Gas Industry Standard

GIS/E55:2025

Specification for

Bolting, Jointing, Threading, Fasteners and Gaskets for all Pressure Retaining Joints

Gas Networks Ireland
Northern Gas Networks
national gas transmission
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WALES&WEST UTILITIES

Contents

Foreword

Gas Industry Standards (GIS) are revised, when necessary, by the issue of new editions. Users shall ensure that they are in possession of the latest edition. Contractors and other users external to gas transporters shall direct their requests for copies of a GIS to the department or group responsible for the initial issue of their contract documentation.

Comments and queries regarding the technical content of this document shall be directed in the first instance to the contract department of the gas transporter responsible for the initial issue of their contract documentation.

This standard calls for the use of procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Compliance with this engineering document does not confer immunity from prosecution for breach of statutory or other legal obligations.

Mandatory and non-mandatory requirements

In this document:

shall: indicates a mandatory requirement;

should: indicates best practice and is the preferred option. If an alternative method is used then a suitable risk assessment shall be completed to show that the alternative method delivers the same, or better, level of protection.

Disclaimer

This engineering document is provided for use by gas transporters and such of their contractors as are obliged by the terms of their contracts to comply with this engineering document. Where this engineering document is used by any other party, it is the responsibility of that party to ensure that the engineering document is correctly applied.

Brief history

Individual DAT sheets published as British Gas documents:	
DAT 2	March 1992
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1 Scope

This GIS consists of the following parts and sections relating to bolting, threading, fasteners and gaskets for all pressure retaining joints on the Gas Transporter Network. The Specification covers joints, typically flanges, which includes Class, Pressure Nominal (PN) and legacy designations for both new and replacement plant.

PART 1: CLASS DESIGNATED APPLICATIONS, TYPICALLY OPERATING AT PRESSURES GREATER THAN 7 BARG

Part 1 of this specification covers Class designated applications and is separated into four sections, as outlined below. Typically, Class designated joints will operate at pressures greater than 7 barg. Where Class designated joints are operating at pressures below 7 barg, and are not covered by Part 2, Part 1 should still be used to ensure compatibility.

- Section A - Stud bolts, nuts, washers and gaskets
- Section B - Designation and identification of metric and imperial bolting (ISO Unified, ISO Metric, Whitworth)
- Section C - Recommended bolting procedure for stud bolts used on Class designated joints
- Section D - Zinc alloy electroplating of bolting for enhanced corrosion protection

PART 2: PN DESIGNATED APPLICATIONS, TYPICALLY OPERATING AT PRESSURES UP TO AND INCLUDING 7 BARG

Part 2 of this specification covers PN designated applications and is separated into three sections, as outlined below. Typically, PN designated joints will operate at pressures below 7 barg. This section should also be used for legacy joints operating at pressures up to 7 barg, excluding Class designated applications.

- Section A - Bolting, nuts, washers and gaskets
- Section B - Recommended Bolting Procedure for stud bolts used on PN16 designated joints
- Section C - Selection and fitting of metric bolts and nuts in imperial flanges operating at pressures up to and Including 7 barg

PART 3: PIPE THREADS FOR PIPE FITTINGS (BS EN 10226 and ANSI/API)

Part 3 provides guidance to avoid mismatch when selecting pipe thread systems on the Gas Transporter network.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including all addenda and revisions) applies.

British Standards

BS 10, Specification for Flanges and Bolting for Pipes, Valves and Fittings.

BS 21, Specification for Pipe Threads for Tubes and Fittings where Pressure-Tight Joints are made on the Threads (Metric Dimensions).

BS 84, Parallel Screw Threads of Whitworth Form. Requirements.

BS 192-1, Open-Ended Wrenches. Metric and Unified.

BS 192-2, Open-ended Wrenches. BS and Whitworth.

BS 916, Specification for Black Bolts, Screws and Nuts, Hexagon and Square, with B.S.W. Threads, and Partly Machined Bolts, Screws and Nuts, Hexagon and Square, with B.S.W. or B.S.F. Threads.

BS 1083, Specification for Precision Hexagon Bolts, Screws and Nuts (B.S.W. & B.S.F. Threads).

BS 1560, Steel Pipe Flanges and Flanged Fittings (Nominal Sizes 1/2 in to 24 in) for the Petroleum Industry.

BS 1560-3.1, Circular Flanges for Pipes, Valves and Fittings (Class Designated). Steel, Cast Iron and Copper Alloy Flanges. Specification for Steel Flanges.

BS 1580-1, Unified Screw Threads. Screw Threads with Diameters ¼ in and Larger. Requirements.

BS 1768, Specification for Unified Precision Hexagon Bolts, Screws, & Nuts (UNC & UNF Threads). Normal Series.

BS 1769, Specification. Unified Black Hexagon Bolts, Screws, Nuts (UNC & UNF threads). Heavy Series.

BS 2779, Specification for Pipe Threads for Tubes and Fittings where Pressure-Tight Joints are not Made on the Threads (Metric Dimensions).

BS 3293, Specification for Carbon Steel Pipe Flanges (over 24 Inches Nominal Size) for the Petroleum Industry.

BS 3410, Specification for Metal Washers for General Engineering Purposes.

BS 3580, Guide to Design Considerations on the Strength of Screw Threads.

BS 3643-1, ISO Metric Screw Threads. Principles and Basic Data.

BS 3643-2, ISO Metric Screw Threads. Specification for Selected Limits of Size.

BS 3692, ISO Metric Precision Hexagon Bolts, Screws and Nuts. Specification.

BS 4190, ISO Metric Black Hexagon Bolts, Screws and Nuts. Specification.

BS 4278, Specification for Eyebolts for Lifting Purposes.

BS 4320, Specification for Metal Washers for General Engineering Purposes. Metric Series.

BS 4882, Specification for Bolting for Flanges and Pressure Containing Purposes.

BS 7531, Rubber Bonded Fibre Jointing for Industrial and Aerospace Purposes. Specification.

Euronorm Standards

BS EN 837-1, Pressure Gauges. Bourdon Tube Pressure gauges. Dimensions, Metrology, Requirements and Testing.

BS EN 1092-1, Flanges and their Joints. Circular Flanges for Pipes, Valves, Fittings and Accessories, PN Designated. Steel Flanges.

BS EN 1514-1, Flanges and their Joints. Dimensions of Gaskets for PN-Designated Flanges. Non-Metallic Flat Gaskets with or without Inserts.

BS EN 1514-2, Flanges and their Joints. Gaskets for PN-Designated Flanges. Spiral Wound Gaskets for use with Steel Flanges.

BS EN 1515-1, Flanges and their joints. Bolting. Selection of Bolting.

BS EN 1515-2, Flanges and their joints. Bolting. Classification of Bolt Materials for Steel Flanges, PN Designated.

BS EN 1759-1, Flanges and their Joints. Circular Flanges for Pipes, Valves, Fittings and Accessories, Class-Designated. Steel Flanges, NPS 1/2 to 24.

BS EN 10204, Metallic Products. Types of Inspection Documents.

BS EN 10226-1, Pipe Threads where Pressure Tight Joints are Made on the Threads. Taper External Threads and Parallel Internal Threads. Dimensions, Tolerances and Designation.

BS EN 10226-2, Pipe Threads where Pressure Tight Joints are made on the Threads. Taper External Threads and Taper Internal Threads. Dimensions, Tolerances and Designation.

BS EN 10226-3, Pipes threads where pressure-tight joints are made on the threads. Verification by means of limit gauges.

BS EN 12308, Installations and Equipment for LNG. Suitability Testing of Gaskets Designed for Flanged Joints used on LNG Piping.

BS EN 12560-1, Flanges and their Joints. Gaskets for Class-Designated Flanges. Non-Metallic Flat Gaskets with or without Inserts.

BS EN 12560-2, Flanges and their joints. Dimensions of Gaskets for Class-Designated Flanges. Spiral Wound Gaskets for use with Steel Flanges.

BS EN 12560-3, Flanges and their Joints. Gaskets for Class-Designated Flanges. Non-Metallic PTFE Envelope Gaskets.

BS EN 14772, Flanges and their Joints. Quality Assurance Inspection and Testing of Gaskets in Accordance with the Series of Standards EN 1514 and EN 12560.

ISO Standards

ISO 7-1, Pipe Threads where Pressure-Tight Joints are made on the Threads — Part 1: Dimensions, Tolerances and Designation.

ISO 4520, Chromate Conversion Coatings on Electroplated Zinc and Cadmium Coatings.

BS EN ISO 148-1, Metallic Materials. Charpy Pendulum Impact Test. Test Method.

BS EN ISO 228-1, Pipe Threads where Pressure-Tight Joints are not made on the Threads. Dimensions, Tolerances and Designation.

BS EN ISO 898-1, Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel. Bolts, Screws and Studs with Specified Property Classes. Coarse Thread and Fine Pitch Thread.

BS EN ISO 898-2, Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel. Nuts with Specified Property Classes. Coarse Thread and Fine Pitch Thread.

BS EN ISO 4016, Hexagon Head Bolts. Product Grade C.

BS EN ISO 4034, Hexagon Regular Nuts (Style 1). Product Grade C.

BS EN ISO 4519, Electrodeposited Metallic Coatings and Related Finishes. Sampling Procedures for Inspection by Attributes.

BS EN ISO 7091, Plain washers. Normal series. Product grade C.

BS ISO 9587, Metallic and Other Inorganic Coatings. Pre-Treatment of Iron or Steel to Reduce the Risk of Hydrogen Embrittlement.

BS ISO 9588, Metallic and Other Inorganic Coatings. Post-Coating Treatments of Iron or Steel to Reduce the Risk of Hydrogen Embrittlement.

BS ISO 12308, Plain Bearings. Quality Assurance of Sample Types. Definitions, Applications and Testing.

BS ISO 15726, Metallic Coatings and Other Inorganic Coatings. Electrodeposited Zinc Alloys with Nickel, Cobalt or Iron

American Standards

ANSI B1.20.1, Pipe Threads, General Purpose, Inch.

ANSI B1.20.3, Dryseal Pipe Threads, Inch.

ANSI B1.20.4, Dryseal Pipe Threads (Metric Translation of B1.20.3-1976)(Partial Revision & Conversion of ANSI B2.2-1968).

API 5B, Threading, Gauging and Inspection of Casing, Tubing and Line Pipe Threads.

ASME B16.20, Metallic Gaskets for Pipe Flanges.

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

ASME B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.

ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).

ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

ASTM A320, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.

ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.

ASTM B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

ASTM B849, Standard Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement.

ASTM B850, Standard Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement.

ASTM F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.

ASTM F812, Standard Specification for Surface Discontinuities of Nuts, Inch and Metric Series.

MSS SP-44, Pipeline Flanges.

Gas Transporter Standards/Procedures

GIS/F7, Specification for Steel Welding Pipe Fittings, Nominal Size 15 mm to 450 mm Inclusive, for Operating Pressures not Greater than 7 Bar.

GIS/F7 Supplement, Supplementary Specification for Steel Welded Pipe Fittings Nominal Size 15 mm to 1200 mm Inclusive, for operating Pressures not Greater than 7 Bar.

*/SP/DAT/6, Carbon and Carbon Manganese Steel Pipe for Operating Pressures Greater than 7 Bar

*/PM/G/17, Management Procedure for the Management of Design and Design Appraisal.

*/PM/G/35, Management Procedure for the Management of Design and Design Appraisal.

*/PM/GR/2, Management Procedure for the Control of Gas Engineering Standards.

*/PM/TR/45, Management Procedure for Determining Flange Protection.

*/PM/PS/5, Management Procedure for the Management of New Works, Modifications and Repairs.

*/SP/F/1, Carbon and Carbon Manganese Steel Forgings and Forged Components for Operating Pressures Greater than 7 Bar.

*/SP/INP/3, Specification for Bourdon Tube Pressure Gauges for Plant Mounting in Distribution and Transmission Installations.

*/SP/PW/6-1, Technical Specification for Auxiliary Services Pipework: Part 1 - General Services using Carbon Steel Pipework.

*/SP/PW/11-1, Technical Specification for Pipework Systems (Excluding Distribution Systems): Part 1 - Design and Materials.

*/SP/PW/11-2, Technical Specification for Pipework Systems (Excluding Distribution Systems): Part 2 - Fabrication and Installation.

*/SP/VS/02, Specification for Detailed Visual Examination (VS/02) of Pipework and Components.

Health and Safety Executive Guidance Note

Guidance Note PM/16, Eyebolts.

3 Abbreviations

This specification makes reference to the following definitions and abbreviations:

ANSI	American National Standards Institute
API	American Petroleum Institute
BS	British Standard
BSF	British Standard Fine
BSI	British Standards Institute
BSP	British Standard Pitch
BSW	British Standard Whitworth
CAF	Compressed Asbestos Fibre
CFG	Compressed Fibre Gasket
CNAF	Compressed Non-Asbestos Fibre
CTR	Certified Test Record
EEMUA	Engineering Equipment and Materials Users Association
EN	Euronorm
FF (Flange)	Flat Face
FF (Gasket)	Full Face
GIS	Gas Industry Standard
HSE	Health and Safety Executive
ISO	International Standards Organisation
LNG	Liquefied Natural Gas
LTG	Long Tongue and Groove
M	Metric
MDT	Minimum Design Temperature
MSDS	Material Data Safety Sheet
NPT	National Pipe Taper
NPTF	National; Pipe Taper-Fuel
PN	Pressure Nominal
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
RF	Raised Face
RTJ	Ring Type Joint
SLS	Selective Laser Sintering
SMYS	Specified Minimum Yield Stress
SPG	Standard Purity Graphite
SWG	Spiral Wound Gasket
UN	Unified
UNC	Unified Course
UNEF	Unified Extra-Fine
UNF	Unified Fine
VTRG	Vender Technical Review Group
W	Whitworth

PART 1: CLASS DESIGNATED APPLICATIONS, TYPICALLY OPERATING AT PRESSURES GREATER THAN 7 BARG

SECTION A - STUD BOLTS, NUTS, WASHERS AND GASKETS

Introduction

This section covers stud bolts, nuts, washers and gaskets for use on pressure retaining bolted joints on Class designated flanges, typically operating at pressures greater than 7 barg. This may include joints on carbon steel pipework flanges, valve bodies and pressure vessels. This section should also be used for Class designated joints that are operating at pressures below 7 barg to ensure compatibility.

