1	≤ M30	ISO 3506-2	≤ M30	N/A	N/A
A4-80 (316SS)		>M30≤ M64	ISO 3506-2	≤ M64	N/A	N/A
Flat Washers:						
[5]	AS 1252.1	M12 to M36	320 – 390HV[1]	M12 to M36	AS/NZS 4680	M12 to M36
[6]	AS 1237.1 AS 1237.2 [4]	Dia < 39mm thickness < 6mm	300HV[1]	ID < 39mm	AS/NZS 4680	≤ M64
		Dia ≥ 39mm thickness > 6mm	100HV[1]	ID ≥ 39mm		
A4 (316SS)	AS 1237.1	≤ M64	ISO 7089 / 200HV	≤ M64	N/A	N/A

NOTE:

1. PC refers to property class; HV refers to hardness (Vickers).
2. Bolts > M39 apply to EN 1092 e.g. for PN 25 > DN 700 and PN 40 > DN 500.
3. Nuts to AS1112.1 shall be tapped oversize after galvanizing to accommodate added coating thickness of bolt.
4. AS 1237.2 specifies acceptable washer dimensional tolerances
5. AS 1252.1 washers shall be used with AS 1252.1 bolting.
6. AS 1237.1 washers shall be used with AS 1110.1 & AS 1112.1 bolting.
7. The head on AS1252.1 nuts and bolts is physically larger than for other listed bolting, the designer / contractor will need to confirm that clearances between the bolt head or nut and the wall of the pipe / valve will be adequate to fit a socket and spanner for assembly.
8. Where carbon steel fasters are used, only PC8.8/PC8 bolt/nut combination is permitted.

2.9.1 Hot-Dip Galvanised Fasteners

The *Designer* shall consider the potential for galling of hot dip galvanised bolts, and the resulting higher torques and bolt relaxation when specifying bolt torques for proprietary items of equipment.

2.9.2 Stainless Steel Fasteners

Stainless steel fasteners shall comply with Table 2.7.

The *Designer* shall address the potential for galling between stainless steel fastener mating threads by either the use of:

(a) different grade bolts and studs to the nuts where available; or

(b) anti-seize compounds where similar grade mating threads are used. (Refer Clause 4.5 of this Standard)

The hardness of stainless steel nuts and washers should differ by at least 50 Brinell wherever practicable and available.

Stainless steel fasteners, where used to bolt to a dissimilar material, shall be insulated by fitting:

(a) G10 washers under stainless steel washers; and

(b) phenolic sleeves around each individual bolt.

2.9.3 Fasteners for Tapped Holes

When mating to a tapped flange the *Designer* shall specify bolts and washers that are either:

(a) Stainless steel.

(b) Galvanised Steel (refer Note)

(c) Black carbon steel bolts (petrolatum tape wrapped) for buried service.

(d) Black bolts (painted) for above ground service.

Where black bolts are used above-ground and corrosion is of concern (moisture laden environments), corrosion mitigation measures such as protective bolt head covers or petrolatum tape wrapping of the flange shall be applied.

NOTE: Problems can occur in fitting hot-dip galvanised bolts or stud bolts into tapped holes in proprietary products because of the coating on the threads e.g. tapped holes in butterfly valves. Under these circumstances hot-dip galvanised fasteners cannot be readily fitted without modification e.g. oversize tapping of the holes, requirement need to be discussed with product manufacturers and requirement included in procurement specification.

2.9.4 Fastener Torquing

The *Designer* shall consider that the nut as the preferred fastener component to be rotated during tightening when designing flange connections. This may not always be practicable for sites where access for torque wrench operation is constrained (restricted).

Bolt torque values shall be specified as lubricated values. (Refer to Appendix A)

The bolts shall be specified to be lightly oiled, in order to reduce the bolting friction co-efficient in the order of $\mu = 0.1 - 0.2$. (Refer to Section 4.5)

NOTE: Lubrication is required to reduce bolting frictional resistance, increase the induced fastener tension, and improve the clamping force. A 10% frictional reduction from lubrication could increase induced tension by 80-90%.

When bolting to proprietary equipment such as mag flowmeters and seal on body butterfly valves, the *Designer* shall establish appropriate bolt torques in consultation with the equipment Manufacturer. Limited informative torques / assembly information is provided in Section 5 Appendix A - Bolting Torques (Informative).

NOTE: Applying bolt torques greater than that recommended by the Manufacturer may damage the equipment and void the equipment warranty.

2.10 Washers

Hot-dip galvanised steel washer faces shall be specified with a smooth finish. One washer shall be fitted under the bolt and one washer under the nut for each flanged joint.

NOTE: Two washers are required for each fastener for all applications in the interest of simplification e.g. rather than having to consider whether the bolt head or nut will be the turned item, or whether coating protection is required.

2.11 Isolation Joints

Isolation flange joints shall be required for:

- Electrical isolation of sections of pipelines where cathodic protection is to be employed.
- Isolation of instrumentation such as magnetic flow meters.
- Isolation of galvanically dissimilar materials e.g. stainless steel and hot dipped galvanised steel.

NOTES:

1. Refer to standard drawing JZ39-91-10 for all isolation flange connection details and DS 91 for further information on cathodic protection.
2. Bolt torques for magnetic flow meters are typically low assuming elastomeric gaskets (refer Section 5.5) and will not be possible for compressed fibre gaskets (refer Section 2.11.1).
3. For all joint types each hole shall be spot faced on the back face surface to prevent the insulating washer from ripping during bolt tightening.
4. Isolation against a magnetic flow meter shall be in accordance with the Manufacturer's recommendations.

2.11.1 Insulating Gaskets

In order to maintain the insulated joint integrity, full face gaskets shall be fitted to all insulated joint types, regardless of whether flat or raised face flanges are used. The gasket shall be 3mm thick compressed material such as the Klinger C-4430, Novus HDS-1, or equivalent. The dielectric strength of the gasket shall be at least 15.2kV/mm (wet and compressed).

Where providing isolation (eg. for dissimilar metals, cathodic protection etc.) and an elastomeric gasket is required, then it may be used provided it can be proven the material is non-conductive (nb. EPDM potable will likely not be suitable due to graphite being added to the material).

Limited trials conducted on PN16 magnetic flow meters indicates that Novus Red Silicon (60 Duro) rubber sheet gasketing is a suitable elastomeric material, which has potable water approval and is non-conductive. Novus Red Silicon has not proved effective in sealing magnetic flow meters above PN16, for higher pressures it is recommended that the use of isolating compressed fibre gaskets are investigated in consultation with the flow meter manufacturer.

