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AEROSPACE INFORMATION REPORT

AIR 1551

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Revised

TORQUE TIGHTENING METRIC SCREW THREADED FASTENERS

1. PURPOSE:

1.1 The purpose of this Aerospace Information Report (AIR) is to provide the aerospace propulsion industry with recommended assembly torque limits for threaded fasteners when a common torque value per fastener size is the objective. (The fasteners are based on the dimensional data in MA1518). It also provides a series of curves that show the effect of the coefficient of friction on the axial load produced in a fastener, when the recommended torques are applied.

2. SCOPE:

2.1 This AIR supplies information on recommended assembly torque limits for tension type nuts and bolts of the materials and plating combinations given in Table I.

TABLE I - Combinations of Fastener Materials

Bolt			Nut			Typical Coefficient of Friction
Material	Plating	*F_{ty}, MPa	Material	Plating	*F_{ty}, MPa	
8740	cadmium	710	8740	cadmium	710	0.12
A286	unplated	586	A286	silver	586	0.13
Inconel 718	unplated	1034	A286	silver	586	0.14
Waspaloy	unplated	793	Waspaloy	silver	793	0.14

* - Minimum tensile yield strength at room temperature.

2.2 In calculating the torque values in Table II, the following assumptions have been made:

(a) Threads and bearing surfaces are lubricated with MIL-L-7808 aircraft engine oil.

(b) The torque is applied to the nut. If torque is to be applied to the bolt head, the induced load may be reduced by friction on the shank.

(c) The tensile preload stress is 440MPa.

3. REQUIREMENTS:

3.1 Assembly Torques for Self Locking Nuts, (e.g. MA3266): The assembly torques shown in Table II are for the self-locking nut and bolt material and plating combinations listed in Table I.

3.1.1 The assembly torque is a rounded value derived from the following formula:

$$T = F\,(K_1 + K_2) \times 10^{-3}$$

where T = torque, N·m

F = axial load, N (440MPa on external thread mean stress area, A x 440 MPa)

$K_1 = 0.5\,[P/\pi + d_2 bsc\,(1.1547 f_1)]$, constant for thread friction, mm.

$K_2 = 0.25\,(d\ bsc + b) f_2$, constant for washer face friction, mm.

$A = 0.0625\pi\,(d_2\ min + d_3\ max)^2$, mean stress area, mm^2.

d_2 bsc = thread basic pitch diameter, mm. (equals d_2 max)

d_2 min = external thread minimum pitch diameter, mm.

d_3 max = external thread maximum root diameter, mm.

P = pitch, mm.

b = washer face diameter (bolt or nut), minimum, mm.

f_1 = coefficient of friction in threads (0.13 assumed)

f_2 = coefficient of friction at washer face (0.13 assumed)

d bsc = thread basic major diameter (equals d max), mm.

TABLE II - Assembly Torques for Self-Locking Nuts

Nominal Thread Size MJ	Assembly Torque N·m		
	Nom	Min	Max
3 x 0.5	1.3	1.2	1.4
4 x 0.7	2.8	2.6	3
5 x 0.8	5.5	5	6
6 x 1.0	9.5	9	10
7 x 1.0	16	15	17
8 x 1.0	24	23	25
10 x 1.25	46	44	48
12 x 1.25	80	75	85
14 x 1.5	130	120	140
16 x 1.5	190	180	200
18 x 1.5	280	260	300
20 x 1.5	380	360	400

Note: Assembly torque tolerance is for variation in reading torque meter dial.

3.1.2 The axial load produced in a threaded fastener by application of a specific torque is dependent on the coefficient of friction in the threads and under the washer face of the bolt or nut. Figures 1, 2, and 3 plot axial load in the threaded fastener against a range of typical coefficients of friction. Each pair of curves depicts the estimated maximum and minimum axial loads that would be produced in each specified size of fastener by application of the maximum and minimum torques listed in Table II. The points on the curves were calculated by using the formula in paragraph 3.1.1, the maximum and minimum torque values from Table II, and a series of coefficients of friction from .05 to .20.

It should be noted that the torques in Table II can produce axial loads that exceed the yield point of some materials when the coefficient of friction is lower than the 0.13 used in calculating the torques. (The lower coefficients of friction usually result from the use of an anti-seize compound as an assembly lubricant, instead of engine oil.)

3.2 Assembly Torques for Positioning Type Nuts: Nuts that require alignment for the insertion of locking devices, such as cotterpins, or spring pins, are allowed a greater tolerance range for assembly torque. The assembly torques for the material and plating combinations in Table I for positioning type tension nuts are shown in Table III. The maximum torque value is the same as the maximum specified in Table II. The minimum torque value is approximately 25% less than the maximum value.

TABLE III - Assembly Torques for Positioning Types Nuts
(Plain Hex, Drilled Hex, Castellated, etc.)

Nominal Thread Size MJ	Assembly Torque N·m		
	Nom	Min	Max
3 x 0.5	1.3	1.0	1.4
4 x 0.7	2.8	2.2	3
5 x 0.8	5.5	4.4	6
6 x 1.0	9.5	7.5	10
7 x 1.0	16	13	17
8 x 1.0	24	19	25
10 x 1.25	46	36	48
12 x 1.25	80	65	85
14 x 1.5	130	105	140
16 x 1.5	190	150	200
18 x 1.5	280	230	300
20 x 1.5	380	300	400

FIGURE 1