This section provides information to be used when ordering materials for pressure retaining Class designated joints consisting of carbon steel flanges to */SP/F/1, BS EN 1759-1, and MSS SP-44.

4 Guidance on Anti-Corrosion Coating

An assessment for required flange protection shall be undertaken, for example in accordance with */PM/TR/45, where this is used by the Gas Transporter. Where it is determined that zinc alloy electroplated bolts are the most suitable method of protection, stud bolts manufactured in accordance with Part 1 of this specification should be zinc alloy electroplated. Any requirements for alternative coatings or uncoated stud bolts shall be justified and proven by design. Alternative coatings shall be managed through the deviation process specified in */PM/GR/2.

Electroplating shall be applied in accordance with Part 1 Section D of this specification.

5 Components

5.1 Stud Bolts

5.1.1 Stud bolts shall be to ASTM A320/A320M, Grade L7, threaded full length. Stud bolts to ASTM A193, Grade B7, may be used by agreement, as long as supplementary impact testing is performed (50 J minimum average and 35 J minimum individual values when tested at room temperature).

5.1.2 The purchase order shall state the quantity required together with the stud bolt length and diameter.

5.1.3 In the case of components formed individually, heat-treated and machined, the test certification shall include the original certificate supplied by the steel making mill.

5.1.4 Uncoated stud bolts should be protected by a suitable corrosion inhibitor, which shall be readily removable prior to use.

5.1.5 For flanged joints, the lengths of stud bolts given in Table 3, 4 and 5 do not include the chamfer at each end of the stud bolt. The stud bolt length allows for the use of nuts to Table 10 of ASME B18.2.2 ‘Heavy Hex Series’ and for washers in Table 1 of this document.

5.1.6 The lengths of stud bolts are applicable to flanges to BS EN 1759-1 and MSS SP-44, the obsolete standard BS 1560 and the current ASME B16.5 standard. They are not appropriate to flanges to the obsolete standard BS 3293.

5.1.7 Where blind flanges are to be used, it should be noted that the flange thickness may be thicker than that required for a weld-neck flange. This subsequently requires stud bolts of additional length when fitting a blind flange. As guidance, Designers, Technicians and Purchasers are directed to the flange size tables contained within MSS-SP-44. The tables identify the difference in thicknesses between a weld neck flange and a blind flange and will aid with sourcing stud bolts of the correct length.

5.1.8 The lengths of stud bolts for applications other than flanged joints shall be specified by the Purchaser.

5.1.9 In any single instance, only matching stud bolts and nuts shall be used.

5.2 Nuts

5.2.1 Nuts shall be to ASTM A194/A194M, Inch Heavy Hex Series, Grade 7 and dimensionally in accordance with Table 10 of ASME B18.2.2.

5.2.2 Two nuts per stud bolt shall be used.

5.2.3 Test certificates shall be provided for nuts and shall include original test certificates to confirm manufacture from impact tested materials. Additional requirements to ASTM A194 clause S5.1 is at the discretion of the Purchaser.

5.2.4 Uncoated nuts shall be protected by a suitable corrosion inhibitor, which shall be readily removable prior to use.

5.3 Washers

5.3.1 Two washers per stud bolt shall be used unless stated otherwise.

5.3.2 Uncoated washers shall be protected by a suitable corrosion inhibitor, which shall be readily removable prior to use.

5.3.3 Washers shall be bright mild steel and shall be chamfered 30°. Material, finish and coating shall be in accordance with ASTM F436 or BS 3410.

5.3.4 All washer dimensions shall be to BS 3410 Table 3 (heavy gauge). Washers of 1⅝, 1⅞, 2½ and 2¾ inch nominal size are not covered by BS 3410 and shall be to Table 1 below.

Table 1: Washer Dimensions (inches)

Nominal Size	Outside Diameter		Inside Diameter		Thickness
	Maximum	Minimum	Maximum	Minimum	
1 5/8	3.125	3.095	1.656	1.651	0.212
1 7/8	3.500	3.470	1.906	1.901	0.212
2 ½	4.500	4.095	2.531	2.526	0.250
2 ¾	5.100	4.950	2.810	2.780	0.312

5.4 Gaskets

This section gives the requirements for selecting gasket types. Appendix A gives guidance on the storage, handling and installation of gaskets.

5.4.1 Compressed Fibre Gaskets

a. CNAF gaskets shall be manufactured in accordance with BS 7531 Grade Y.

b. Compressed fibre gaskets shall be 1.5 mm thick. The purchase order shall state the quantity required together with the corresponding flange nominal size and Class rating in accordance with:

1. BS EN 1759-1 if 15 mm to 250 mm inclusive nominal size

2. MSS SP-44 if equal to or greater than 300 mm nominal size

If CAF gaskets are found on the Gas Transporter network, they shall be replaced with an equivalent non-asbestos compressed fibre gasket as per 5.4.1 a) and b) above.

Note: Asbestos and asbestos products were banned in the UK in November 1999 including CAF jointing materials which have been historically used on gas installations.

5.4.2 Spiral Wound Gaskets

a. Spiral wound gaskets up to and including 250 mm nominal diameter shall either be in accordance with BS EN 12560 or ASME B16.20. For sizes greater than 300 mm nominal diameter, ASME B16.20 gaskets shall be used.

b. A carbon steel inner ring, corrosion protected to the supplier's standard procedure, shall be required unless stated by the Purchaser.

c. The purchase order shall state the quantity required together with the corresponding flange nominal size and Class rating in accordance with;

    1) BS EN 1759-1 if 15 mm to 250 mm inclusive nominal size.

    2) MSS SP-44 if equal to or greater than 300 mm nominal size.

d. The inner ring internal diameter shall also be stated on the purchase order.

e. These diameters shall be used for all pipe to sizes specified in */SP/DAT/6 and when so used shall not obstruct the pipe bore. The diameters may be increased to suit commercially available gasket diameters.

f. For guidance on inner ring internal diameters and ring groove numbers, see Table 2.

5.4.3 Ring Joint Gaskets

There are two main shapes of ring joint (RTJ) gaskets, **oval** and **octagonal**. The dimensions of the rings are standardised to the tolerances of the RTJ groove on the flange. The cross-section of the octagonal ring has a higher sealing efficiency than an oval type ring and the octagonal ring is the preferred option.

Although the majority of RTJ flanges installed on the Gas Transporter network are manufactured with an octagonal groove, there remains the likelihood that some flanges were manufactured with an oval shaped groove. The main difference will be observed at the bottom of the groove on the flange, this will either be rounded (oval groove) or flat (octagonal groove).

The following shall be applied when fitting ring joint gaskets;

For RTJ flanges with an octagonal groove only octagonal section gaskets shall be used.

For RTJ flanges with an oval groove only oval section gaskets shall be used.

a. Ring joint gaskets shall be manufactured in accordance with ASME B16.20 from soft iron. Octagonal cross-section rings shall be used except for RTJ flanges with an oval groove.

b. The purchase order shall state the quantity required together with the corresponding flange nominal size and Class designation in accordance with;

    1. BS EN 1759-1 if 15 to 250 mm inclusive nominal size.

    2. MSS SP-44 if equal to or greater than 300 mm nominal size.

c. The ring groove number shall also be stated on the purchase order.

d. For guidance on ring groove numbers, see Table 3, 4 and 5.

For 1050 mm and 1200 mm nominal size flanges, in pressure-temperature Classes 300 and 600, no RTJ ring groove number is specified because the applicable flange standards do not specify RTJ flanges in these sizes and ratings. In these cases, the flange Manufacturer shall provide, and the purchase order shall include, the following ring groove data:

i. Pitch diameter.

ii. Depth of groove.

iii. Width of groove.

For 15 mm to 20 mm and 750 mm to 1200 mm nominal size flanges in pressure-temperature Class 150, no RTJ stud bolt length or ring groove number is specified because the applicable flange standards do not specify RTJ flanges in these sizes at this rating.

Table 2: Internal Diameters for Inner Rings

Nominal Size of Pipe (mm)	Minimum Internal Diameter of Gasket Inner Ring (mm)
15	14.3
20	19.9
25	25.0
40	39.4
50	50.6
80	79.3
100	105.9
150	158.6
200	208.0
250	261.9
300	311.3
400	391.1
450	440.5
500	491.5
600	591.5
750	739.4
900	890.3
1050	1040.0
1200	1193.0

Table 3: Stud Bolt Data and Ring Groove Number (Class 150)

Flange Nominal Size		Number of Bolts	Stud bolt Diameter in.	Stud bolt Length		Ring Groove Number
mm	in.			RF in.	RTJ in.	
15	1/2	4	1/2	2 1/2	*	*
20	3/4	4	1/2	2 3/4	*	*
25	1	4	1/2	2 3/4	3 1/4	R 15
40	1 1/2	4	1/2	3	3 1/2	R 19
50	2	4	5/8	3 1/2	4	R 22
80	3	4	5/8	3 3/4	4 1/4	R 29
100	4	8	5/8	3 3/4	4 1/4	R 36
150	6	8	3/4	4 1/4	4 1/2	R 43
200	8	8	3/4	4 1/4	5	R 48
250	10	12	7/8	5	5	R 52
300	12	12	7/8	5	5 3/4	R 56
400	16	16	1	5 3/4	6 1/4	R 64
450	18	16	1 1/8	6 1/4	7	R 68
500	20	20	1 1/8	6 1/2	7 1/4	R 72
600	24	20	1 1/4	7 1/4	7 3/4	R 76
750	30	28	1 1/4	9 1/4	*	*
900	36	32	1 1/2	11	*	*
1050	42	36	1 1/2	11 1/2	*	*
1200	48	44	1 1/2	12 1/2	*	*

*Applicable flange standards do not specify RTJ flanges in these sizes at this rating See Clause 5.4.3.d.

Table 4: Stud Bolt Data and Ring Groove Number (Class 300)

Flange Nominal Size		Number of Bolts	Stud bolt Diameter in.	Stud bolt Length		Ring Groove Number
mm	in.			RF in.	RTJ in.	
15	1/2	4	1/2	2 3/4	3 1/4	R11
20	3/4	4	5/8	3 1/4	3 3/4	R13
25	1	4	5/8	3 1/4	3 3/4	R16
40	1 1/2	4	3/4	4	4 1/2	R20
50	2	8	5/8	3 3/4	4 1/2	R23
80	3	8	3/4	4 1/2	5 1/4	R31
100	4	8	3/4	4 3/4	5 1/2	R37
150	6	12	3/4	5	5 3/4	R45
200	8	12	7/8	5 3/4	6 1/2	R49
250	10	16	1	6 1/2	7 1/4	R53
300	12	16	1 1/8	7	7 3/4	R57
400	16	20	1 1/4	7 3/4	8 1/2	R65
450	18	24	1 1/4	8	8 3/4	R69
500	20	24	1 1/4	8 1/2	9 1/4	R73
600	24	24	1 1/2	9 1/2	10 1/2	R77
750	30	28	1 3/4	11 3/4	12 3/4	R95
900	36	32	2	13 1/4	14 1/2	R98
1050	42	32	1 5/8	13 3/4	15 1/2	*
1200	48	32	1 7/8	15 1/2	17	*

*No applicable standard designation. See Clause 5.4.3.d.

Table 5: Stud Bolt Data and Ring Groove Number (Class 600)

Flange Nominal Size		Number of Bolts	Stud bolt Diameter in.	Stud bolt Length		Ring Groove Number
mm	in.			RF in.	RTJ in.	
15	1/2	4	1/2	3 1/4	3 1/4	R11
20	3/4	4	5/8	3 3/4	3 3/4	R13
25	1	4	5/8	3 3/4	3 3/4	R16
40	1 ½	4	3/4	4 1/2	4 1/2	R20
50	2	8	5/8	4 1/2	4 3/4	R23
80	3	8	3/4	5 1/4	5 1/2	R31
100	4	8	7/8	6	6 1/4	R37
150	6	12	1	7	7 1/4	R45
200	8	12	1 1/8	8	8 1/4	R49
250	10	16	1 1/4	8 3/4	9	R53
300	12	20	1 1/4	9	9 1/4	R57
400	16	20	1 1/2	10 1/4	10 1/2	R65
450	18	20	1 5/8	11 1/4	11 1/2	R69
500	20	24	1 5/8	11 3/4	12	R73
600	24	24	1 7/8	13 1/4	14	R77
750	30	28	2	14 1/2	15 1/4	R95
900	36	28	2 1/2	16 1/4	17	R98
1050	42	28	2 1/2	19 3/4	21	*
1200	48	32	2 3/4	22 1/2	23 1/2	*

*No applicable standard designation. See Clause 5.4.3.d.

5.5 Data Sheet

A data sheet covering the Purchaser's required order information for the above components is provided in Appendix D, D.1.

6 Quality Assurance

6.1 General

None of the processes of a GIS/E55 approval issued to a Manufacturer by the Gas Transporter may be subcontracted to a third party without authorisation from the Gas Transporter.

6.2 Sample Testing

In order to attain, or retain, confidence in the supply chain for goods supplied to the Gas Transporter, the Manufacturer shall carry out sample testing on raw materials and finished products.

The level and quantity of samples tested is at the Manufacturer's discretion but shall be sufficient to justify the material supply chain used and verify compliance to the relevant material and product specifications.

Full lot traceability records, stating the heat numbers tested, shall be maintained by the Manufacturer and made available to the Gas Transporter when requested.