NOTES:

1. For sealing of magnetic flow meters, it is important that the joint detail as per JZ39-91-10 be applied as appropriate for the body liner material.
2. Standard installation of magnetic flow meters incorporates potential equalization rings in the joints, these should be supplied with a sealing surface profile as per Section 3.1.3 improve resistance to gasket blow out.

2.11.2 Insulating Kits

Flange cathodic protection isolation shall be achieved by the use of Klinger, Novus or Savcor insulating flange kits (or approved equivalent) and installed in accordance with the Manufacturer's recommendations. A flange insulating kit includes:

- Insulating gasket
- One full length insulating sleeve per bolt
- Two insulating washers per bolt

The insulating sleeve material shall be polyester resin (Mylar or equivalent). It shall be sized to fit the entire length of the exposed fastener in the joint. The insulating washer material shall be G10 glass epoxy laminate.

2.11.3 Cathodic Protection Isolation Test Points

Insulated flange test points shall be provided on flanged isolation joints in accordance with LL33-54-4.

3 MANUFACTURING REQUIREMENTS

This section covers manufacturing requirements relating to flanges and flange fasteners. The *Designer* shall detail all requirements relevant to flange manufacture, material specifications, and joint configuration details.

3.1 Flanges

Flanges shall be manufactured in accordance with the requirements contained in the relevant standard (AS 4087 or EN 1092 as applicable) except where varied in accordance with the following:

3.1.1 Ultrasonic Testing of Large Flanges

Ultrasonic test acceptance shall comply with AS 1710 Table 5.2 for steel flanges and AS 2574 Level 2 for ferritic steel castings.

For pressure ratings greater than PN16, DN 500 and larger flanges shall be subject to ultrasonic testing after manufacture to check for laminations.

3.1.2 Tolerances

Flange face flatness shall comply with the relevant standard (AS 4087 or EN 1092 as applicable) after fabrication. The flanges shall be perpendicular to the pipe centerline within 0.25º or 2mm (at the outside diameter) whichever is the lesser. Any distortion shall be corrected by machining.

Flanges shall be drilled and fitted off-centre. Bolt holes shall comply with AS 4087 (or EN 1092 as applicable), and shall be drilled parallel to the axis of the flange. If the rake angle is greater than 2°, the backs of all flanges shall be machined or each hole spot faced to provide a satisfactory bearing for bolt heads and nuts. Machining or spot facing shall not reduce the flange thickness to less than the minimum required flange thickness specified.

3.1.3 Sealing Surface

The contact surface shall be whip blasted, and given a gramophone finish within the roughness range of 6.3µm to 3.2µm.

NOTE: If the serrations were to exceed 6.3µm as given in AS 4087, there is the possibility that the serrations could cut too deeply into the surface of a gasket which could ultimately result in premature failure of the gasket.

3.1.4 Face Coating

A thin layer of anticorrosive coating such as Lanotec Type A grease shall be applied to flange faces after welding and machining. The gasket face coating shall be removed prior to flange installation.

Where epoxy coatings are applied to the flange non-sealing surface, the protective coating thickness shall be 80 – 250µm.

NOTE: Epoxy coating over a machined flange face gramophone finish is not recommended as this may result in poor or non-leak tight sealing.

3.2 Gaskets

Gasket dimensions shall be as required by the relevant flange product standard e.g. AS 4087 or EN 1092 (which references EN 1514 for gasket types), except where varied by this Standard. Refer to Table 3.1 for a summary of required gasket properties and reference manufacturing standards.

Gaskets shall be dimensioned such that the ID does not protrude into the bore of the pipe.

Table 3.1 Gasket Material and Size Requirements

Item	Standard	Material	Thickness mm	Nominal Hardness
Elastomeric gasket	AS 1646 AS 4087 EN 1092 WSA 109	NBR, EPDM, Viton	3	55 – 75 IRHD
Compressed Fibre gasket	WSA 109 EN 1092	Compressed fibre	3	N/A

NOTES: 1. AS 1646 includes AS 681.1, AS 681.2, AS 681.3 and AS 681.4.

2. 1.5mm compressed fibre gaskets are permitted in various standards but are reported to be less durable in storage and handling, and more sensitive to flange face irregularities. Widespread Water Corporation operational preference is therefore for the use of 3mm compressed fibre gaskets.

3.3 Flange Fasteners

3.3.1 Quality

The fastener Supplier shall provide valid certification (on request), issued by a certification body accredited by JAS-ANZ, certifying that the flange fasteners comply with relevant Australian (or international) standards.

3.3.2 Fastener Marking

Marking of bolts, nuts and washers shall be in accordance with the following table, which summarises the fastener marking requirements of AS1252.1, AS 4291.1, AS/NZS 4291.2 and ISO 3056.

Table 3.2 –Fastener Markings

Item	PC	Marking Requirement	Standards	Comments
Bolt	AS1252.1 PC 8.8	Property class and manufacturer's trademark	AS1252.1	Fully marked on top of the bolt head
	AS1110.1 PC 8.8	Property class and manufacturer's trademark	AS 4291.1	
	A4-70 A4-80		ISO 3506-1	
Nut	AS1252.1 PC 8	Property class and manufacturer's trademark. 3 raised circumferential arcs on non-bearing face or indented on face for double-chamfer nuts.	AS1252.1	PC marked on nut side, bearing surface or chamfer
	AS1112.1 PC 8	Property class and manufacturer's trademark	AS/NZS 4291.2	
	A4-70 A4-80		ISO 3506-2	
Washer	AS1252.1	3 radial nibs on washer outer edge.	AS1252.1	3 radial nibs on washer outer edge.
	AS1110.1 PC 8.8 &	No marking requirement	AS 1237.1	

	AS1112.1 PC 8			Round plain faced washer
	A4		ISO 7089	

4 INSTALLATION

4.1 General

The design and installation of flanged joints shall embody the following principles:

(a) Fit for purpose pipework materials and configuration.

(b) Selection of appropriate fasteners for each joint application.

(c) Appropriate gasket materials and configuration.

(d) Pre-installation preparation of joints and mating equipment to deliver the required service life expectancy.

(e) Appropriate bolt tightening and associated practices e.g. lubrication etc.

4.2 Flanged Joint Preparation

Preparation of flanged joints shall embody the following:

(a) Torquing equipment shall be calibrated in accordance with the equipment calibration requirements and shall be maintained in clean condition.

(b) Flange faces and sealing components shall be clean and free from defects that could potentially impair joint service life expectancy.

4.3 Gaskets

The flange gaskets used shall be:

(a) To appropriate material specification and shall be dimensioned and configured to meet the requirements of Clause 3.2.

