Defence Infrastructure Organisation

Technical Bulletin

Subject: Fastener & Torque Specifications for Bolted Flange Joints

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Mechanical & Fuels Infrastructure

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This Technical Bulletin is to be read by the following so appropriate action can be taken:

1. DIO Service Manager (or equivalent for non FDIS contracts)

2. DIO's Maintenance Management Organisations

3. Others interested in the content of this Safety Alert might include:

Prime Contractors, Private Finance Initiatives, Public-Private Partnership and other traditionally procured contracts, Infrastructure Managers and Property Managers with responsibility for MOD projects and Property Management Works Services (including the legacy work of EWCs/WSMs), Health & Safety Advisors, Accommodation Managers, and providers of Alternative Living Accommodation.

When it takes effect: Immediately	**When it is due to expire**: When updated or rescinded.

This Technical Bulletin does not necessarily cover all aspects of the subject matter and readers should make themselves aware of other potential issues. Readers should also not rely on DIO publications as their only means of becoming aware of safety, operational or technical issues, but they should consult widely across other media to maintain awareness.

Aim

1. To provide appropriate guidance for the attention of responsible persons regarding the correct fastener and torque specifications to be applied for bolted flange joints.

Introduction

2. Compliance with the contents of this Technical Bulletin (TB) will enable compliance with the Health & Safety at Work etc Act 1974 and its subordinate Regulations.
3. The appropriate MOD officer shall arrange for the User and Owner as defined by the Pressure Systems Safety Regulations 2000 to be made aware of the requirements of this TB.
4. Any work required as a result of this TB must be carried out in accordance with JSP 375, Part 2, Volume 3 – High Risk Activities on the Defence Estate.
5. On MOD establishments occupied by United States Visiting Forces (USVF), responsibility is jointly held by USVF and DIO(USF). At base level this jointly managed organisation is to take appropriate action to implement the contents of this TB.

Background

6. DIO TS have evidence to suggest that bolted flange joints made on MOD fuel installations have been assembled with cut down threaded bar and unsuitable studs/bolts and nuts. Such evidence would indicate that there exists a clear lack of understanding of the important need to ensure that these type of joints are sound in their mechanical integrity. Therefore, the use of studs/bolts and nuts not in compliance with the contents of Technical Standard Pet 01 is to be discontinued immediately due to the risk of failure of a joint resulting in a major loss of containment of petroleum product.
7. There also exists little evidence to indicate that the correct torque-tightening procedures are being applied when making these type of joints. It follows, therefore, where MMOs identify shortfalls in the competency levels of their workforce, then retraining shall be required to ensure that the correct procedures are adhered to.

Requirement

8. When making bolted flange joints on the MOD's ANSI/ASME Class 150 petroleum installations from new and when replacing system components, the correct material and rating of bolts, studs and nuts shall be used. Details of the correct material grade and rating can be found in the DIO's Technical Standard – Petroleum 01 - Specialist Works on Petroleum Installations on MOD Property*.
9. When making bolted flange joints on the MOD's ANSI/ASME Class 150 petroleum installations, the correct torque loading shall be applied using a calibrated torque wrench via the method outlined in the following sections contained in this TB. Once correctly applied, the torque loading does not need to be periodically checked.

   *Note. Technical Standard - Petroleum 01 - Specialist Works on Petroleum Installations on MOD Property will be updated accordingly with the guidance provided in this TB.

Bolted Flange Joint Making Procedure

Note. Lubrication reduces the coefficient of friction (CoF) and results in less torque needed to achieve a given tension. It also improves the consistency of achieving bolt to bolt loading and aids in the disassembly of the fasteners.

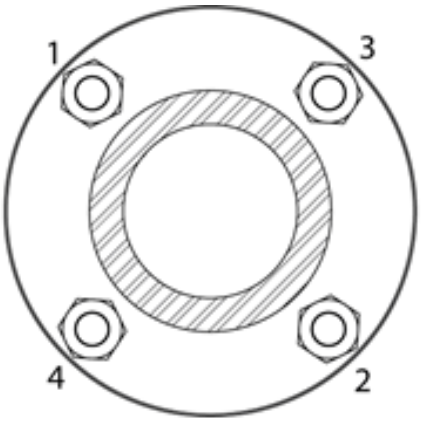
10. Before the lubricant is added, ensure that the nuts run freely by hand to where they will rest after tightening.