6.3 Minimum Document Requirements

Each delivery of stud bolts shall be accompanied by the following documents and certificates;

a. Stud bolt Manufacturer's Certificate of Conformity to include itemised listings by heat number.

b. Original Manufacturer's certificates as follows;

   I. Stud bolt by Heat Number - material (mill) certificates as per BS EN 10204, minimum of 3.1 certification.

   II. Nuts by batch number – to include material test certificates confirming manufacture from impact tested materials.

   III. Washers by batch number – Certificate of Conformity to ASTM F436.

   IV. Gaskets – Manufacturers Certificate of Conformity.

   V. Coatings – Coating applicator's Certificate of Conformity.

Failure to provide the required documentation listed within this specification shall be grounds for rejection of the delivered items.

6.4 Visual Inspection

Whilst it is accepted that some surface breaking defects and material discontinuities are permissible under specifications such as ASTM F812, GIS/E55 manufacturers are to visually inspect stud bolts, nuts and washers prior to delivery and remove any that display a surface breaking indication or discontinuity. Any component received showing such indications will be rejected.

6.5 Data Sheet

A data sheet covering the required receipt information for the above components is supplied in Appendix D, D.3.

SECTION B - DESIGNATION AND IDENTIFICATION OF METRIC AND IMPERIAL BOLTING

Introduction

Three screw thread systems are currently in use for general purpose fasteners and bolting, namely ISO Unified, ISO metric and Whitworth.

With the move to the metric system in 1965 it was decided that the use of parallel screw threads of the Whitworth form, used for general fastening purposes, should be declared obsolete. The recommendation was made that ISO metric and ISO unified threads only should be used, but that ISO unified should be generally regarded as second choice. However, unified (inch series) bolting is preferred for Class designated flanges.

It is likely that the transition period to the sole use of ISO metric bolting will continue for some years to come. During this period, the use of all three systems of bolting will continue, particularly for maintenance purposes in the case of Whitworth bolting.

This section gives details of the designation and identification of bolting using the three screw thread systems.

Information of the designation and selection of pipe threads is given separately in Part 3 of this specification.

7 System Thread System

7.1 Systems in Use

Thread systems in use on the Gas Transporter network are presented in Table 6. Guidance on the interchangeability of threaded fasteners using metric or imperial thread systems is given in Appendix B.

Table 6: Thread Systems

System	Standard for Screw Threads	Standards for Hexagonal Bolts, Screws and Nuts
Whitworth (Obsolete)	BS 84 (Current)	BS 916-Black (Obsolescent) BS 1083-Precision (Becoming Obsolete)
ISO Unified (Imperial sizes i.e. inch series)	BS 1580 Part 1 (Current)	BS 1768-Precision-normal series (Current) BS 1769-Black: Heavy Series (Current)
ISO Metric	BS 3643 Parts 1,2 & 3 (Current)	BS 3692-Precision (Current) BS 4190-Black (Current)

ASTM A320/A320M and ASTM A194/A194M specifies stud bolts and nuts for pressure purposes in both ISO Unified and ISO Metric thread forms.

7.2 Whitworth Thread Form

The Whitworth thread form has a 55° included angle with rounded root and crest.

The Whitworth thread form is used both for bolting and for the British standard pipe thread. However, although the pipe thread (BS 21 now BS EN 10226 series) has been adopted as an international standard (ISO 7-1), the use of Whitworth threads for bolting was declared obsolete in 1965 and should be discontinued.

7.3 ISO Unified and ISO Metric

The ISO unified and ISO metric thread forms both have a 60° included angle with a flat crest, the root being rounded in the bolt and flat in the nut.

8 Designation of Screw Threads

8.1 Whitworth

Whitworth bolting is normally specified in two series:

a. A coarse thread series, BSW.

b. A fine thread series, BSF.

Designation is in terms of the nominal size in inches, e.g. ½ in BSW, ½ in BSF.

8.2 ISO Unified

ISO unified bolting is specified in four categories:

a. A coarse thread series, UNC.

b. A fine thread series, UNF.

c. An extra fine thread series, UNEF.

d. A number of constant pitch series, UN.

UNF and UNEF are not recommended above 1-inch diameter. UNF is a finer thread than BSF and is used only on precision bolts. UNEF is used only in special applications.

Designation is in terms of the nominal size in inches, and, in the case of the constant pitch series, the number of threads per inch e.g. ½ in UNC, ½ in UNF, 1 ¼ in x 8 UN.

For flanges to BS EN 1759-1 and BS 3293 stud bolts larger than 1-inch diameter uses the 8 UN constant pitch series, below 1-inch diameter UNC is used.

8.3 ISO Metric

ISO metric bolting is specified in two categories:

a. A coarse series.

b. A number of fine series with constant pitches.

Designation is by means of the letter M followed by the nominal diameter and the pitch, both in millimetres, e.g. M6 x 0.75.

The absence of an indication of pitch means that a coarse thread is specified, e.g. a coarse thread M6 x 1 may be designated M6.

9 Identification

A summary of identification markings is presented in Table 7.

9.1 Whitworth

Whitworth bolts and nuts to BS 916 and BS 1083 were not required to carry any identification marking for the screw thread type.

9.2 ISO Unified

Unified precision hexagon bolts and nuts are identified by means of a circular groove or recess in the top of the hexagon head or a line of indented circles on one of the hexagon flats.

Unified black hexagon bolts are identified by means of a circular recess in the top of the hexagon head. There is no marking for black nuts.

9.3 ISO Metric

Precision ISO metric hexagon bolts are identified by the letters ISOM or M indented or embossed on the top of the head or by the letter M indented or rolled into one of the hexagon flats. Nuts are marked with the letter M on the flats only.

Black metric bolts are identified as for precision bolts. Marking of black nuts is optional, but where used is as for precision nuts.

9.4 Stud Bolts to ASTM A320/A320M

ASTM A320/A320M requires one end of the stud bolt to be marked with the strength grade and Manufacturer's identification symbols. If the available area is inadequate, the grade symbol may be marked on one end and the Manufacturer's identification symbol marked on the other end.

In addition to the product marking requirements above, the Manufacturer shall apply an alpha/numerical code to each individual stud bolt to identify the original material Heat number. The code is also to be annotated on the supplied original material certificate.

The strength grade includes the letter M for ISO metric and thus will also indicate the thread form e.g. L7 or 7 is ISO unified, L7M or 7M is ISO metric 6.5.

9.5 Nuts to ASTM A194/A194M

ASTM A194/A194 requires one end face or one flat of the nut to be marked with the strength grade and Manufacturer's identification symbols.

Nuts manufactured from materials that have been impact tested shall he marked with the letter "L." This to be marked immediately following the grade, e.g. 7L.

Table 7: Summary of Identification Markings

	Whitworth		ISO Unified		ISO Metric	
	Black	**Precision**	**Black**	**Precision**	**Black**	**Precision**
Identification of thread form	None	None	Bolts - Recess in the head (see Figure 3) Nuts - None	Bolts and Nuts - Groove or recess in head or indented circles on flats (see Figure 3)	Bolts - As precision bolts Nuts - As precision nuts (optional)	Bolts and Nuts - M or ISOM on head or M continuous on flats (see Figure 4)
Identification of strength grade	None	Grade letter or number for high strength grades only.	None	Grade letter or number for high strength grades only	None	Grade number for bolts and nuts or “clock face” system for nuts only (see Figure 4) for high strength grades only.
Identification of spanners and wrenches	Nominal diameter of bolt as a as a fraction in inches followed by the letters BS. Additionally, at the makers option the nominal bolt size corresponding to the obsolete large hexagon, followed by the letter W		The fractional sizes across the flats in inches followed by AP. The decimal equivalent of the fractional size may also be given		The nominal size across the flats in mm.	

10 Strength Grades

10.1 Whitworth

Black bolts and nuts to BS 916 are in one strength grade having a tensile strength of 401 N/mm^2 to 432 N/mm^2 and carry no grade marking.

Precision bolts to BS 1083 are supplied in seven strength grades (A, B, P, R, T, V, X) ranging from 432 N/mm^2 to 1158 N/mm2 tensile strength. For all grades other than A and B, the grade letter is marked on the head.

Precision nuts to BS 1083 are supplied in four strength grades (A, P, R, T) ranging from 432 N/mm^2 to 849 N/mm^2 tensile strength. For all grades other than A, the grade letter is marked on one hexagon flat.

10.2 ISO Unified and ISO Metric

Black bolts to BS 4190 are supplied in strength grades, designated 4.6, 4.8, 6.8, 8.8 and 10.9. The first figure represents one tenth of the tensile strength in MPa, the second figure is one tenth of the ratio between yield stress, and tensile strength, e.g. 40 MPa tensile, yield 60% of tensile, strength grade 4.6.

Black nuts are supplied in strength grades 4, 6, 8, 10 and 12, where the grade figure is one tenth of the minimum tensile strength of the highest grade of bolt for which the nut is recommended to be used. Black bolts and nuts do not carry any strength grade marking.

The strength grade designation for precision bolts and nuts to BS 3692 is similar to that for BS 4190. Ten strength grades of bolts, 4.6 to 14.9, are supplied, and six grades of nuts, 4 to 14.

Precision bolts of grade 8.8 and higher and nuts of grade 8 and higher in sizes 6 mm diameter and larger are required to carry the grade designation numbers on the top of the hexagon head or on one face or one hexagon flat of the nut. Alternatively, for nuts the 'clock face' system may be used.

10.3 Stud Bolts to ASTM A320/A320M

Stud bolts to ASTM A320/A320M are supplied in numerous strength grades in materials ranging from carbon to alloy steels and stainless steel. All materials other than mild steel have alpha/numerical grade designations, e.g. L7 or L7M and this designation appears on one end of the stud bolt.

10.4 Nuts to ASTM A194/A194M

Nuts to ASTM A194/A194M are supplied in numerous strength grades in materials ranging from carbon to alloy steels and stainless steel. All materials other than mild steel have Numerical and/or Alpha Grade designations, e.g. 7, 7L or 7LM and this designation appears on one face or one flat of the nut.

11 Designation of Spanners (Open Ended Wrenches)

Open-ended wrenches are specified in BS 192 Parts 1 and 2. A summary of Spanner markings is presented in Table 7.

There is no inter-changeability between spanners designed to suit Whitworth, ISO unified and ISO metric hexagon bolting.

11.2 Whitworth

Whitworth spanners and wrenches are designated by the nominal diameter of the bolt, expressed as a fraction in inches, followed by the letters BS.

At the option of the Manufacturer, the bolt size corresponding to the now obsolete large hexagon size may also be given, followed by the letter W.

11.3 ISO Unified

The fractional size of the across flats dimension in inches is given, followed by the sign A/F. The decimal equivalent of the fractional size may also be given.

11.4 ISO Metric

The nominal dimension across the flats in millimetres is given followed by the letters mm.

12 Safety

12.1 General

Care shall be taken to avoid mismatch between threaded fasteners in the different thread systems. Details of possible mismatch are given in Appendix B.

12.2 Eyebolts

The specific problem regarding the possibility of mismatch when using eyebolts is covered in the Health and Safety Executive Guidance Note PM/16 - 'Eyebolts'. Three specific designs are covered in BS 4278. The "Eyebolt with Link" is capable of withstanding greater side loads.

SECTION C – RECOMMENDED BOLTING PROCEDURE FOR LOW ALLOY STEEL STUD BOLTS USED ON CLASS DESIGNATED JOINTS

Introduction

This section recommends the bolting procedure to be adopted for joints with flanges to **/SP/F/1, BS EN 1759-1, MSS SP-44 or BS 3293. Recommended torque values are given for low alloy steel Grade L7 stud bolts to ASTM A320/A320M and Grade 7 nuts to ASTM A194/A194M.

This bolting procedure does not include the process of removing or replacing bolts on live (pressurised) flange joints, known as hot bolting.

13 Examination and Preparation of Bolts

13.1 It is recommended that the actions specified in 13.2 to 13.4 should be carried out immediately prior to assembly.

13.2 Each stud bolt, nut and washer should be thoroughly cleaned before use.

13.3 The screw thread of each stud bolt should be checked for imperfections along its length of engagement by running the two mating nuts along it, the nuts being rotated by hand. Any stud bolt and nuts with excessively tight or slack fit should be set aside for further investigation.

13.4 The screw thread of each stud bolt and the nut bearing face should then be coated with a film of thread lubricant to facilitate tightening and easy nut removal. The lubricant should be formulated to give a constant torque/tension relationship maintainable over a number of tightening sequences. The lubricant should be Copaslip™. Bolts should not be tightened in dry metal condition.

14 Bolting Procedure

14.1 Flange faces should be thoroughly cleaned and inspected. Surface marks extending across the joint face or heavy pitting are unacceptable.

14.2 The alignment of the flanges should be in accordance with the tolerance quoted in the relevant Gas Transporter pipework standards e.g. */SP/PW/6 or */SP/PW/11. The flanges and adjacent pipework should be visually inspected in accordance with */SP/VS/02.

14.3 The gasket or sealing ring should be inspected immediately prior to use.

14.4 For larger raised face flanges, three stud bolts should first be inserted to centralise the gasket. After insertion of all remaining stud bolts, the nuts should be fitted finger tight, checking that there is an equal protrusion of stud bolt through each nut.

14.5 Stud bolt tightening should be carried out in stages to a predetermined sequence. Acceptable tightening sequences are shown in Figure 1. The sequences shown in Figure 2 should be used until any flange misalignment is taken up.

14.6 Throughout the stud bolt tightening sequence, frequent checks should be made to ensure parallel 'pull-up' of the flanges.

14.7 Tightening shall be carried out by using a calibrated torque wrench. Torque values are shown in Table 8. Torque wrenches should be calibrated regularly (as a minimum every 12 months or 5000 cycles), and calibration records kept with the wrench. The designer shall specify the torque settings appropriate to each size and type of flange on the site-specific */PM/G/17, */PM/G/35, */PM/PS/5 or GL/5.

The stages of tightening shall be as follows:

1. Hand tighten,
2. Tighten to 20% to 30% of minimum torque,
3. Tighten to 50% to 70% of minimum torque,
4. Tighten to 100% of minimum torque,
5. Continue tightening at 100% of minimum torque in a circular pattern (see Figure 1) until no nut movement,
6. Wait for short-term creep relaxation (typically 4 hours) and repeat step 5.