(b) New, unused, undamaged and shall be clean without distortion in any plane.

Where a narrow face gasket is used, the gasket may be fixed in place by small points of silicon sealant or adhesive tape.

4.4 Fasteners

The flange fastener used shall:

(a) Be to appropriate material specification and shall be free from material and coating defects. The capacity of nuts to run freely on the threads shall be verified prior to installation.

(b) For hot-dip galvanised nuts subject to tapping, nut threads shall be oiled for corrosion protection in accordance with Clause 5.1 of AS 1214.

(c) Bolt lengths shall be designed so that a minimum of 2 and a maximum of 5 threads protrude past the nut after installation.

(d) Include two washers for each bolt assembly. (Refer Clause 2.10)

4.5 Fastener Lubrication

During assembly of flanged joints, fasteners and bearing surfaces shall be lubricated (in addition to factory applied lubricants) as specified below. Contamination of flange and gasket faces with fastener lubricant shall be avoided.

Flange fastener and bearing surface lubricants selected for use in drinking and non-drinking water applications shall comply with AS/NZS 4020, a scaling factor of 0.05 should be used for assessment of products.

Fasteners will typically be supplied with an oily residue, this is not considered sufficient lubrication for assembly and additional lubrication shall be applied to fasteners and contiguous bearing surfaces.

Nickel based lubricants shall not be permissible as they emit carcinogenic fumes when burnt (e.g. oxy-cutting bolts).

A high quality solid type lubricant such as molybdenum disulphide shall be used for stainless steel bolts.

Fasteners for isolation joints shall be lubricated with a non-conductive lubricant such as NCH Thread-Eze Ultra or Loctite heavy duty anti seize.

NOTE: NCH Thread-Eze Ultra has AS/NZS 4020 approval and is suitable for use in drinking and non-drinking water applications

4.6 Flange Fastening Procedure

The procedural sequence and mechanics of flange fastener installation are critical elements in the assembly of fit for purpose flange joints intended for long term service life. Flange installation shall be undertaken as follows:

4.6.1 Fitting Fasteners

Flange fastener installation procedures shall be as follows:

(a) Flange bolt holes shall be numbered by marker pen or other suitable means in accordance with the sequence shown in Figure 4.1 for the designated number of flange bolts in order to enable identification during the fastener tightening sequence.

(b) Flange mating holes shall be lined up to facilitate insertion of flange bolts without excessive tightening force.

(c) A thin uniform coating of lubricant shall be applied to fastener threads and to bolt, nut and washer bearing surfaces.

(d) One flat washer shall be placed under the bolt head and one under the nut.

4.6.2 Joint Tightening

Fasteners shall be tightened in the sequence shown in Figure 4.1 for the designated number of flange bolts. During assembly and tensioning, bolt heads shall be held fast. Tightening should be achieved using a minimum of 5 passes as detailed in the following:

1st Pass

Tighten each nut loosely by hand in the first instance and then to snug tight using a spanner with an even effort in accordance with the tightening sequence (Figure 4.1).

- Check during tightening that the flanges are being pulled together parallel by measuring the distance between the flange faces at the 3, 6, 9 and 12 o'clock positions around the circumference of the flanges.
- Check the final seating is uniform and in correct alignment.

2nd Pass

Proceed to further tighten the nuts using a preset manual torque wrench. Torque the bolts to a maximum of 30% of the full torque requirement shown in the relevant bolt torque table below (refer Appendix A as applicable) for the first time around, in accordance with the tightening sequence.

- Check that the flanges are bearing uniformly on the gasket.

3rd Pass

Torque the bolts to a maximum of 60% of the full torque requirement (refer Appendix A as applicable) in accordance with the tightening sequence.

4th Pass

Torque to the full torque requirement (refer Appendix A as applicable) in accordance with the tightening sequence.

5th Pass

Conduct a final pass at full torque, in a clockwise direction on all adjacent fasteners.

For assembly of a flanged joint which includes at least one polyethylene pipe, the bolting shall be re-torqued to the initial target torque within 4 -24 hrs after the initial tightening to compensate for visco-elastic torque relaxation. The re-torque shall be undertaken using the sequence shown in Figure 4.1 and using Passes 3 to 5 as above.

4.6.3 Fastener Tightening Sequence

Fasteners shall be tightened in accordance with the sequence shown in Figure 4.1 below for the relevant flange number of holes applicable.

4.7 Isolating Joint Integrity

Where flanged joint isolation is required due to imposed Cathodic Protection current on a piping system, continuous insulation testing shall be carried out during assembly and tensioning using Tinkor or Rasor flange insulation checkers.

All isolation joints shall be tested for acceptance by a Corporation testing Officer prior to any joint wrapping and burial that may be required.