11. Ensure that the correct gasket has been fitted and insert the bolts/studs in the flange. Check that they are the correct length and will have between three to five complete threads showing when fully tightened.
12. Apply the lubricant (e.g., Rocol J166 Anti-Seize Compound, with a CoF of 0.15 or similar product) to the nut contact faces and the bolt/stud threads where the nut will run.
13. Number the location of each bolt on the flange. The use of masking tape around the flange may make it easier to number the locations – see below for an example.

The correct numbering of bolts should result in the odd-numbered bolts being around one side of the flange and the even-numbered bolts being around the other side.

14. The correct sequence for numbering the bolt locations is in a diagonal fashion, see the following diagrams for typical examples.

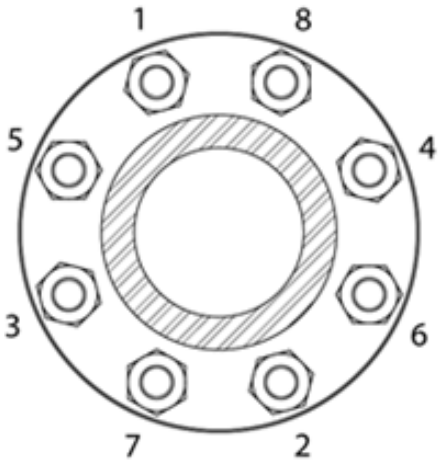
(a) 4-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 – 3 – 2 – 4

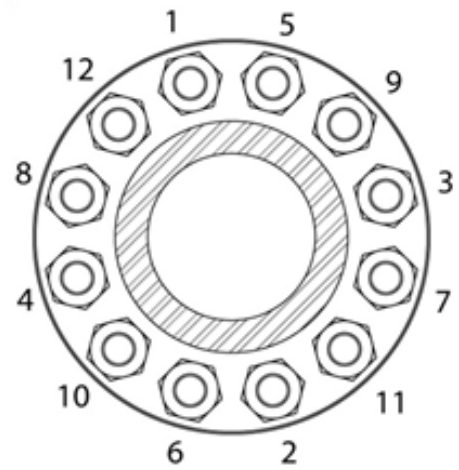
(b) 8-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 – 8 – 4 – 6 – 2 – 7 – 3 – 5

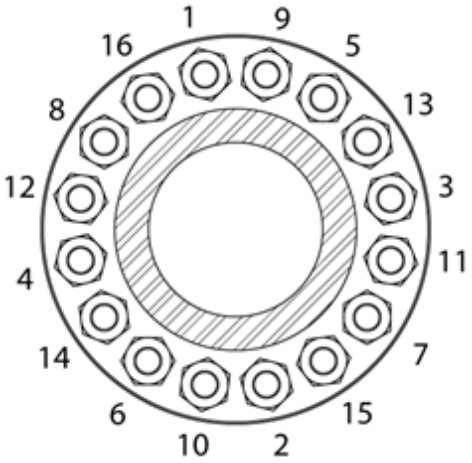
(c) 12-Bolt Flange – Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 5 – 9 – 3 – 7 – 11 – 2 – 6 – 10 – 4 – 8 – 12

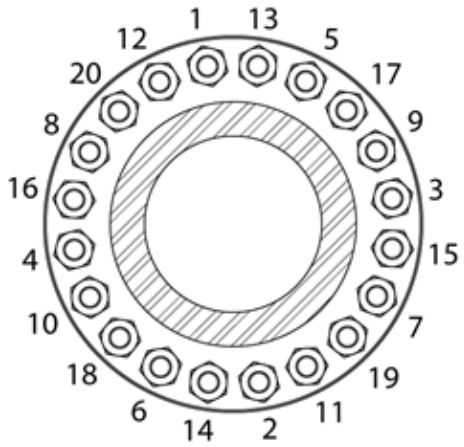
(d) 16-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 9 - 5 - 13 - 3 - 11 - 7 - 15 - 2 - 10 - 6 - 14 - 4 - 12 - 8 - 16