14.8 After final assembly of the flanges, there should be a minimum of two threads protruding beyond each nut face after final tightening. The screw threads protruding beyond the nut faces should be protected against corrosion. The use of flange protectors should also be considered.

14.9 On completion of bolting activities, a joint completion certificate (See Appendix C, C.1) shall be populated and retained as part of records completion.

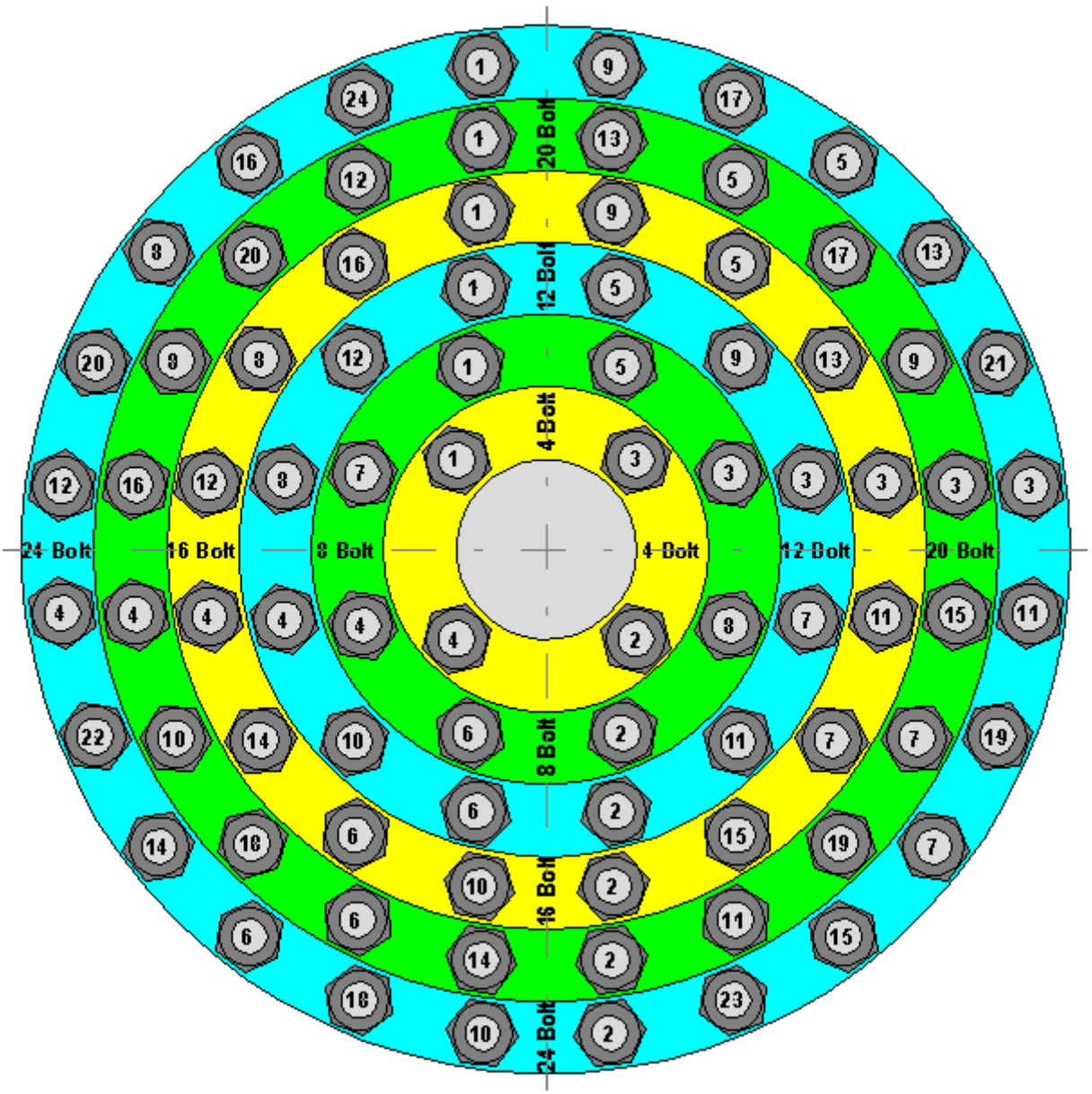


Figure 1: Typical Bolt Tightening Sequence (1)

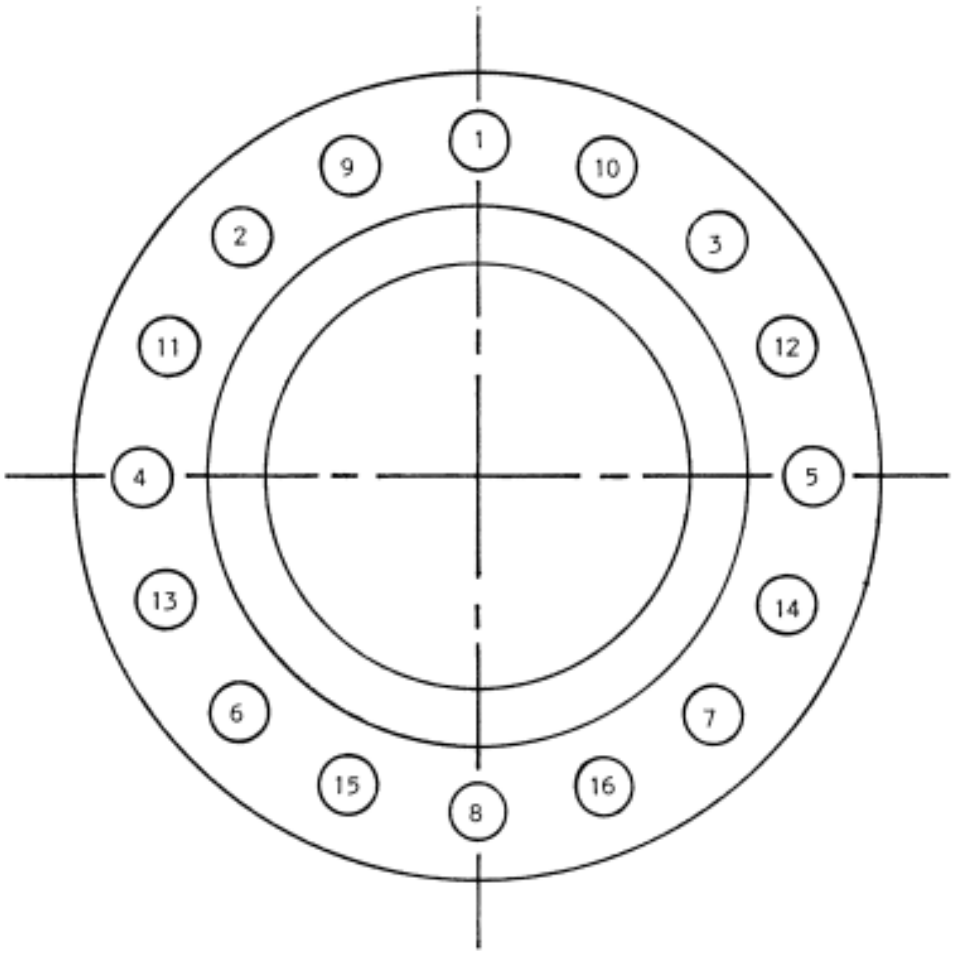


Figure 2: Typical Bolt Tightening Sequence (2)

A tightening sequence similar to that shown above is recommended for use until any angular misalignment is taken up. When flange faces are parallel, the tightening sequence shown in Figure 1 should be used.

Table 8: Bolting Torques for Class 150 to 600 Flanges

Bolt Diameter (inch)[6]	Recommended Minimum Torque[1] [2] [3] Nm	Maximum Permitted Torque[4] [5] Nm
1/2	65	90
5/8	130	180
3/4	230	315
7/8	370	515
1	560	770
1 1/8	810	1150
1 1/4	1135	1625
1 1/2	2030	2925
1 5/8	2620	3805
1 3/4	3295	4785
1 7/8	4105	5960
2	5020	7325
2 1/2	10050	13860
2 3/4	13495	18680

NOTES:

[1] The recommended minimum torque figures given above are considered to be sufficient for normal purposes and take into account permitted misalignment between flanges.

[2] If necessary a torque greater than the recommended minimum may be used but the maximum permitted torque should not be exceeded.

[3] The recommended minimum torque is based upon an axial bolt stress of 275 N/mm^2.

[4] The maximum permitted torque is based upon a combined stress at 2/3 yield for the bolt material, taking account of torsional stress in accordance with Appendix B of BS 3580.

[5] The maximum permitted torques tabulated are for bolts lubricated to a friction coefficient of 0.16. They are applicable to lubricants with friction factors in the range of 0.12 to 0.20. They are not appropriate to dry steel with substantially higher friction (0.44) or specialised lubricants (e.g. molybdenum disulphide) with substantially lower (0.10) or variable friction characteristics.

[6] Bolts up to 2" size have an assumed minimum specified yield strength of 730 N/mm^2 (BS EN 1515, 42 CrMo4, similar to ASTM A320/A320M, L7). Bolts of 2 ½" and 2 ¾" size have a lower assumed SMYS of 700 N/mm^2 (BS EN 1515, 42CrMo5-6) so maximum permitted torque is reduced accordingly.

SECTION D - ZINC ALLOY ELECTROPLATING OF BOLTING FOR ENHANCED CORROSION PROTECTION

Introduction

This section specifies the application requirements for an electroplated Zinc alloy coating to be applied to threaded fasteners. It may also be used for the coating of other Carbon and Alloy Steel components where a higher level of corrosion protection is beneficial. It is the responsibility of the Purchaser to ensure that coating requirements for components other than fasteners are detailed to the electroplater on an individual basis.

Zinc alloy electroplating shall be performed in accordance with BS ISO 15726 and the additional requirements of this section.

15 Information for the Electroplating Supplier

15.1 Mandatory Information

15.1.1 Unless otherwise specified by the Purchaser, the Class and Grade of the coating required shall be ZnNi (12-16)10A – a Zinc/Nickel electroplated coating with 12-16% nickel to a thickness of 10 microns and a clear or transparent conversion coating.

15.1.2 Total coverage is required, unless otherwise specified by the Purchaser.

15.1.3 The only acceptable conversion coatings to be applied to items supplied to the Gas Transporter under this specification are trivalent chromium or, if specified, chromium free coatings in accordance with ISO 4520. Hexavalent chromate coatings shall not be used.

15.2 Additional Information

Any additional information required by the electroplater shall be supplied in accordance with BS ISO 15726.

16 Preparation for Processing

16.1 Surface Condition

The surface of the base metal shall be free of all defects such as pits, pores, inclusions, tool marks or other similar defects that will affect the coating or treatment properties. The plating applicator shall notify the Purchaser before processing when defects are found.

16.2 Cleaning, Surface Preparation and Masking

All surfaces shall be free from soils, such as soap, drawing compounds, oil, grease etc., discoloration, oxide, scale or other foreign matter. The parts shall have clean surfaces free of water break before immersion into the plating solution.

Materials, which require partial coverage, shall be masked.

The vendor has the option to dry or wet abrasive blast the production parts, but this shall be agreed with the Purchaser. Blasting is allowed as long as the surface texture or the quality of the part is not changed.

16.3 Heat Treatment Requirements

The GIS/E55 stud bolt Manufacturer shall assess the original material certification for individual batches of stud bolts, by heat number, to note the recorded tensile strength and hardness.

If the recorded tensile strength value is equal to, or, greater than 1000 MPa (equivalent to 31 HRC hardness), to mitigate the risk of process-induced stress or embrittlement, the stud bolts shall be treated in accordance with BS ISO 9587 and ASTM B849 Class SR-6 (pre) and BS ISO 9588 / ASTM B850 Class ER9 (post). This requirement shall be agreed with the Purchaser prior to processing.

The pre-heat treatment, if required, shall be carried out before commencement of any preparation of cleaning treatment using aqueous solutions, and before any treatment liable to cause embrittlement.

17 Quality Requirements

17.1 Sampling

In order to attain, or retain, confidence in goods supplied, the electroplater shall produce a sampling plan and carry out sample testing on purchase orders placed as per the requirements of Tables 1, 2, and 3 of ISO 4519.

The level and quantity of samples tested shall be agreed by the Purchaser but shall be sufficient to verify compliance to the relevant product specifications.

17.2 Visual Inspection

All coated surfaces of the finished parts shall be visually inspected by the vendor. The coated surfaces shall be free of detrimental defects such as burns, pores, non-uniform deposit thickness, pits, exfoliation and blisters. The results of the visual examination (i.e. pass/fail) shall be reported on the Certified Test Report.

17.3 Thickness Measurement, Adhesion Testing, Porosity and Composition of Coating

The number of parts requiring a test shall be determined by the electroplater's sampling plan. Non-destructive tests and measurements as detailed by ISO 15726 shall be taken directly from production parts.

17.4 Neutral Salt Spray

Corrosion performance of the coating process shall be evaluated by exposure to neutral salt spray testing in accordance with ASTM B117.

The electroplater's process shall produce a coating capable of withstanding continuous exposure to neutral salt spray with no red corrosion evident after 1000 hrs. The results shall be reported on the electroplater certification.

PART 2: PN DESIGNATED APPLICATIONS, TYPICALLY OPERATING AT PRESSURES UP TO AND INCLUDING 7 BARG

Part 2 of this specification covers PN designated applications and is separated into three sections, as outlined below. Typically, PN designated joints will operate at pressures up to and including 7 barg. This section should also be used for legacy joints operating at pressures up to 7 barg, excluding Class designated applications not covered by this section.

SECTION A – BOLTING, NUTS, WASHERS AND GASKETS

Introduction

This section provides information for materials for pressure retaining joints and bolting up of PN designated carbon steel butt and filled welding flanges to GIS/F7 (Including supplement to GIS/F7) or BS EN 1092-1 operating at pressures up to and including 7 barg.

18 Bolting Requirements

18.1 Bolting shall conform to the requirements of the relevant flange standard BS EN 1092-1 (or ASME B16.47 for DN 750 and 1050 mm). Bolts, stud bolts, nuts and washers shall be to the following criteria, standards and grades, except by agreement.