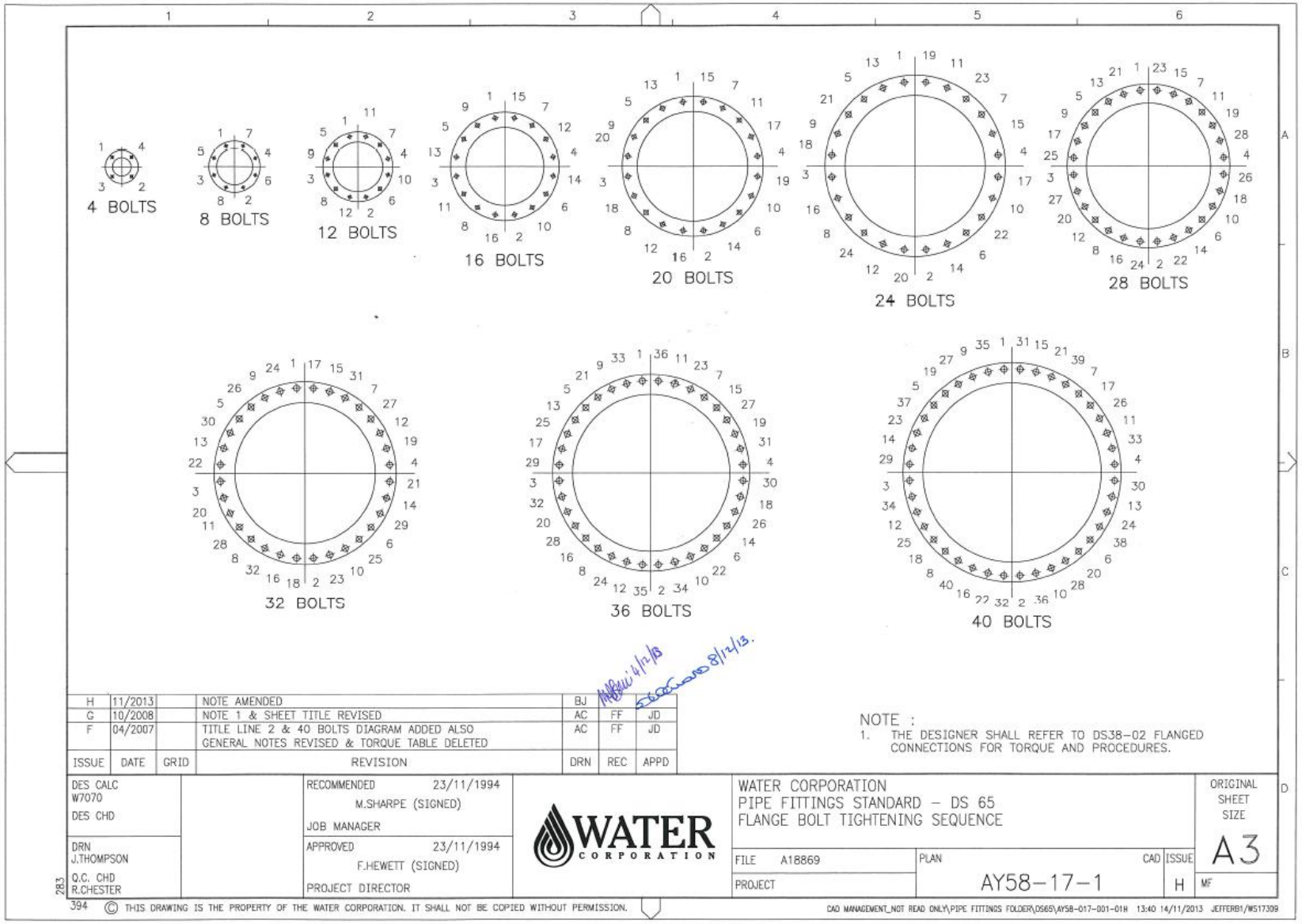
4.8 Wrapping

Flanged joints, which are buried or located in a pit prone to flooding or condensation, shall be sealed from the external environment by completely wrapping it with a Petrolatum Tape wrapping system in accordance with the Water Corporation Technical Specification L1 (System B) in DS 95.

4.9 Coating

Flanged pipework connections, where exposed to external environment, shall be inorganic zinc silicate coated in accordance with Water Corporation Technical coating specification B1. Where a topcoat is required it shall be in accordance with Water Corporation coating specification B2 in DS 95 and AS2700. Top coat colour should be in accordance with Water Corporation drawing EG71-1-1 provides standard colour coding for pipework.

Figure 4.1 – Bolt Tightening Sequence



NOTE: The latest issue of Drawing No AY58-17-1 shall be used.

5 Appendix A - Bolting Torques (Informative)

The following tables present the nominal required bolt torques for commonly used standard flange sizes and pressure ratings. For bolting of proprietary items of equipment, refer to the *Manufacturer's* guidelines (limited information for proprietary equipment is provided in Sections 5.5 to 5.7).

5.1 Elastomeric Gasket Bolting Torques – Steel / DI Flanges

Table 5.1 – Elastomeric Gasket Bolting Torques for AS 4087 PN 16 Flanges

Bolt Size	Bolt /torque (Nm)	
	Flat Face Flange	Raised Face Flange
M16	120	26
M20	204	60
M24	320	144

NOTES:

1. Assumed friction factor: μ = 0.12 based on NCH Thread-Eze Ultra lubricant.
2. Elastomeric gasket material: EPDM rubber, thickness 3 mm, allowable gasket stress of 8 MPa @ 20 ºC
3. Grade 8.8 bolts for all flange sizes.

Table 5.2 – Elastomeric Gasket Bolting Torques for EN 1092 PN 16 Flanges

Bolt Size	Bolt /torque – (Nm)	
	Flat Face Flange	Raised Face Flange
M16	70	21
M20	134	38
M24	213	53

NOTES:

1. Assumed friction factor: μ = 0.12 based on NCH Thread-Eze Ultra lubricant
2. Elastomeric gasket material: EPDM rubber, thickness 3 mm, allowable gasket stress of 8 MPa @ 20 ºC
3. Grade 8.8 bolts for all flange sizes.

5.2 Compressed Fibre (CF) Gasket Bolting Torques – Steel/DI Flanges

Table 5.3 – Galvanised Bolting Torques for AS 4087 PN16, 21, 35 and EN1092 PN25, 40 Flanges

Bolt Size	Bolt /torque – (Nm)
M16	170
M20	331
M24	574
M27	833
M30	1137
M33	1528
M36	1971
M39	2538
M45	3917

NOTES:

1. Assumed friction factor: $\mu = 0.12$ based on NCH Thread-Eze Ultra lubricant
2. Raised face joint only.
3. Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 3.0mm
4. Grade 8.8 bolts for all flange sizes
5. Bolt yield approximately 65%

Table 5.4 – Stainless Steel Bolting Torques for AS 4087 16, 21, 35 and EN1092 PN25, 40Flanges

Grade A4-70 Bolts

Bolt Size	Bolt /torque – (Nm)
M16	129
M20	251
M24	435
M27	631
M30	861

Grade A4-80 Bolts

Bolt Size	Bolt /torque – (Nm)
M33	1524
M36	1990
M39	2562
M45	3390

NOTES:

1. Assumed friction factor: $\mu = 0.12$ based on NCH Thread-Eze Ultra lubricant
2. Raised face joint only.
3. Compressed fibre gasket material: Novus 30 or Klingersil C4430, thickness 3.0mm.

4. Grade 8.8 bolts for all flange sizes
5. Bolt yield approximately 70%

5.3 Corporation-Designed Flanges Bolt Torques

Bolt torques, bolt and gasket specifications for Corporation designed flanges may be found on drawings as referenced in the following table.

Table 5.5 – Corporation Designed Flanges

Flange Type	Size (DN)	Drg Number
PN 25 Raised face slip-on	900 – 1400	JZ39-91-4
PN 25 Flat face slip-on	700 – 1400	JZ39-91-5
PN 25 Raised face weld neck	1200 – 1400	JZ39-91-6
PN 25 Flat face weld neck	700 – 1400	JZ39-91-7
PN 40 Raised face weld neck	700 – 1400	JZ39-91-9

5.4 PE Flanged Joints Bolt Torques

The lack of standards and consistency between PE manufacturers with regards to the outside diameter of stub flanges, the low stress tolerance of elastomeric gaskets and variation in diameters of what the PE stub flange is mated to, makes specification of universal bolt torques difficult. The tabulated torque figures presented in this section may be used subject to the indicated constraints. Inherently, these torques are compromise values which allow coverage of a range of flange details. For this reason, it is recommended that optimised bolt torques are determined for individual joints in consultation with the PE or gasket manufacturer, alternatively suitable bolt torques may be determined in accordance with the procedure outlined in Section 5.4.3.

