

TECHNICAL STANDARD**BOLT TIGHTENING PROCEDURE FOR
MECHANICAL PLANT**

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APPROVAL TO DEVIATE FROM THIS STANDARD

Approval may be granted by the Asset Owner to deviate from the requirements as stipulated in this Standard if the functional requirements (e.g. Asset Life) for the asset differs from those stated in the Standard, but is assessed as still being acceptable by the Asset Owner's nominated representative.

Any approval to deviate from the stated requirements of this Standard will not be seen as creating a precedent for future like project. Any request to deviate from this Standard must be carried out on a project by project basis where each alternate proposal will be individually assessed on its own merit.

NO CHANGES REQUIRED IN THE JANUARY 2007 EDITION

The following lists the major changes to the July 1984 edition and published in the September 2004 edition of TS 27.

1. Reformatted from DS to TS (Departmental Standard to Technical Standard), and updated referenced Australian Standards.
2. Conversion to a technical standard by removal of contractual conditions (to be included in the contract that references this specification).

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REFERENCED DOCUMENTS

AS 1110:	ISO metric hexagon bolts and screws – Products grades A and B
AS 1111:	ISO metric hexagon bolts and screws – Products grade C
AS 1252:	High strength steel bolts with associated nuts and washers for structural engineering

- AS/NZS 2451:** Bolts, screws and nuts with British Standard Whitworth threads (rationalized series)
- BS 1083:** Specification for precision hexagon bolts, screws and nuts (B.S.W. & B.S.F. threads)
- BS 1768:** Specification for Unified precision hexagon bolts, screws, & nuts (UNC & UNF threads). Normal series
- TS 59:** Flanges

SECTION 1: SCOPE

This Technical Standard covers the procedures for tightening bolts on mechanical installations, and other non permanent joints using ordinary mild steel B.S.W. bolts in accordance with AS 2451, or metric mild steel or high strength bolts in accordance with AS 1110, AS 1111 or AS 1252.

For information specific to bolting for flanges, refer to TS 59.

1.1 SA Water's Representative

SA Water's Representative will be nominated to the Contractor.

SECTION 2: METHOD AND APPLICATION

The specified method of bolt tightening is equally applicable to galvanised and ungalvanised bolts.

The bolts shall be tightened by torque control, using the specified lubricant, in accordance with the following procedure;

2.1 Lubrication

Before assembly, the bolt and nut threads shall be lubricated with Molycoat P74 molybdenum grease.

2.2 Assembly

After assembly, all bolts and nuts in the joint shall be tightened evenly to a snug tight condition.

2.3 Tightening


Each nut shall be tightened with a continuous smooth action using a calibrated torque device set to the appropriate assembly torque, for different types of bolt and bolt tension, as given in the following Tables in this Technical Standard.

This assembly torque is designed to achieve a preloading in the bolt expressed in percentage of the bolt yield stress.

SECTION 3: BOLT SIZES

It is preferred that metric bolts shall be used in the assembly of mechanical plant, but in some cases these may be unavailable. In such instances it is permissible to use an equivalent inch series bolt as set out below.

Where metric bolting is unavailable, the following equivalent inch series bolt shall be used:

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M12 M16 M20 M24 M27 M30 M33 M36 M39 M45
 1/2" 5/8" 3/4" 7/8" 1" 1 1/8" 1 1/4" 1 3/8" 1 1/2" 1 3/4"

SECTION 4: CALIBRATION OF TORQUE DEVICE

The torque device shall be calibrated regularly and for large projects where large numbers of bolts are to be tightened an approved load cell shall be used for calibration. A suitable load cell will be made available by SA Water's Representative. Calibration shall consist of tightening at least three sample bolts complete with nuts and washers, lubricated with Molycoat P74 molybdenum grease as stated in Clause 2.1.

SECTION 5: BOLT IDENTIFICATION

Head markings and the corresponding tensile strengths for various commercial bolts are as tabulated below.

Table 5.1 American S.A.E. Standard (UNC & UNF Threads)

SAE Grade	Head Making	Minimum Tensile Strength
1	Plain	25 t.s.i.
2	Plain	28 t.s.i.
3	2 – Opposite Radial Strokes	45 t.s.i.
4	3 – Radial Strokes – 120E Apart	50 t.s.i.
5	4 – Radial Strokes – 90E Apart (for all sizes of bolts)	60 t.s.i.
6	5 – Radial Strokes – 72E Apart (for all sizes of bolts)	60 t.s.i.
7	6 – Radial Strokes – 60E Apart (for all sizes of bolts)	67 t.s.i.

Table 5.2 British Standards (BS 1083, BS 1768) (BSW and BSF Threads)

Code Symbol	Tensile Strength	Code Symbol	Minimum Tensile Strength
A	26 t.s.i.	T	55 t.s.i.
B	28 t.s.i.	V	65 t.s.i.
P	35 t.s.i.	X	75 t.s.i.
R	45 t.s.i.		

Table 5.3 AJAX, British Standard and SAE Bolts (Examples)

Code Symbol/Letter/Number Thread Designation	Tensile Strength
No marking	28 t.s.i
BSW R	45 – 55 t.s.i
BSF T	55 – 65 t.s.i.
BSW 40	40 – 50 t.s.i.
BSF 50	50 – 60 t.s.i.
UNC 3 – radial strokes – 120E apart	56.6 t.s.i.
UNF 3 – radial strokes – 120E apart	53.6 t.s.i.