18.2 Shear strength of bolting shall be consistent with the tensile strength of PN 16 flanges. Therefore, bolting should be to ‘low’ strength, as defined in BS EN 1515-2 (e.g. Grade 4.6 and equivalent). ‘Normal’ or ‘high’ strength grade bolting (e.g. Grade 6.8 and equivalent) may be provided by agreement, in which case the installer shall take due care not to over-stress and distort the flanges during assembly.

18.3 Bolting (Stud bolts, hexagonal bolts and nuts) with tested Charpy toughness is not required except where:

a. It is specified by the Purchaser at the time of order, or Certification is incomplete (see Section 19), or,

b. Chemical composition is incomplete or non-conformant (see Section 20).

18.4 Bolting dimensions shall be compatible with the flanges:

18.5 Bolting should be to the current BS EN standard. Where this is not possible, alternative ASTM or legacy BS material and dimensional standards listed in Table 9 may be used. Bolting to alternative standards or grades shall be by agreement with the Gas Transporter.

a. Hexagon bolts shall be to BS EN 1515-1 (BS EN ISO 898-1) Grade 4.6 (or Grade 6.8 by agreement), with dimensions to BS EN ISO 4016, or to ASTM 307 Grade B (by agreement), or to BS 4190 grade 4.6 or Grade 6.8 (by agreement).

b. Stud bolts, where required, shall be to BS EN 1515-1 (BS EN ISO 898-1) Grade 4.6 (or Grade 6.8 by agreement), or to ASTM A307 Grade B (by agreement) or, to BS 4882 grade B7/M or L7/M (by agreement).

c. Nuts shall be to BS EN 1515-1 (BS EN ISO 898-2) Grade 4.6 (or Grade 6.8 by agreement) with dimensions to BS EN ISO 4034, or to ASTM A563 (or ASTM A307 by agreement) Grade B or to BS 4190 Grade 4.6 (or Grade 6.8 by agreement).

d. Washers shall be to BS EN ISO 7091 Class C, or to ASTM F436, plain steel washer, BS 3410 or to BS 4320 (metric series), black or bright type.

18.6 Gaskets shall be compressed fibre or spiral wound. Compressed fibre gaskets shall be manufactured from non-asbestos material in accordance with BS 7531 Grade Y. Spiral wound gaskets shall be in accordance with BS EN 12560.

18.7 Dimensions of compressed fibre gaskets shall be in accordance with BS EN 1514-1 and spiral wound gaskets shall be in accordance with BS EN 1514-2 for bolting of PN designated flanges to BS EN 1092-1. Gaskets and rings shall be in accordance with ASME B16.20 for bolting of Class designated flanges to ASME B16.47. Filler material shall be a non-asbestos compound.

18.8 If compressed Asbestos Fibre gaskets are found on the Gas Transporter network they shall be replaced with an equivalent non-asbestos compressed fibre gasket as per 18.6.

Note: Asbestos and asbestos products were banned in the UK in November 1999 including CAF jointing materials which have been historically used on gas installations.

18.9 Guidance on the on the storage, handling and installation of gaskets is given in Appendix A.

19 Certification Requirements

19.1 For bolting, the Seller shall provide the following certification:

a. The Finisher's (bolting manufacturer / machinist) inspection certificate to BS EN 10204 Type 3.1, and, unless waivered by the Gas Transporter.

b. Steel Mill's inspection certificate for the starting bar stock from the same heat as that used to manufacture the bolting.

c. Washers by batch number – Certificate of Conformity.

d. Gaskets – Manufacturers Certificate of Conformity.

19.2 If the above certification is not available for either stud bolts / hexagon bolts or nuts, the following shall be provided / performed by the Seller:

- Evidence that all items are traceable to a known heat of steel.
- Chemical analysis from each heat to demonstrate that the requirements of Section 20.1 are met.
- Tensile and hardness testing from each heat, in accordance with the base material standard, to demonstrate that the material meets the mechanical test requirements.

20 Chemical Composition Requirements

20.1 In order to indicate fracture toughness, steel shall be fully killed, of fine grain structure, with Aluminium in the range 0.015% to 0.060% and Silicon in the range 0.10% to 0.40%. It shall have low inclusions with Sulphur not exceeding 0.020% and Phosphorus not exceeding 0.025%.

20.2 Measured notch toughness in terms of Charpy energy is not required for fully recorded and conformant values of these elements, unless specified by the Purchaser or the Gas Transporter at the time of order. In the absence of recorded and conformant values of these elements, a tested Charpy energy of 27 J (minimum average, transverse direction, full size sample at 0 °C) shall be provided in accordance with Table 10.

20.3 Charpy impact testing shall be performed in accordance with BS EN ISO 148-1 at a test temperature of 0 °C or MDT, whichever is lower.

Table 9: Applicable Bolting Standards and Grades for PN16 Flanges to BS EN 1092-1

Item	Bolting Standard						
	Type[1], [2],[3]	Preferred BS EN ISO		Alternative ASTM		Legacy BS	
		Standard	Grade[4], Series	Standard[4]	Grade, Series	Standard	Grade[4] Series
Hexagonal Bolts	P	BS EN 1515-1	4.6 [6.8]	ASTM A307	B	BS 4190	4.6 [6.8]
	M	BS EN ISO 898-1					
	D	BS EN ISO 4016	M Table 1	-	-		
Stud Bolts	P	BS EN 1515-1	4.6 [6.8]	ASTM A307	B		
	M	BS EN ISO 898-1					
	D	BS EN 1515-1	Annex A	-	-		
Nuts	P	BS EN 1515-1	4.6 [6.8]	ASTM A563 [ASTM A307]	B		
	M	BS EN ISO 898-2					
	D	BS EN ISO 4034	M Table 1		-		
Washers	P	BS EN ISO 7091	Class C	ASTM F436	Plain steel	BS 4320	Mild Steel
	M	-					
	D	-	-				Black or Bright
Gaskets	M	BS 7531	Grade Y	-	-	-	-
	D	BS EN 1514-1	-	-	-	-	-
	M	BS EN 1514-2	-	-	-	-	-
	D	BS EN 1514-2	-	-	-	-	-

NOTES:

[1] P = Primary Standard

[2] M = Material Standard

[3] D = Dimensional Standard

[4] [ ] = By Agreement

Table 10: Charpy Impact Toughness Requirements at 0 °C on finished products where Chemical Composition is Non-Conformant of Incomplete.

Minimum Charpy impact energy at 0 °C or MDT[1] KV (J)						Minimum Charpy shear area [2] (%) at 0 °C	
Full Size (10 x 10 mm)		2/3 Size (10 x 6.7 mm)		1/2 Size (10 x 5 mm)		Full or Sub-Size	
Average [3]	Individual	Average [3]	Individual	Average [3]	Individual	Average [3]	Individual
27	20	23	17	15	11	50	40

NOTES:

[1] Whichever temperature is lower

[2] Reporting of Charpy shear area may be waivered by agreement

[3] Average of 3 samples for Charpy energy and shear area

21 Data Sheets

21.1 Data sheets covering required order and receipt information for the components covered in this section are provided in Appendix D, D.2 and D.4 respectively.

SECTION B – RECOMMENDED BOLTING PROCEDURE FOR PN DESIGNATED JOINTS

This section recommends the bolting procedure to be adopted for joints with flanges to BS EN 1092-1 or ASME B16.47 (750 mm and 1050 mm nominal diameter inclusive). Recommended torque values are given for Grade 4.6 bolts and nuts to BS EN 1515-1 and BS 4190 or Grade B bolts to ASTM A307.

22 Examination and Preparation of Bolts

22.1 It is recommended that the actions specified in 22.2 to 22.4 should be carried out immediately prior to assembly.

22.2 Each bolt, nut and washer should be thoroughly cleaned before use.

22.3 The screw thread of each stud bolt should be checked for imperfections along its length of engagement by running the two mating nuts along it, the nuts being rotated by hand. Any bolt and nuts with excessively tight or slack fit should be set aside for further investigation.

22.4 The screw thread of each stud bolt and the nut bearing face should then be coated with a film of thread lubricant to facilitate tightening and easy nut removal. The lubricant should be formulated to give a constant torque/tension relationship maintainable over a number of tightening sequences. The lubricant should be Copaslip™. Bolts should not be tightened in dry metal condition.

23 Bolting Procedure

23.1 Flange faces should be thoroughly cleaned and inspected. Surface marks extending across the joint face or heavy pitting are unacceptable.

23.2 The alignment of the flanges should be in accordance with the tolerance quoted in the relevant Gas Transporter pipework standards.

23.3 The gasket or sealing ring should be inspected immediately prior to use.

23.4 For larger raised face flanges three stud bolts should first be inserted to centralise the gasket. After insertion of all remaining stud bolts the nuts should be fitted finger tight, checking that there is an equal protrusion of stud bolt through each nut.

23.5 Stud bolt tightening should be carried out in stages to a predetermined sequence. Acceptable tightening sequences are shown in Figure 3.

23.6 Throughout the stud bolt tightening sequence frequent checks should be made to ensure parallel 'pull-up' of the flanges.

23.7 Final tightening shall be carried out by using a torque wrench. Torque values for PN flanges are shown in Table 11. For Class rated flanges (NB 750 mm and 1050 mm) use the guidance given in Table 8. Where a torque value is not stated the manufacturers recommended torque value shall be used. Torque wrenches should be calibrated regularly (as a minimum every 12 months or 5000 cycles), and calibration records kept with the wrench. The designer shall specify the torque settings appropriate to each size and type of flange on the site-specific */PM/G/17, */PM/G/35, */PM/PS/5 or GL/5 documentation.

23.8 After final assembly of the flanges, there should be a minimum of two threads protruding beyond each nut face after final tightening. The screw threads protruding beyond the nut faces should be protected against corrosion. The use of flange protectors should also be considered.

23.9 On completion of bolting activities, the joint completion certificate (See Appendix C, C.2) shall be completed.

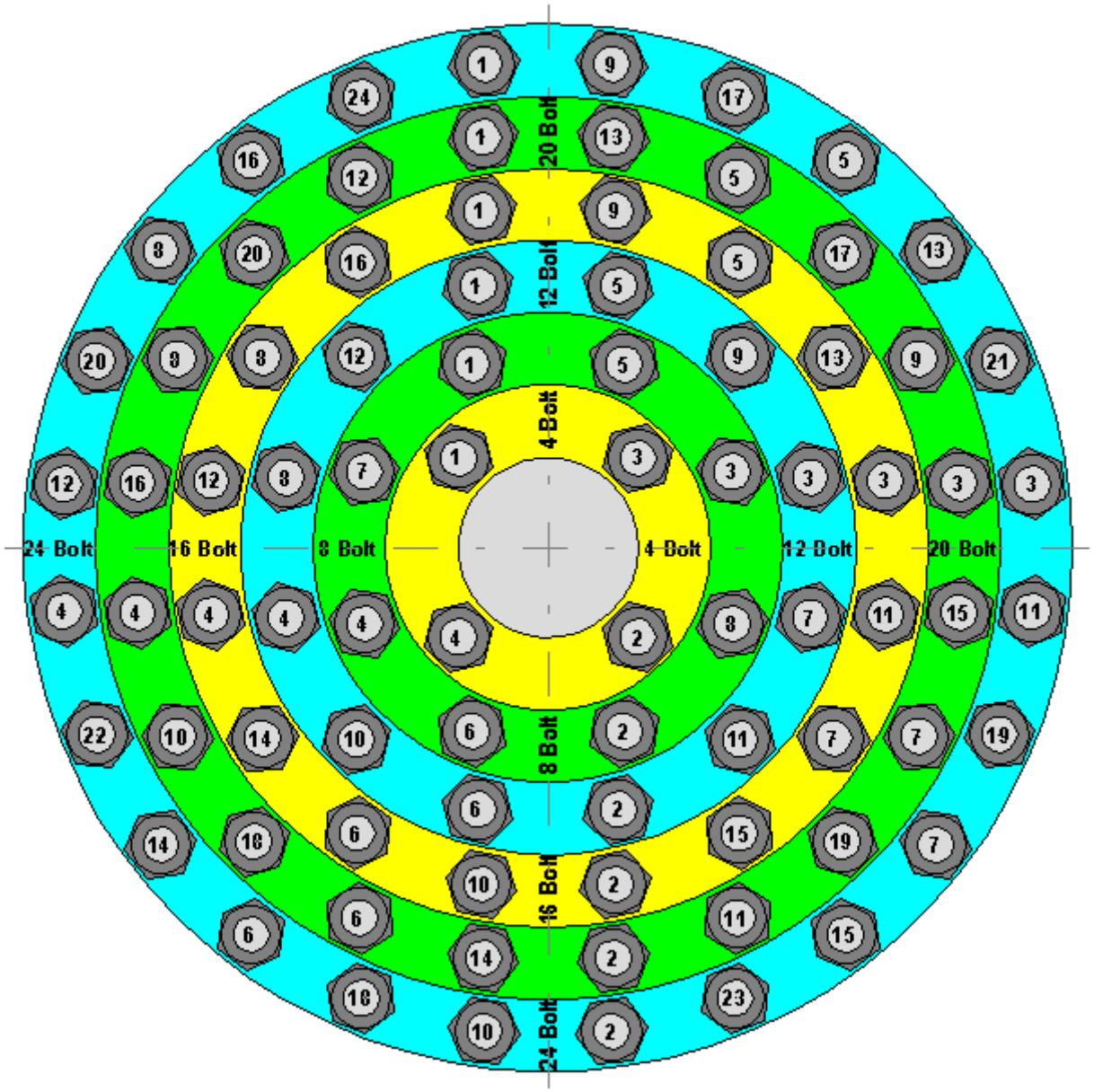


Figure 3: Typical Bolt Tightening Sequence

Table 11: Torque Table for PN16 Flanges

Flange NB (mm)	No of Bolts	Grade 4.6 - BS EN 1515-1 and BS 4190		ASTM A307 Grade B (Imperial Equivalent)	
		Bolt Diameter (mm)	Approximate Bolting Torque to Seal (Nm. (ft. lb.))	Bolt Diameter (in.)	Recommended Bolting Torque to Seal (Nm. (ft. lb.))
15	4	M12	35 (26)	1/2	43 (32)
20	4	M12	35 (26)	1/2	43 (32)
25	4	M12	35 (26)	1/2	43 (32)
32	4	M16	80 (59)	5/8	87 (64)
40	4	M16	80 (59)	5/8	87 (64)
50	4	M16	80 (59)	5/8	87 (64)
80	8	M16	80 (59)	5/8	87 (64)
100	8	M16	80 (59)	5/8	87 (64)
125	8	M16	80 (59)	5/8	87 (64)
150	8	M20	160 (118)	3/4	153 (113)
200	12	M20	160 (118)	3/4	153 (113)
250	12	M24	275 (203)	7/8	225 (166)
300	12	M24	275 (203)	7/8	225 (166)
350 - 1200	The flange supplier shall supply the bolting torque settings				

NOTES:

[1] The recommended approximate torque figures given above are considered to be sufficient for normal purposes and take into account permitted misalignment between flanges.