All torques presented in this Section are based on the following common assumptions –

1. Assumed coefficient of friction: $\mu = 0.12$ (friction factor 0.16) based on using NCH Thread-Eze Ultra lubricant
2. Flat or raised face mating flange against PE stub flange creating raised face joint.
3. Elastomeric gasket material: EPDM rubber, thickness 3 mm
    a. target stress of 8 MPa @ 20 ºC with joint unpressurised
    b. effective seal stress range of 2 MPa to 10 MPa
    c. minimum gasket stress for pressurised joint 2.7 MPa
    d. Allowance of +/-25% for torque wrench method inaccuracy
    e. Mating flanges and backing rings are drilled in accordance with the applicable pressure rating of AS4087. Flanges to a different standard but drilled to AS4087 should be checked in accordance with procedure outlined in Section 5.4.3.
4. Grade 8.8 bolts for all flange sizes

In general, compressed fibre gaskets should not be used for joints where either flange is polyethylene, this is because the gasket stresses required to form an effective seal will likely require bolt loads which may deform the PE stub and backing ring, thereby reducing the effectiveness of the joint. If insulated flange joints are required for dissimilar bolting / backing flange /mating flange materials, then elastomeric gaskets shall be used with properties in accordance with this section and Section 2.11.1. Elastomeric gaskets for pressures above PN16 should not be used due to the tendency to blow out. In these cases, the pipe system or gasket manufacturers should be consulted for gasket selection and suitable bolt torques.

5.4.1 PE to Non-PE Flanged Joint

The figures presented in the following table are only applicable for flanged joints where a PE100 SDR 11or PE100 SDR13.6 stub flange is mated to a Non-PE AS4087 PN16 full flange (eg. MSCL pipe, DI pipe, gate valve etc.), both raised and flat face mating flanges are covered. In order to use the indicated torques, the PE stub flange outside diameter and Non-PE mating flange inside diameter must be within the ranges indicated in Table 5.6. In addition, the gasket outside diameter (OD) must not be less than the PE stub Min OD, nor shall the gasket inside diameter (ID) be greater than the mating pipe Max ID.

As indicated at Section 5.4, it is preferred that suitable torques are determined in consultation with the PE or gasket manufacturer, alternatively **bolt torques may be calculated as per the procedure outlined in Section 5.4.3**.

Table 5.6 – PN16 / PN12.5 PE to Non-PE Flanged Joint Torques

PE Pipe DN	Mating Flange DN	Poly Pipe Details (mm)				Mating Pipe Details (mm)		Bolt Details (AS4087 PN16)		Bolt Torque (N-m)
		PN12.5 ID	PN16 ID	Stub Max OD	Stub Min OD	Max ID	Min ID	No. of Bolts	Bolt Size	
63	65	53	51	102	94	76	62	4	M16	12
75	65	63	61	122	108	76	62	4	M16	19
90	100	76	73	129	128	112	100	4	M16	15
110	100	93	89	160	158	117	100	4	M16	40
125	100	106	101	160	158	117	100	4	M16	40
140	150	118	114	192	187	160	150	8	M16	19
160	150	136	130	217	211	171	150	8	M16	31
180	150	153	145	217	211	171	150	8	M16	31
200	200	170	162	274	268	222	200	8	M16	45
225	200	191	183	274	268	222	200	8	M16	45
250	250	212	203	334	320	276	250	8	M20	66
280	250	238	228	334	320	276	250	8	M20	66
315	300	268	256	384	370	320	300	12	M20	58
355	350	300	289	444	430	361	337	12	M24	110
400	400	340	326	495	481	412	386	12	M24	124
450	450	382	366	558	544	462	438	12	M24	166
500	500	424	407	596	590	513	489	16	M24	128
560	600	475	455	685	675	591	580	16	M27	180
630	600	535	512	718	710	615	591	16	M27	214
710	700	603	573	816	800	701	690	20	M27	202
800	800	679	646	952	940	820	799	20	M33	350

NOTES:

1. Bold sizes are preferred PE pipe sizes in accordance with DS31-01, the Strategic Product Register, DS60 & SPS125. Use of other sizes shall be subject to the requirements of these standards and advice from the Principal Engineer.
2. Torques applicable to PE100 SDR11 PN16 or SDR13.6 PN12.5 PE stub to AS4087 PN16 Non-PE mating flange.
3. Poly Pipe ID PN12.5 & Poly Pipe ID PN16 refer to the inside diameter of PE100 SDR13.6 PN12.5 and PE100 SDR11 PN16 polyethylene pipe respectively.

4. Poly Stub Max and Min OD refers to the outside diameter of the sealing face on the PE stub flange. The range of diameters is selected to accommodate the variation seen between some PE manufacturers.
5. Mating pipe details (Max & Min ID) refers to the inside diameter of the sealing face for the Non-PE mating flange. The variation results from the consideration of mating with various types of pipe and components (eg. MSCL pipe, DI pipe, gate valves etc.)
6. Pressure rating of the resulting joint shall be that of the lowest rated component, it is assumed that test pressure will not exceed this rating.
7. DN combinations presented are based on best ID compatibility and available clearance between the OD of the stub and the diameter to the inside surface of the bolts.
8. Overall dimensional compatibility of backing ring, stub flange and mating flanges for the size combination is the responsibility of the designer.
9. Selection and procurement of components should ensure that the contact area between the back face of the stub and backing ring is maximised. Backing rings used shall be suitable for the pressure rating of the joint.
10. The above figures may be suitable for mating with butterfly valves, however stub flange face dimensions and pipe ID shall be checked to ensure compatibility with the butterfly valve (refer Section 2.6 for additional information regarding seal on body valves). A PE butterfly valve spacer may be required to ensure that the butterfly valve disk does not fowl on the pipe ID.

5.4.2 PE to PE Flanged Joint

The figures presented in the following table are only applicable for flanged joints between PE100 SDR11 PN16 to like PE or PE100 SDR13.6 PN12.5 to like PE (ie. not intended for PN16 to PN12.5), with backing ring drilled to AS4087 PN16. In order to use the indicated torques, the PE stub flange outside diameter must be within the range indicated in Table 5.7. In addition, the gasket OD must not be less than the PE stub Min OD, nor the gasket ID greater than the PN12.5 Poly Pipe ID.