Table 5.4 Australian Standard Metric Bolts

Grade	Markings	Minimum Tensils Strength	Yield Stress
4.6	4.6 to 46	400 MPa	240 MPa
5.8	5.8 to 58	500 MPa	400 MPa
8.8	8.8 to 88	800 MPa	640 MPa
10.9	10.9 to 109	1000 MPa	900 MPa

NOTE:

- 1) When there is any doubt regarding the tensile strength of the bolt, the manufacturer should be consulted.
- 2) Only for the commonly used bolts the tightening torques are specified in this Technical Standard.
- 3) The Tables of Torques specified in this Technical Standard are also applicable to UNC and UNF bolts of equivalent tensile strength.
- 4) For bolts of tensile strength higher than 53.6 t.s.i. or 800 MPa, the applied torques should be derived from Table V multiplied by the ratio of the tensile strength.

SECTION 6: TIGHTENING TORQUES

The following Table I to V inclusive set out the tightening torques, for B.S.W. and metric bolts of different strength materials, and give the corresponding pre load to be applied to the bolts when lubricated with Molycoat P74 molybdenum grease.

For B.S.W. bolts the torques are specified in lb. ft. and for metric bolts the torques are specified in Nm.

Table 6.1 Tightening Torque – B.S.W. Bolts

Material:	Tensile Strength	= 28 t.s.i.	(432 MPa)	
	Yield Strength	= 16 t.s.i.	(247 MPa)	
Bolt Sizes	Tightening Torque (ft. lb.)			
	40% Yield	65 % Yield	80% Yield	95% Yield
1/2" B.S.W.	11	18	22	26
5/8" B.S.W.	22	36	45	53
3/4" B.S.W.	40	64	80	94
7/8" B.S.W.	60	98	120	145
" B.S.W.	92	150	185	220
1 1/8" B.S.W.	130	210	260	305
1 1/4" B.S.W.	185	300	370	440
1 3/8" B.S.W.	245	400	490	585
1 1/2" B.S.W.	315	510	630	745
1 3/4" B.S.W.	465	800	990	1170

Table 6.2 Tightening Torque – B.S.W. Bolts

Material:	Tensile Strength	= 35 t.s.i.	(540 MPa)	
	Yield Strength	= 18 t.s.i.	(278 MPa)	
Bolt Sizes	Tightening Torque (ft. lb.)			
	40% Yield	65 % Yield	80% Yield	95% Yield
1/2" B.S.W.	12	20	25	29
5/8" B.S.W.	25	41	51	60
3/4" B.S.W.	45	72	90	106
7/8" B.S.W.	68	110	135	163
" B.S.W.	104	169	208	248
1 1/8" B.S.W.	146	236	293	343
1 1/4" B.S.W.	208	338	416	495
1 3/8" B.S.W.	276	450	551	658
1 1/2" B.S.W.	354	574	709	838
1 3/4" B.S.W.	557	900	1114	1316

Table 6.3 Tightening Torque – Metric Bolts (AS 1110, AS 1111)

Material: Grade 4.6 Strength				
Tensile Strength = 400 MPa				
Yield Strength = 240 MPa				
Bolt Sizes	Tightening Torque (Nm)			
	40% Yield	65 % Yield	80% Yield	95% Yield
M 12	15	24	30	35
M 16	30	48	60	71
M 20	70	110	140	160
M 24	123	200	250	295
M 27	170	270	320	400
M 30	220	350	420	510
M 33	260	440	520	640
M 36	330	536	660	785
M 39	390	650	790	950
M 42	450	735	905	1080
M 45	510	850	1040	1250
M 48	590	970	1200	1420

Table 6.4 Tightening Torque – Metric Bolts (AS1110)

Material: Grade 5.8 Strength				
Tensile Strength = 500 MPa				
Yield Strength = 440 MPa				
Bolt Sizes	Tightening Torque (Nm)			
	40% Yield	65 % Yield	80% Yield	95% Yield
M 12	25	40	50	58
M 16	50	80	100	118
M 20	110	170	220	260
M 24	205	335	420	490
M 27	280	460	530	680
M 30	360	590	700	900
M 33	450	740	890	1080
M 36	550	895	1100	1310
M 39	640	1050	1280	1550
M 42	750	1225	1510	1800
M 45	860	1380	1760	2080
M 48	980	1620	2000	2370

Table 6.5 Tightening Torque – Metric Bolts (AS 1110, AS 1252)

Material: Grade 8.8 Strength Tensile Strength = 800 MPa Yield Strength = 640 MPa				
Bolt Sizes	Tightening Torque (Nm)			
	40% Yield	65 % Yield	80% Yield	95% Yield
M 12	30	48	60	70
M 16	60	96	120	142
M 20	135	220	275	300
M 24	246	400	500	590
M 27	350	570	700	770
M 30	450	730	910	1000
M 33	560	920	1120	1270
M 36	660	1070	1320	1570
M 39	800	1300	1600	1860
M 42	900	1470	1810	2160
M 45	1040	1690	2100	2470
M 48	1180	1940	2400	2840