[2] The approximate bolting torque setting for Grade 4.6 (BS EN 1515-1 or BS 4190) bolts is generally based upon approximate 50% to 75% of their UTS.

[3] ‘Approximate’ bolting for metric BS EN 1515-1, BS 4190 bolt and ‘Sealing’ bolting torque for the imperial equivalents from ASTM A307 Grade B are both for ‘dry’ plain nuts and bolts. Bolts/nuts that are waxed, greased, galvanised or are coated by an alternative electro-plating corrosion protection system shall have different torque settings from those shown above. These alternative torque settings shall be requested from the supplier of the bolts and adequately recorded for future reference.

[4] Low carbon steel bolts, such as those specified to BS EN 1515-1, BS 4109 and ASTM A307 contain less than 0.25% carbon and cannot be straightened by heat treatment; this may only be accomplished through cold working. Bolts of this type are designed so that if inadvertently over-tightened they will shear prior to taking the flange material past yield stress.

SECTION C - SELECTION AND FITTING OF METRIC BOLTS AND NUTS IN IMPERIAL FLANGES FOR 7 BARG AND BELOW APPLICATIONS

Introduction

Imperial flanges are no longer used for new construction below and including 7 barg (formerly BS 10 now to metric BS EN 1092-1), but the existing pipe systems that incorporate them are being refitted with metric bolts and flanges as the need arises.

This section gives details of ISO Metric black bolts, which may be used as replacements for inch size BSW and Unified hexagon headed black bolts in Imperial flanges to BS 10 and BS 1560-3.1 for applications below and including 7 barg.

24 Guidance

ISO Metric black bolts to BS 4190, Grade 4.6 shall be used to replace BSW black bolts to BS 916 and Unified black bolts to BS 1769. Metric black bolts shall be selected in accordance with Table 12 and shall be fitted complete with nuts to BS 4190 Grade 4 and with washers under both the bolt head and the nut.

Table 12: Selection Table for Metric Black Bolts[1]

Bolts to BS 4190 Metric Size	Replacing bolts to BS 916 & BS 1769 Inch Size	Flange Hole Size in.	Minimum Diametrical Clearance of Metric Bolt		Remarks
			in.	mm	
M12	1/2	5/8	0.125	3.18	[2]
		9/16	0.063	1.60	[3]
M16	5/8	¾	0.093	2.36	[2]
		11/16	0.031	0.79	[3]
M20	3/4	7/8	0.055	1.40	
M22	7/8	1	0.101	2.57	
M24	1	1 1/8	0.148	3.76	
M27	1 1/8	1 ¼	0.154	3.91	
M30	1 1/4	1 3/8	0.161	4.09	
M33	1 3/8	1 ½	0.162	4.12	
M36	1 1/2	1 5/8	0.169	4.29	
M39	1 5/8	1 ¾	0.175	4.45	
M45	1 3/4	1 7/8	0.064	1.63	

NOTES:

[1] This table shall not be used for the selection of metric stud bolts.

[2] Applies to flanges drilled in accordance with BS 1560.

[3] Applies to flanges drilled in accordance with BS 10.

PART 3 - PIPE THREADS FOR PIPES AND FITTINGS

Part 3 provides guidance to avoid mismatch when selecting pipe thread systems on the Gas Transporter network.

Introduction

Two pipe thread systems are in current use for pipe threads (see clause 25 for details). To avoid mismatch, pipe threads shall be selected in accordance with the following principles.

25 Preferred Selection

25.1 To avoid mismatch, the all installations shall be designed using, wherever practicable, BSP threads in accordance with Table 13. This shall apply to both new works and major modifications.

Table 13: Preferred Selection of Pipe Threads

Application	Pressure Range (barg)	Nominal Size	Threaded Form	Remarks
Pipework	≤ 7	All sizes	BSP to BS EN 10226 Series	[1]
	>7	All sizes	BSP to BS EN 10226 Series	[2]
Pressure Gauges	All pressures	[3]	BSP to BS 2779	[3]

NOTES:

[1] For applications at pressures of 7 barg and below, BSP threads shall be specified as either taper male/taper female or taper male/parallel female.

[2] For applications at pressures above 7 barg, BSP threads shall be specified as taper male/taper female only.

[3] Pressure gauges are covered by BS EN 837-1 and */SP/INP/3. Pressure gauges as standard have a parallel BSP connection (G $^{1}/_{2}$ to BS EN ISO 228-1).

25.2 If it is found to be impractical or uneconomic to obtain proprietary equipment with connections tapped BSP, such equipment should be purchased with ANSI or API tappings (see Section 26). In all such cases, an ANSI or API to BSP adaptor, as appropriate, shall be used as first connection to the equipment. This is intended to prevent thread mismatch within an installation.

26 Non-Preferred Selection

26.1 ANSI/API pipe threads may be used for applications other than those covered by 25.2 above where, in the judgement of a responsible engineer, this is warranted by circumstances, but shall be restricted to ¼, ½, ¾ and 1 in. sizes and to pressures greater than 7 barg only, in accordance with Table 14. The requirements in 26.2, 26.3 and 26.4 shall also apply in such cases.

Table 14: Non-Preferred Selection of Pipe Threads

Application	Pressure Range (barg)	Nominal Size	Threaded Form	Remarks
Pipework	≤ 7	All sizes	Use Table 13	-
	>7	All sizes	NPT to ANSI B1.20.1 or API 5B line-pipe thread	See also sections 26.2, 26.3 and 26.4 below
Pressure Gauges	All pressures	Use Table 13		

26.2 If ¼, ½, ¾, or 1 in. sizes in ANSI/API are used, BSP ¼, ½, ¾, or 1 in. sizes should not be used in the same part of the installation.

26.3 Where both the preferred and non-preferred selection of pipe threads are used on different parts of the same installation, (e.g. major modifications to an existing site) the correct identification of thread forms is of prime importance. Suitable methods, such as the use of thread profile gauges, shall be used to enable the different thread forms to be identified. The engineer responsible for authorising the use of the alternative (non-preferred) selection of pipe threads shall also be responsible for instituting a satisfactory system both for the identification of differing thread systems and avoidance of mismatch.

27 Information on Thread Systems

27.1 The two pipe thread systems, each with its own thread form, in current use are based on the standards listed below:

British Standards, BSP (55° Thread Form)

- BS EN 10226 Series — Pipe threads where pressure-tight joints are made on the threads.
- BS EN ISO 228 Series — Specification for pipe threads where pressure-tight joints are not made on the threads.

BS 21 has been partially superseded by BS EN 10226. The standards are compatible.

ANSI and API Standards, BSP (60° Thread Form)

- ANSI B1.20.1 — Pipe threads (except Dryseal) NPT.
- ANSI B1.20.3 — Dryseal pipe threads (inch) NPTF.
- ANSI B1.20.4 — Dryseal pipe threads (metric).
- API 5B — Specification for threading, gauging and thread inspection of casing, tubing and line pipe threads.

27.2 The two thread systems, BSP and ANSI/API are not interchangeable due to their differing thread forms but, for practical purposes, screw threads to the ANSI and API standards may be considered to be mutually interchangeable.

28 Gauging Practices for Pipe Threads

28.1 General

The use BS EN 10226 pipe threads in high pressure applications in accordance with Part 3 necessitates that these pipe threads conform fully to the requirements of the standard so that satisfactory threaded joints can be made.

28.2 Thread Form

The BS 10226 pipe thread having a 55° thread angle with equally rounded root and crest. It is intended for use on pipes and fittings where pressure-tight joints are made on the threads, normally using some form of thread sealant. The external pipe thread is of taper form, having a taper of 1 in 16 on diameter or may be parallel. The internal thread is either similarly tapered or may be parallel.

28.3 Gauge System

Because direct gauging methods of the taper thread profile would require elaborate methods of inspection, taper ring or plug gauges are used for the inspection of both the taper (external and internal) and the parallel (internal) threads.

A number of gauging are used in BS EN 10226-3 namely Gauge No 1 to 6. The systems comprise of taper full form plug parallel ring gauges and a taper parallel plain gauge. The full form gauges serve to determine the position of the gauge plane - the plane at which the major cone - an imaginary conical surface, which just touches the crests of external threads or the roots of internal threads, has the gauge diameter. The plain gauge further checks the taper and the thread depth.

28.4 Length of Engagement

The principle upon which a taper thread system such as BS EN 10226 series is based is that the threaded components are screwed together until hand-tight engagement is obtained. The length of hand-tight engagement is nominally equal to the gauge length of the external thread (see Table 15). Further tightening of the joint enables a leak-tight joint to be made, making use of the wrenching allowance due to yielding of the threaded components.

29 Chamfer at Start of Thread

29.1 General

It is normal practice to provide a chamfer at the start of both internal and external threads. BS EN 10226 series states that when the chamfer does not exceed one pitch in length, it is included in the length of complete thread. However, the application of the plug or ring gauges depends upon the location of the end of the thread in relation to the face or the step of the gauge, as applicable. It is therefore important to appreciate the effect of an excessive chamfer that can lead to incorrect gauging of the threads.

29.2 Internal Threads

The position of the gauge plane is the most important feature, which determines the dimensional accuracy of a pipe thread and the resultant length of engagement in a threaded joint. For an internal thread, the theoretical location of the gauge plane is at the face of threaded component so, to satisfy BS EN 10226, the gauge plane shall lie within a plus or minus tolerance of this position. However, the presence of an excessively large chamfer will mean that the end of the thread does not coincide with the face of the component, which can lead to incorrect gauging practice. To ensure correct interpretation of the fit of the plug gauge, it is necessary to take the end of an internal thread as that position where the chamfer intersects the major cone of the thread.

29.3 External Threads

For external threads, the gauge plane shall lie at the gauge length, within a plus or minus tolerance from the small end of the thread. In this case, the end of the thread shall be taken as that position where the chamfer intersects the minor cone of the thread.

30 Tolerances and Length of Engagement

Table 15 illustrates the effect of tolerances on the length of hand tight engagement of pipe threads, expressed in terms of number of turns of thread. Because the minimum length of engagement can be as small as 2¼ turns of thread, it is important to apply correct gauging practice. Incorrect interpretation of an excessive chamfer can lead to the acceptance of threaded components, which will not permit even the minimum length of engagement indicated in Table 15.

It should be noted that Table 15 refers to hand-tight engagement. In practice, there will be some further engagement of threaded components due to the wrenching allowance. However, the design of steel fittings for high pressure use, for example, is such that there is very little yielding on wrenching up and therefore the additional engagement past the hand-tight position will be small. For this reason, it is necessary to ensure that at least the minimum length of hand-tight engagement is obtained and not reduced due to incorrect gauging practice resulting from an excessive chamfer at the start of the thread.

Similarly, the effect of a large chamfer at the start of the thread, internal or external, could lead to excessive insertion of the threaded component into a tapped hole having a counter bore. This could result in both failure to attain the correct wrenching allowance and failure to achieve a pressure-tight joint. The presence of an excessively large chamfer at the start of the thread should therefore not be permitted.

31 Recommendations

31.1 Care should be exercised in gauging pipe threads to ensure correct interpretation of the gauging procedure due to the significance of the actual position of the start of the thread.

31.2 In order to avoid the possibility of fouling between a threaded component and the bottom of a counter-bored tapped hole, the provision of a chamfer at the start of the thread (internal and external) exceeding one pitch in length should not be permitted.

Table 15: Tolerances and Length of Hand Tight Engagement

Nominal Size in.	TP1	Basic Gauge Length (Turns of Thread)	Tolerance (+/-) on Gauge Length or Position of Gauge Plane (Turns of Thread)		Length of Hand Tight Engagement (Turns of Thread)	
			External Thread	Internal Thread	Minimum	Maximum
1/2	14	4 1/2	1	1 1/4	2 1/4	6 3/4
3/4	14	5 1/4	1	1 1/4	3	7 1/2
1	11	4 1/2	1	1 1/4	2 1/4	6 3/4
1 1/2	11	5 1/2	1	1 1/4	3 1/4	7 3/4
2	11	6 7/8	1	1 1/4	4 5/8	9 1/8
2 1/2	11	7 9/16	1 1/2	1 1/2	4 9/16	10 9/6
3	11	8 15/16	1 1/2	1 1/2	5 15/16	11 15/16

Appendix A - Guidance on the Storage, Handling and Installation of Gaskets

A.1 Storage of Gaskets

A.1.1 The Manufacturer shall provide procedures and guidance for storage of their gaskets, so they are not damaged before use.

A.1.2 The Manufacturer shall provide information on shelf life.

A.1.3 The Manufacturer shall provide exposure limits of temperatures and humidity levels during transportation, handling and storage.

A.1.4 Before delivery, the Manufacturer's guidelines should be followed. As a minimum, the following best practice guideline should be followed:

A.1.4.1 During storage, gaskets should not be subjected to extreme heat or humidity – store in cool, dry place, away from direct sunlight, water, oil and chemicals.