Table 5.7 – PN16 / PN12.5 PE to PE Flanged Joint Torques

PE Pipe DN	AS4087 Backing Ring DN	Poly Pipe Details (mm)				Bolt Details AS4087 PN16		Bolt Torque (N-m)
		ID PN12.5	ID PN16	Stub Max OD	Stub Min OD	Qty.	Size	
63	65	53	51	102	94	4	M16	24
75	65	63	61	122	108	4	M16	31
90	100	76	73	130	128	4	M16	43
110	100	93	89	160	158	4	M16	66
125	100	106	101	160	158	4	M16	55
140	150	118	114	193	187	8	M16	42
160	150	136	130	217	211	8	M16	52
180	150	153	145	217	211	8	M16	42
200	200	170	162	274	268	8	M16	86
225	200	191	183	274	268	8	M16	71
250	250	212	203	334	320	8	M20	144
280	250	238	228	334	320	8	M20	115
315	300	268	256	384	370	12	M20	109
355	350	300	289	444	430	12	M24	191
400	400	340	326	495	481	12	M24	233
450	450	382	366	558	544	12	M24	302
500	500	424	407	596	584	16	M24	243
560	600	475	455	669	657	16	M27	350
630	600	535	512	726	710	16	M27	370
710	700	603	573	816	800	20	M27	375
800	800	679	646	952	940	20	M33	701

NOTES:

1. Bold sizes are preferred PE pipe sizes in accordance with DS31-01, the Strategic Product Register, DS60 & SPS125. Use of other sizes shall be subject to the requirements of these standards and advice from the Principal Engineer.
2. Poly Pipe ID PN12.5 & Poly Pipe ID PN16 refer to the inside diameter of PE100 SDR13.6 PN12.5 and PE100 SDR11 PN16 polyethylene pipe respectively.
3. Poly Stub Max and Min OD refers to the outside diameter of the sealing face on the PE stub flange. The range of diameters is selected to accommodate the variation seen between some PE manufacturers.
4. DN combinations presented are based on best ID compatibility and available clearance between the OD of the stub and the diameter to the inside surface of the bolts.
5. Overall dimensional compatibility of backing ring, stub flange and mating flanges for the size combination is the responsibility of the designer.
6. Selection and procurement of components should ensure that the contract area between the back face of the stub and backing ring maximize the contact area. Backing rings used shall be suitable for the pressure rating of the joint.
7. It is assumed that test pressure will not exceed the flange rating.

5.4.3 Calculation of Bolt Torques

Where consultation with the PE or gasket manufacturer is not able to identify suitable bolt torques, the following procedure may be used to determine custom torques for PE to PE and PE to Non-PE (eg. MSCL pipe, DI pipe, gate valve etc.) flanged joints only.

1. Determine the effective gasket inside and outside diameters

   The effective gasket inside diameter (ID) will be the greater of the actual gasket ID and the maximum ID of the two mating flanges.

   The effective gasket outside diameter (OD) will be the lesser of the actual gasket OD, the minimum OD of the two mating flanges or the raised face diameter of a flange (if applicable).

2. Calculate the effective gasket stress area, as per the following equation –

   $$\mathbf{A = \pi(OD^2 - ID^2)/4}$$

   Where A = gasket effective area in mm^2

   OD = gasket effective outside diameter in mm

   ID = gasket effective inside diameter in mm

3. Determine total and individual bolt load to give target stress using the following equations –

   $$\mathbf{F = s_T.A}$$

   Where F = total gasket load to be provide by the bolts in Newtons (N)

   sT= target gasket stress = 8 MPa for EPDM

   A is as per Step 2

   Individual bolt load is given by –

   $f = F/n$

   Where f = individual bolt load in Newtons (N)

   n = total number of bolts

   F is as per Step 3

4. Calculate bolt torque –

   Bolt torques are calculated in accordance with the simplified equation as per Section 6.6 of ESA / FSA Publication No 009/98 Guidelines for safe seal usage – Flanges and Gaskets (Part 1 – guidelines for maintenance operators / engineers / fitters).

   $T = (f/1000) \times 0.16 \times db$

   Where T = torque per fastener in Nm

   f is as per Step 3

   db = nominal diameter of fastener in mm (ie. db = 16 for M16 bolt etc.)

   0.16 = factor loss due to friction (equivalent to coefficient of friction: $\mu = 0.12$)

   The resulting bolt torque when applied to each bolt in accordance with the procedures outlined in Section 4.6.2, subject to the accuracy of torque wrench method, should produce a gasket stress near the target stress of 8 MPa in the unpressurised condition. The gasket stress should be back calculated for a pressurised joint to ensure that the stress remains within the acceptable range (nominally 2.7 to 8 MPa), refer following Step 5.

   The calculated bolt torque should also be checked as per Step 6 to confirm that bolts will not be overstressed.

5. Gasket Stress Check

   Calculate hydrostatic end force is the resulting axial force on the joint by virtue of the internal pressure, it may be calculated using the following equation –

   $F_H = \pi.ID^2/4 \times P$

   Where FH = hydrostatic end force in N

   ID is as per Step 2 above.

   P = Rated Pressure in MPa (ie. PN16 = 1.6 MPa)

   With the joint pressurised, the resulting effective compressive load on the gasket will be the total bolt pre-load minus the hydrostatic end force (ie. F - FH) and so the resulting gasket stress in the pressurised condition may be calculated using the following equation –

   $s_P = (F - F_H) / A$

   Where sP = gasket stress with the flanged joint pressurised in MPa

   F is as per Step 3

   FH is as above

   A is as per Step 2

   If the stress calculated with the joint pressurised is between 2.7 MPa and 8 MPa, the bolt torques calculated at Step 4 are suitable for the application. If the stress is not within this range, then the gasket manufacturer should be contacted for advice.

6. Bolt Stress Check

It is highly unlikely that an unacceptable bolt stress would be achieved when using grade 8.8 bolts, however, to ensure this, the adequacy of the bolts should be checked as follows. The below table lists torques which will give a bolt stress of approximately 65% of grade 8.8 bolt yield. If the bolt torque T calculated at Step 4 is less than the torque listed in the following table for the given bolt size, then the bolt torque T from Step 4 is suitable for the use of grade 8.8 bolts.

Table 5.8 – Bolt Torque at ~65% Grade 8.8 Bolt Yield

Bolt Size	Torque Nm
M16	170
M20	331
M24	574
M27	833
M30	1137

If torque T from Step 4 is greater than the listed value, then the calculated torque is not suitable and the PE / gasket manufacturer should be consulted for suitable bolting / torques.