(e) 20-Bolt Flange - Bolting Pattern



Once marked-up the bolt numbers should read as follows in the clockwise direction:

1 - 13 - 5 - 17 - 9 - 3 - 15 - 7 - 19 - 11 - 2 -14 - 6 - 18 - 10 - 4 - 16 - 8 - 20 - 12

15. Tightening shall be carried out in the following manner using a calibrated torque wrench:
    1. Before starting, hand tighten and check that the bolts fit snugly.
    2. First Pass: tighten the nuts/bolts/studs to 30% of the required final torque setting following the correct sequential order (e.g., 1, 2, 3….).
    3. Second Pass: tighten the nuts/bolts/studs to 60% of the required final torque setting following the correct sequential order (e.g., 1, 2, 3….).
    4. Third Pass: tighten the nuts/bolts/studs to 100% of the required final torque setting following the correct sequential order (e.g., 1, 2, 3….).
    5. Final Pass: tighten the nuts/bolts/studs to 100% of the required final torque setting following the <u>rotational</u> order.
    6. Leave for four hours and repeat the Final Pass until all nuts/bolts/studs will no longer move when the torque application equipment is applied to them.

16. The final torque settings for the correct fasteners* to be used on the MOD's ANSI/ASME Class 150 petroleum installations (see below), as referenced in Technical Standard - Petroleum 01, are shown in Table 1.

Carbon Steel Pipework:	Bolts = ASTM A 193/A 193M GR B7 Stud Bolts
	Nuts = ASTM A 194/A 194M GR 2H Heavy Hex Nuts
Stainless Steel Pipework:	Bolts = ASTM A 193/A 193M GR B8M Stud Bolts
	Nuts = ASTM A 194/A 194M GR 8M Heavy Hex Nuts

*Important Note. Hot dip galvanized or coated studs, bolts, washers, and nuts are not to be used as the coating will degrade in service and have an impact on maintaining the final torque loading figure. All fasteners used on these systems are to be bare metal.

Notes:

1. The settings in Table 1 are only to be used when the following parameters are followed.
2. Lubricant to be used on bolts and threads to have a CoF = 0.15 (copper anti-seize should not be used on stainless steel as this will create inter-crystalline corrosion which can cause parts to crack or break when under heavy loads)
3. Gaskets are to be spiral wound.
4. Flanges are to be ANSI B16.5.

It is important that these settings are only used for the bolt materials and lubricants shown. Different bolt materials and lubricants will affect the torque values.

Size	Nominal Bolt Stress (lbf/in^2)	Torque (lbf)	Thread Size (UNC)	Min Bolt Length	Qty	Spanner Sizes	
						A/F Metric	A/F Imperial
½”	-	46	1/2”	2.1/4"	4	22 mm	7/8"
¾”	-	46	1/2”	2.1/4"	4	22 mm	7/8"
1”	-	46	1/2”	2.1/2"	4	22 mm	7/8"
1½”	45000	52	1/2”	3"	4	22 mm	7/8"
2"	45000	102	5/8”	3.1/2"	4	27 mm	1.1/16"
3"	50000	113	5/8”	4"	4	27 mm	1.1/16"
4"	45000	102	5/8”	4"	8	27 mm	1.1/16"
6"	50000	199	3/4”	4.1/2"	8	32 mm	1.1/4"
8"	50000	199	3/4”	4.3/4"	8	32 mm	1.1/4"
10"	40000	255	7/8”	5.1/4"	12	37 mm	1.7/16"
12"	45000	287	7/8”	5.1/4"	12	37 mm	1.7/16"
14"	45000	380	1”	6"	12	41 mm	1.5/8"
16"	40000	428	1”	6"	16	41 mm	1.5/8"

Table 1. ANSI/ASME Class 150 Flanges: Torque Loading Values