A.1.4.2 Store sheet materials.

A.1.4.3 Avoid hanging gaskets – they may distort soft gaskets. Large diameter spiral wound gaskets should be retained on their mounting board.

A.1.4.4 Gaskets should be kept clean and free from mechanical damage (or for maximum protection, store in sealed polythene bag).

A.2 Handling of Gaskets

A.2.1 The condition of the gasket will affect its performance. Some gasket materials are relatively robust, but others may be brittle or prone to cracking.

A.2.2 The Manufacturer shall provide procedures and guidance for handling of their gaskets, so they are not damaged before use.

A.2.3 In general, before delivery, the Manufacturer should follow these procedures or at the minimum, the following best practice guidelines should be followed.

A.2.3.1 Carry gaskets carefully within some form of protective cover.

A.2.3.2 Do not bend or buckle.

A.2.3.3 Do not damage the surface.

A.2.4 For larger diameter metallic and semi metallic gaskets always transport the gasket on its mounting to the installation site.

A.3 Installation of Gaskets

A.3.1 The Manufacturer shall provide procedures and guidance for installation of their gaskets. This shall include, if any, a recommended list of lubrication materials for 'special' gaskets. This shall also include the bolting stress and friction factor to be used.

A.3.2 100% visual inspection shall be carried out prior to installation.

A.3.3 Do not install gaskets show any signs of damage such as dents, tears and distortion.

A.3.4 Do not install any used gaskets.

Appendix B - Interchangeability of Threaded Fasteners using Metric or Imperial Thread Systems other than Pipe Threads

Introduction

The purpose of this section is to draw the attention of users to the possibilities of mismatch between different thread systems and to the risks involved, with particular reference to general purpose set screws, bolts, studs, eye bolts, nuts and tapped holes.

It should be noted that this section is concerned with general purpose threaded fasteners only and not with pipe threads

In any screw thread system, it is desirable that for a given size, the male and female threads of that particular size only should be able to screw together. Unfortunately, this condition is not realised with some thread systems and since many different thread systems are in use for fasteners, the possibilities of partial interchangeability and opportunities for mismatching are multiplied.

An in-depth survey of possible mismatching between different systems and sizes up to 1 in size general purpose connections has been made by member companies of EEMUA. Figure 4 derives from the survey and shows possible combinations of thread mismatch which can occur. Although referencing eyebolts, the information is also applicable to ordinary bolts and nuts.

B.1 Interchangeability Problems

At present, there are five screw thread systems in common use in the United Kingdom for general purpose threaded fasteners:

- BS 84 - BSW
- BSF
- BS 1580 - UNC
- UNF
- BS 3643 - ISO metric screw thread system

This section is not concerned with pipe threads covered by BS 21, BS EN 10226 or BS EN ISO 228.

ISO metric coarse threads were introduced in 1963 with the intention of superseding the inch series of threads. The process of replacing other systems has been rather slow and, since capital equipment is costly to replace, many items of plant and equipment having non-metric fasteners will continue in use for many years with the consequent risk of mismatching of threads during repair or maintenance operations.

However, even if all imperial size threaded items were taken out of use at once, the risk of mismatch will still exist within the ISO metric system. This system is capable of almost complete mismatch within itself, in that all sizes of male threads will engage with the female thread of the next larger size, with the exception of M14 (14 mm coarse thread).

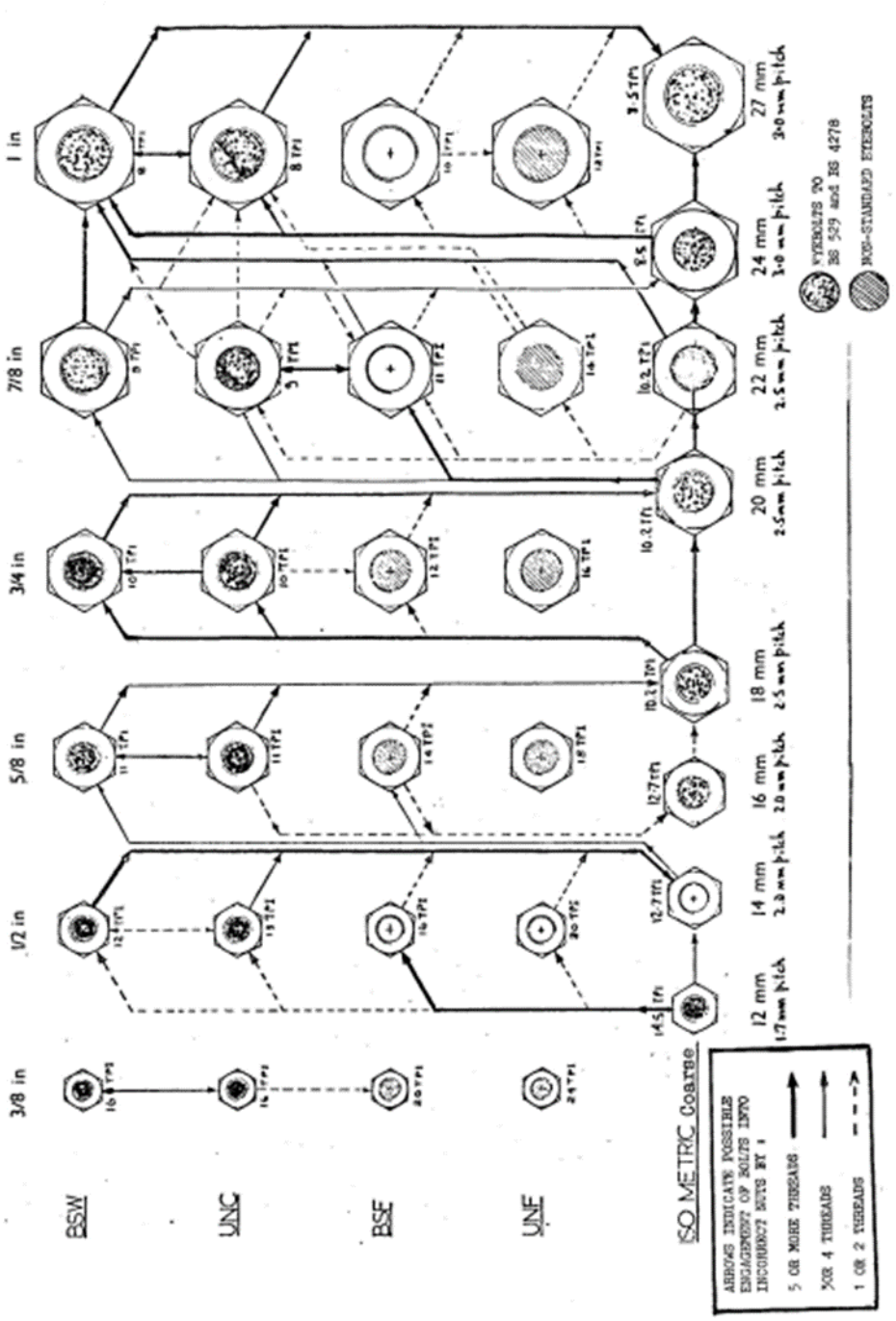


Figure 4: Possible Mismatching of General Purpose Threads up to 1 in. Size

B.2 Examples Using Figure 10

Example (1) 12 mm ISO metric coarse bolt or eyebolt can be engaged with ½ in BSF nut or tapped hole, resulting in 5 or more thread engagement.

Example (2) ½ in UNC (13 tpi) can be engaged with a 14 mm ISO metric coarse (2.0 mm pitch) resulting in 3 or 4 thread engagement.

Example (3) ⅞in UNC (9 tpi) can be engaged with a 22 mm ISO metric coarse (2.5 mm pitch) resulting in 1 or 2 thread engagement.

B.3 Possible Hazards

There are various potential hazards in the engagement of different thread systems or the same thread systems with different sizes.

When threaded joints are used for load carrying, weak engagements can result in total failure of the joint, i.e. eye bolt, hook, etc.

If tapped holes are used on equipment or components that are of soft materials (e.g. aluminium copper, etc.) forced engagement of a mismatched thread would result in stripping of threads, leading to eventual failure or to costly repairs.

Loose threaded joints could lead to noise or to total disengagement resulting in malfunction or failures.

B.4 Precautions

Users and operators should be aware of the associated problems, warn others in the construction, operation and servicing functions, and alert them to the possible dangers.

Various warnings have been issued by Metrication Board, Engineering Organisations and BSI on this matter. The Health and Safety Executive may be issuing HSE technical data notes to cover eye bolts, etc., for safety reasons. Close attention should be paid to such information.

Appendix C - Joint Completion Certificates

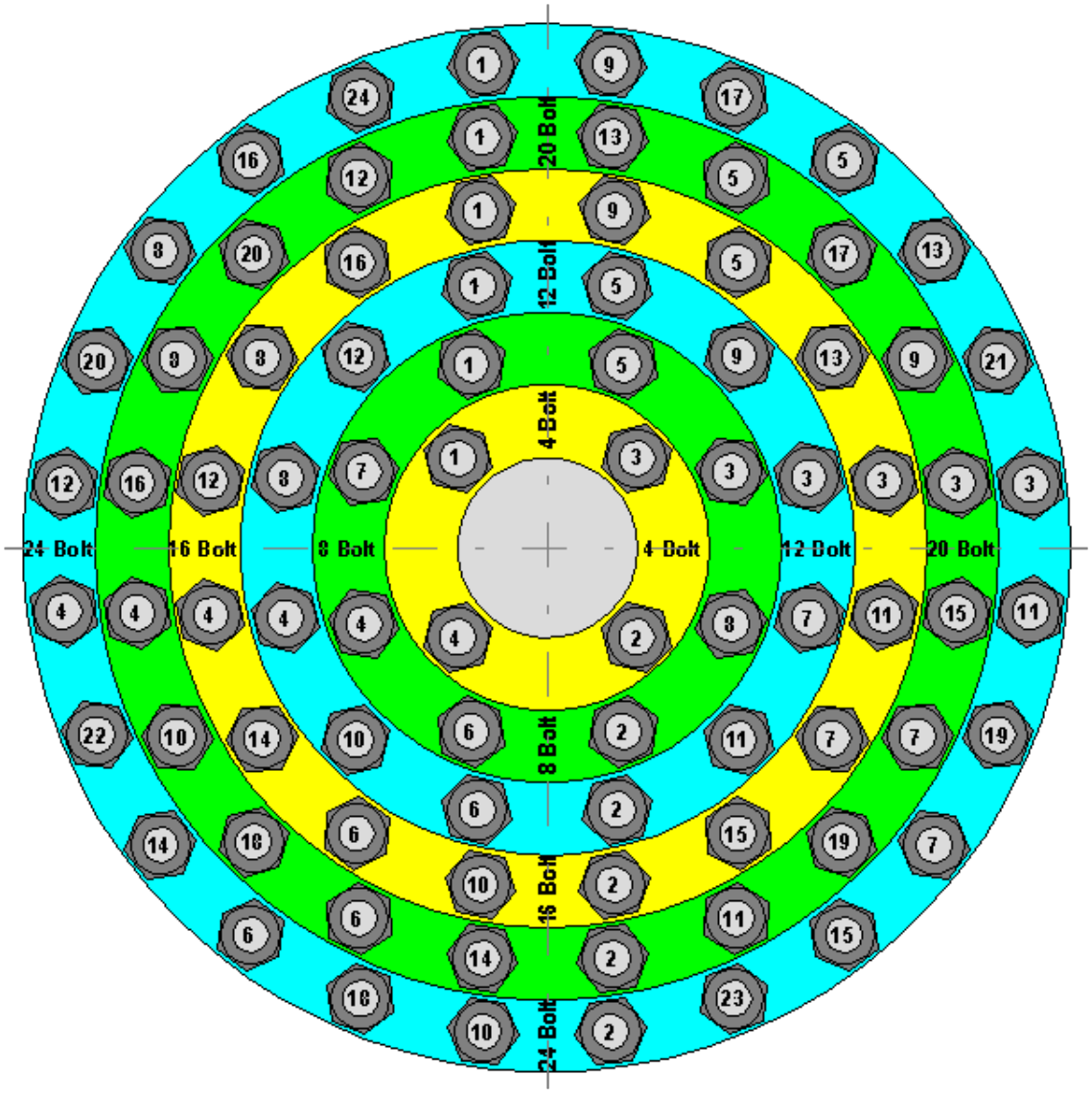
C.1 Class Designated Applications

Flanged Joint Completion Form (Class Designated Flanges)

Ref Number:		Client[1]:		Joint(s) Completed By:		Designation:	
Work Order Number:		Location/Site Details:		Signature:		Date:	

Flange Details				Bolting Details					Torque Wrench Details			Gasket Details	
Location/Joint Number (Include ELD with Joint Numbers Annotated)	Class[2]	Size	Type[3]	Qty	Dia	Length	Thread Lubricant Used	Torque Applied (Nm)	Make/Model	Serial Number	Calibration Valid Until:	Type[4]	Details if Other

Notes:
1: Client – GN, if other specify
2: Class – 150, 300 or 600.
3: Flange Type – e.g. Weld Neck, Blind
4: Gasket Type – Compressed Fibre (CNAF), Spiral Wound (SW), Ring Type Joint (RTJ)



Bolt Diameter (inch)	Recommended Minimum Torque Nm	Maximum Permitted Torque Nm
1/2	65	90
5/8	130	180
3/4	230	315
7/8	370	515
1	560	770
1 1/8	810	1150
1 1/4	1135	1625
1 1/2	2030	2925
1 5/8	2620	3805
1 3/4	3295	4785
1 7/8	4105	5960
2	5020	7325
2 1/2	10050	13860
2 3/4	13495	18680