5.5 Magnetic Flow Meter Bolt Torques

The information presented in this section is for makes / models as per the Water Corporation SCADA Approved Equipment List. Where a different magnetic flow meter is used, the manufacturer shall be consulted to determine suitable bolt torques and assembly details.

5.5.1 Siemens

The torque figures presented in the following table are taken directly from the Siemens Quick Start publication (edition 09/2009-revision 6) for the Siemens MAG 3100 / 3100HT / 3100P / 5100W. The 5100W is commonly used on Water Corporation jobs and hence the torques will be applicable in many cases.

Table 5.9 – Siemens MFM Bolt Torques

DN	Bolt Torque N-m		
	AS4087 PN16	AS4087 PN21	AS4087 PN35
50	21	33	33
65	22	22	22
80	32	28	28
100	50	35	35
150	60	50	50
200	55	78	37
250	94	110	49
300	72	105	43
350	153	164	94
400	172	158	105
450	224	204	129
500	198	210	141
600	287	277	183
700	228	246	207
800	426	304	286
900	416	371	287
1000	386	326	326
1200	443	471	471

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. The OEM recommends Gasket material not exceeding 75 shore A durometer (also refer Section 2.11), however experience suggests that this may only be effective for sealing at PN16 and size DN600 or smaller.
3. Grade 8.8 bolts for all flange sizes.
4. Compressed fibre gaskets are not recommended by the manufacturer. However Water Corporation experience indicates that for pressures above PN16 compressed fibre gaskets may be required. This is subject to the manufacturer confirming suitable bolt torques.
5. For pressures above PN16 and for sizes above DN600 flow meters should be procured with a hard liner (eg. hard rubber or Ebonite).
6. The torques presented in this table are the minimum required torques for sealing with a gasket meeting criteria at Note 2, the OEM should be consulted for higher bolt torques.

5.5.2 Endress & Hauser

The Promag 400 is also approved for use in Water Corporation installations. The AS4087 PN16 torque values below are taken directly from their Proline Promag W 400 Operating Instructions (version 02.00.zz). AS4087 PN21 & PN35 figures have been advised by E&H (refer Nexus #136995704)

Table 5.10 – E&H MFM Bolt Torques

DN	Bolt Torque N-m		
	AS4087 PN16	AS4087 PN21	AS4087 PN35
50	32	71	71
80	49	61	61
100	76	76	76
150	52	108	108
200	77	168	83
250	147	240	113
300	103	228	100
350	203	359	209
375	137	301	142
400	226	347	234
450	301	447	287
500	271	458	313
600	393	600	402
700	330	548	465
800	631	670	632
900	627	818	640
1000	595	727	727
1200	703	1052	1052

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. Gasket material refer Section 2.11
3. Grade 8.8 bolts for all flange sizes.
4. For pressures above PN16 and for sizes above DN600 flow meters should be procured with a hard liner (eg. hard rubber or Ebonite). Hard rubber is the standard liner supplied by this manufacturer.
5. Compressed fibre gaskets are not recommended by the manufacturer. However, Water Corporation experience indicates that for pressures above PN16 compressed fibre gaskets may be required. This is subject to the manufacturer confirming suitable bolt torques.

5.6 Butterfly Valve Bolt Torques

The torques presented are for mating against Steel or DI flanges with Grade 8.8 bolting, the bolts should be lubricated in accordance with Section 4.5. The manufacturer should be consulted for mating against flanges of other materials or bolting in other grades. In general tightening procedure as per Section 4.6.2 & Section 4.6.3 should be followed.

5.6.1 SPS261 Seal on Body Butterfly Valves

Flanged joints for seal on body valves are covered in Section 2.6. A gasket is not required, the seal is made against the body liner which wraps around onto the valve face.

5.6.1.1 EBRO F012A

The tightening torques presented in the following table are maximum values appropriate for AS4087 PN16 & PN21, also EN1092 PN25 drilled flanges.

Table 5.11 – Bolt Torques EBRO F012A

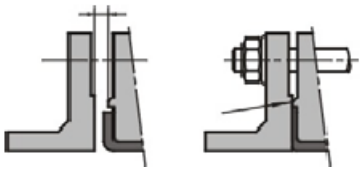
Bolt Size	Bolt Torque – (Nm)
M10	23
M12	40
M16	90
M20	180
M24	310
M27	450
M30	615
M33	830
M36	1070
M39	1385
M42	1725
M45	2145
M48	2595
M52	3310
M56	4095

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. Grade 8.8 bolts for all flange sizes.
3. No gasket is required, seal is achieved by compressing the elastomeric body liner.
4. The tabulated values provided by EBRO are based on a percentage of bolt yield which will not damage the bolts or flanges but will ensure metal to metal contact on the flange faces to create an effective seal. Crush on the valve elastomeric liner is limited by this arrangement.

5.6.1.2 Wouter Witzel Series 75 (EVFS)

Wouter Witzel recommend that the bolts are tightened in a criss-cross fashion until there is metal on metal contact between the raised face on the butterfly valve and the mating flange (refer to below diagram).



The tightening torques presented in the following table are maximum values appropriate for AS4087 PN16 & PN21 drilled flanges using galvanized bolting.

Table 5.12 – Bolt Torques Wouter Witzel Series 75 (EVFS) for AS4087

Size DN	PN16			PN25 (Drilled to suit PN21)		
	Qty	Bolt Size	Bolt Torque (Nm)	Qty	Bolt Size	Bolt Torque (N-m)
80	4	M16	69	8	M16	44
100	4	M16	89	8	M16	59
150	8	M16	85	12	M20	95
200	8	M16	132	12	M20	150
250	8	M20	236	12	M24	261
300	12	M20	213	16	M24	269
350	12	M24	305	16	M27	354
400	12	M24	390	20	M27	366
450	12	M24	511	20	M30	509
500	16	M24	430	24	M30	512
600	16	M27	638	24	M33	757
700	20	M27	1039	24	M33	1378
750	20	M30	1290	28	M33	1318
800	20	M33	1577	28	M33	1495
900	24	M33	1069	32	M36	1327
1000	24	M33	1315	36	M36	1451
1200	32	M33	1333	40	M39	1885

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. Grade 8.8 bolts for all flange sizes.
3. No gasket is required, seal is achieved by compressing the elastomeric body liner.
4. The tabulated values provided are based on torques provided by Wouter Witzel for AS4087 flanges

The tightening torques presented in the following table are maximum values appropriate for AS2129 PN10 & PN16 drilled flanges using galvanized bolting.