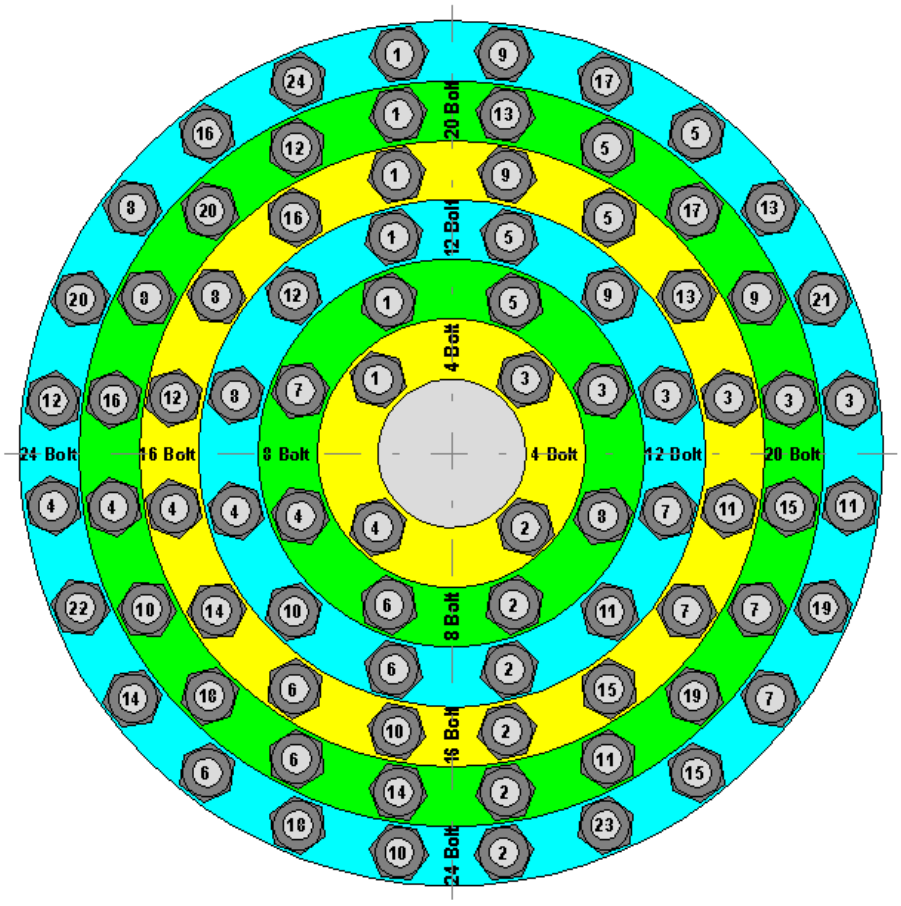
C.2 PN Designated Applications

Flanged Joint Completion Form (PN Designation)

Ref Number:		Client[1]:		Joint(s) Completed By:		Designation:	
Work Order Number:		Location/Site Details:		Signature:		Date:	

Flange Details				Bolting Details					Torque Wrench Details			Gasket Details	
Location/Joint Number (Include ELD with Joint Numbers Annotated)	Class[2]	Size	Type[3]	Qty	Dia	Length	Thread Lubricant Used	Torque Applied (Nm)	Make/Model	Serial Number	Calibration Valid Until:	Type[4]	Details if Other

Notes:
1: Client – GN, if other specify
2: Class – PN16
3: Flange Type –e.g. Weld Neck, Blind
4: Gasket Type – Compressed Fibre (CNAF), Spiral Wound (SW)



Flange NB (mm)	No of Bolts	Grade 4.6 - BS EN 1515-1 and BS 4190		ASTM A307 Grade B (Imperial Equivalent)	
		Bolt Diameter (mm)	Approximate Bolting Torque to Seal (Nm. (ft. lb.))	Bolt Diameter (in.)	Recommended Bolting Torque to Seal (Nm. (ft. lb.))
15	4	M12	35 (26)	1/2	43 (32)
20	4	M12	35 (26)	1/2	43 (32)
25	4	M12	35 (26)	1/2	43 (32)
32	4	M16	80 (59)	5/8	87 (64)
40	4	M16	80 (59)	5/8	87 (64)
50	4	M16	80 (59)	5/8	87 (64)
80	8	M16	80 (59)	5/8	87 (64)
100	8	M16	80 (59)	5/8	87 (64)
125	8	M16	80 (59)	5/8	87 (64)
150	8	M20	160 (118)	3/4	153 (113)
200	12	M20	160 (118)	3/4	153 (113)
250	12	M24	275 (203)	7/8	225 (166)
300	12	M24	275 (203)	7/8	225 (166)
350 - 1200	The flange supplier shall supply the bolting torque settings				

Appendix D - Data Sheets

D.1 Class Designated Applications Typically Operating at Pressures Greater than 7 Barg - Order Information

<table>
<tr><td colspan="2">STANDARD DATA SHEET FOR BOLTING TO GIS TECHNICAL SPECIFICATION GIS/E55 - ABOVE 7 BAR APPLICATIONS</td><td>Ref:…….
Date:……. Issue No.:…….</td></tr>
<tr><td colspan="3">1. Checked
2. Project
3. Location
4. Title
5. Manufacturer/ Supplier
Approved
Order Number</td></tr>
<tr><td colspan="3">INFORMATION TO BE SUPPLIED BY GAS TRANSPORTER (Tick boxes as appropriate)</td></tr>
<tr><td>6. Component</td><td>Stud bolt □</td><td>Quantity (5.1.2):…….
Length (5.1.2 and Tables 2, 3 and 4 / 5.1.7):
• Flanged joints:…….
• Other than flanged joints:…….
Diameter (5.1.2 and Tables 2, 3 and 4):…….
Electroplated (Section 4 and Part A, Section D) □
• Grade ZnNi(12-16)10A: Yes □ No □
• If no, specify alternative grade:…….
• Total coverage: Yes □ No □
• If no, specific areas:…….</td></tr>
<tr><td></td><td>Nuts □</td><td>Quantity:…….
Dimensions (ASME B18.2.2 Table 10):
• Nominal thread size:…….
ASTM A194 clause S5.1 required (5.2.3) □
Electroplated (Section 4 and Part A, Section D) □
• Grade ZnNi(12-16)10A: Yes □ No □
• If no, specify alternative grade:…….</td></tr>
<tr><td></td><td>Washers □</td><td>Quantity:…….
Dimensions (BS 3410 Table 3 or Table 1):
• Nominal bolt size:…….
Electroplated (Section 4 and Part A, Section D) □
• Grade ZnNi(12-16)10A: Yes □ No □
• If no, specify alternative grade:…….</td></tr>
<tr><td></td><td>Gasket □</td><td>Compressed Fibre Gasket □
Quantity (5.4.1 b.):…….
Flange nominal size (5.4.1 b.):…….
Flange class (5.4.1 b.):…….</td></tr>
<tr><td></td><td></td><td>Spiral Wound Gasket □
Corrosion protected inner steel ring not required (5.4.2 b.) □
Quantity (5.4.2 c.):.....
Flange nominal size (5.4.2 c.):…….
Flange class (5.4.2 c.):…….
Inner ring diameter (5.4.2 d and Table 2):…….</td></tr>
<tr><td></td><td></td><td>Ring Joint Gasket □
Quantity (5.4.3 b.):…….
Flange nominal size (5.4.3 b.):…….
Flange class (5.4.3 b.):…….
Ring groove number (5.4.3 c. and Table 3, 4 and 5):…….
1050 mm and 1200 mm nominal size flanges (5.4.3 d.) □
• Pitch diameter:…….
• Depth of groove:…….
• Width of groove:…….</td></tr>
</table>

D.2 PN Designated Applications Typically Operating at Pressures Less than or Equal to 7 Barg - Order Information

<table>
<tr><td colspan="2">STANDARD DATA SHEET FOR BOLTING TO GIS TECHNICAL SPECIFICATION GIS/E55 - UP TO 7 BAR APPLICATIONS</td><td>Ref:……
Date:…….. Issue No.:……..</td></tr>
<tr><td colspan="3">1. Checked Approved
2. Project Order Number
3. Location
4. Title
5. Manufacturer/ Supplier</td></tr>
<tr><td colspan="3">INFORMATION TO BE SUPPLIED BY GAS TRANSPORTER (Tick boxes as appropriate)</td></tr>
<tr><td rowspan="5">6. Component</td><td>Stud bolt □</td><td>Quantity:…….
Length (BS 1515-1 Annex A):……..
Nominal thread size i.e. M10 (BS 1515-1 Annex A):.....
Charpy toughness testing required: Yes □ No □</td></tr>
<tr><td>Hexagonal Bolt □</td><td>Quantity:…….
Length (BS EN ISO 4016):……..
Nominal thread size i.e. M10 (BS EN ISO 4016):.....
Charpy toughness testing required: Yes □ No □</td></tr>
<tr><td>Nuts □</td><td>Quantity:…….
Nominal thread size i.e. M10 (BS EN ISO 4034):.....
Charpy toughness testing required: Yes □ No □</td></tr>
<tr><td>Washers □</td><td>Quantity:…….
Diameter i.e. M12 (BS EN ISO 7091):…….</td></tr>
<tr><td>Gasket □</td><td>Quantity:…….
Compressed Fibre Gasket □
Spiral Wound Gasket □
Flange nominal size:……</td></tr>
</table>

D.3 Class Designated Applications Typically Operating at Pressures Greater than 7 Barg - Receipt Form

<table>
<tr><td colspan="2">STANDARD DATA SHEET FOR BOLTING TO GIS TECHNICAL SPECIFICATION GIS/E55 - UP TO 7 BAR APPLICATIONS</td><td>Ref:…….
Date:……. Issue No.:…….</td></tr>
<tr><td colspan="3">1. Checked Approved
2. Project Order Number
3. Location
4. Title
5. Manufacturer/ Supplier</td></tr>
<tr><td colspan="3">(Tick boxes as appropriate)</td></tr>
<tr><td>6. Component</td><td>Stud bolt □</td><td>Quantity:
• Has the correct quantity been received ?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (5.1.1):
• Are the stud bolts the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 6.3 a.?: Yes □ No □
• Does the certification meet 6.3 b (I)?: Yes □ No □
• Does the certification meet 6.3 b (V)?: Yes □ No □ N/A □</td></tr>
<tr><td></td><td>Nuts □</td><td>Quantity:
• Has the correct quantity been received?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (5.2.1):
• Are the nuts the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 6.3 b (II)?: Yes □ No □
• Does the certification meet 6.3 b (V)?: Yes □ No □ N/A □
Charpy Impact Testing:
• Have the requirements of ASTM A194 clause S5.1 been met? Yes □ No □ N/A □</td></tr>
<tr><td></td><td>Washers □</td><td>Quantity:
• Has the correct quantity been received?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (5.3.3):
• Are the washers the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 6.3 b (III)?: Yes □ No □
• Does the certification meet 6.3 b (V)?: Yes □ No □ N/A □</td></tr>
<tr><td></td><td>Gasket □</td><td>Type:
• Are the gaskets the correct type ?: Yes □ No □
Quantity:
• Has the correct quantity been received: Yes □ No □
Dimensions:
• Are the dimensions correct: Yes □ No □
Grade, where applicable (5.4.1 a. / 5.4.2 a. / 5.4.3 a.):
• Are the gaskets the correct Grade: Yes □ No □
Certification:
• Does the certification meet 6.3 b (IV).: Yes □ No □</td></tr>
</table>

D.4 PN Designated Applications Typically Operating at Pressures Less than or equal to 7 Barg - Order Information

<table>
<tr><td colspan="2">STANDARD DATA SHEET FOR BOLTING TO GIS TECHNICAL SPECIFICATION GIS/E55 - ABOVE 7 BAR APPLICATIONS</td><td>Ref:…….
Date:……. Issue No.:…….</td></tr>
<tr><td colspan="3">1. Checked Approved
2. Project Order Number
3. Location
4. Title
5. Manufacturer/ Supplier</td></tr>
<tr><td colspan="3">(Tick boxes as appropriate)</td></tr>
<tr><td>6. Component</td><td>Stud bolt □</td><td>Quantity:
• Has the correct quantity been received ?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (Table 9):
• Are the stud bolts the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 19.1 a. and b.?: Yes □ No □
• If no above, has 19.2 been satisfied?: Yes □ No □
Chemical Composition:
• Has 20.1 been satisfied? Yes □ No □
Charpy Impact Testing:
• Has Charpy impact testing been performed? Yes □ No □ N/A □
• If yes, does it meet the requirements in Table 10?: Yes □ No □</td></tr>
<tr><td></td><td>Hexagonal Bolt □</td><td>Quantity:
• Has the correct quantity been received ?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (Table 9):
• Are the hexagonal bolts the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 19.1 a. and b.?: Yes □ No □
• If no above, has 19.2 been satisfied?: Yes □ No □
Chemical Composition:
• Has 20.1 been satisfied? Yes □ No □
Charpy Impact Testing:
• Has Charpy impact testing been performed? Yes □ No □ N/A □
• If yes, does it meet the requirements in Table 10?: Yes □ No □</td></tr>
<tr><td></td><td>Nuts □</td><td>Quantity:
• Has the correct quantity been received ?: Yes □ No □
Dimensions:
• Are the dimensions correct?: Yes □ No □
Grade (Table 9):
• Are the nuts the correct Grade?: Yes □ No □
Certification:
• Does the certification meet 19.1 a. and b.?: Yes □ No □
• If no above, has 19.2 been satisfied?: Yes □ No □
Chemical Composition:
• Has 20.1 been satisfied? Yes □ No □
Charpy Impact Testing:
• Has Charpy impact testing been performed? Yes □ No □ N/A □
• If yes, does it meet the requirements in Table 10?: Yes □ No □</td></tr>
</table>

	Washers □	**Quantity:** • Has the correct quantity been received ?: Yes □ No □ **Dimensions:** • Are the dimensions correct?: Yes □ No □ **Grade (Table 9):** • Are the washers the correct Grade?: Yes □ No □ **Certification:** • Does the certification meet 19.1 c.?: Yes □ No □
	Gasket □	**Quantity:** • Has the correct quantity been received ?: Yes □ No □ **Dimensions:** • Are the dimensions correct?: Yes □ No □ **Grade, where applicable (Table 9):** • Are the washers the correct Grade?: Yes □ No □ **Certification:** • Does the certification meet 19.1 d.?: Yes □ No □