Table 5.12 – Bolt Torques Wouter Witzel Series 75 (EVFS) for AS2129

Size DN	PN10			PN16		
	Qty	Bolt	Torque	Qty	Bolt	Torque
50	4	M16	37	4	M16	44
65	4	M16	46	4	M16	56
80	4	M16	56	4	M16	69
100	8	M16	71	8	M16	45
125	8	M16	55	8	M16	69
150	8	M16	66	8	M20	106
200	8	M16	102	8	M20	166
250	8	M20	178	12	M20	157
300	12	M20	159	12	M24	256
350	12	M24	224	12	M24	305
400	12	M24	283	12	M24	390
450	12	M24	343	16	M24	383
500	16	M24	305	16	M24	430
600	16	M27	445	16	M30	716
700	20	M27	828	20	M30	1165
750	20	M30	1020	20	M33	1392
800	20	M33	1246	20	M33	1577
900	24	M33	723	24	M33	1069
1000	24	M33	890	24	M36	1449
1200	32	M33	884	32	M36	1468

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. Grade 8.8 bolts for all flange sizes.
3. No gasket is required, seal is achieved by compressing the elastomeric body liner.
4. The tabulated values provided are based on torques provided by Wouter Witzel for AS2129 flanges

5.6.1.3 Keystone Resilient Seated Butterfly Valves

The tightening torques presented in the following table are maximum values appropriate for AS4087 PN16 & PN21 drilled flanges using galvanized bolting.

Table 5.12 – Bolt Torques Keystone Resilient Seated Butterfly Valves

Bolt Size	Bolt Torque – (Nm)
M12	25
M16	60
M20	82
M24	204
M27	285
M30	413
M33	526
M36	707

NOTES:

1. Use NCH Thread-Eze Ultra lubricant
2. Grade 8.8 bolts for all flange sizes.
3. No gasket is required, seal is achieved by compressing the elastomeric body liner.
4. The tabulated values provided are based on torques provided by Emerson for AS2129 flanges, multiplied by 1.4 for zinc plating and 1.05 for max value.

5.6.1.4 AFFCO Resilient Seated Butterfly Valves

The tightening torques presented in the following table are maximum values appropriate for AS4087 PN16 & PN21 drilled flanges using galvanized bolting.

Table 5.12 – Bolt Torques Keystone Resilient Seated Butterfly Valves

Size DN	PN16		PN21	
	Bolt Size	Bolt Torque – (Nm)	Bolt Size	Bolt Torque – (Nm)
50	M16	129	M16	129
80	M16	129	M16	129
100	M16	129	M16	129
150	M16	129	M20	251
200	M16	129	M20	251
250	M20	251	M24	435
300	M20	251	M24	435
350	M24	435	M27	631
400	M24	435	M27	631
450	M24	435	M30	861
500	M24	435	M30	861
600	M27	631	M33	1524

700	M27	631	M33	1524
750	M30	861	M33	1524
800	M33	1524	M33	1524
900	M33	1524	M36	1990
1000	M33	1524	M36	1990
1200	M33	1524	M39	2562

1. Use NCH Thread-Eze Ultra lubricant
2. Grade 8.8 bolts for all flange sizes.
3. No gasket is required, seal is achieved by compressing the elastomeric body liner.
4. The tabulated values provided are based on torques provided by AFFCO for AS4087 flanges.

5.6.2 SPS262 Seal on Disk Butterfly Valves

Narrow face joint as per Section 2.7.2 will be typical for these valves.

5.6.2.1 OZ-KAN W25

Refer to Section 5.2 , Table 5.3 for suitable torques.

5.6.2.2 VAG EKN

Refer to Section 5.2 , Table 5.3 for suitable torques.

5.7 Existing Vintage Grey Cast Iron Valves

In the limited circumstances where existing aged valves are to be re-used, reference may be made to Section 1.7.1 of DS38-03 Ver 1 Rev 0 for suitable torques. A copy of the relevant page may be found at Nexus #44896840.

6 Appendix B – Flange / Gasket Sizing (Informative)

The following tables present the nominal required flange and gasket sizing information for commonly used standard flange sizes and pressure ratings.

Values for nominal gasket internal diameters were presented in previous versions of this standard. This information has been removed as Novus have advised that gasket internal diameters are cut to the nominal flange size as standard i.e. a DN400 gasket will have an internal diameter of 400 mm.

Table 6.1 – AS 4087 PN 16 Flanges

Flange Size	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts
80	185	146	4	M16
100	215	178	4	M16
150	280	235	8	M16
200	335	292	8	M16
250	405	356	8	M20
300	455	406	12	M20
400	580	521	12	M24
500	705	641	16	M24
600	825	756	16	M27
700	910	845	20	M27
800	1060	984	20	M33
900	1175	1092	24	M33
1000	1255	1175	24	M33
1200	1490	1410	32	M33

Table 6.2 –EN 1092 PN 16 Flanges

Flange Size	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts
80	200	160	8	M16
100	220	180	8	M16
150	285	240	8	M20
200	340	295	12	M20
250	405	355	12	M24
300	460	410	12	M24
400	580	525	16	M27
500	715	650	20	M30
600	840	770	20	M33
700	910	840	24	M33
800	1025	950	24	M36
900	1125	1050	28	M36
1000	1255	1170	28	M39
1200	1485	1390	32	M45

Table 6.3 –AS 4087 PN21/PN35 Flanges

Flange Size	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts
80	205	165	8	M16
100	230	191	8	M16
150	305	260	12	M20
200	370	324	12	M20
250	430	381	12	M24
300	490	438	16	M24
400	610	552	20	M27
500	735	673	24	M30
600	850	781	24	M33
700	935	857	24	M33
800	1060	984	28	M33
900	1185	1105	32	M36
1000	1275	1194	36	M36
1200	1530	1441	40	M39

Table 6.4 –EN 1092 PN 25 Flanges

Flange Size	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts
80	200	160	8	M16
100	235	190	8	M20
150	300	250	8	M24
200	360	310	12	M24
250	425	370	12	M27
300	485	430	16	M27
400	620	550	16	M33
500	730	660	20	M33
600	845	770	20	M36

Table 6.5 – EN 1092, PN 40 Flanges

Flange Size	Flange OD (mm)	PCD (mm)	No of Bolts	Size of Bolts
80	200	160	8	M16
100	235	190	8	M20
150	300	250	8	M24
200	375	320	12	M27
250	450	385	12	M30
300	515	450	16	M30
400	660	585	16	M36
500	755	670	20	M39
600	890	795	20	M45

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