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AEROSPACE INFORMATION REPORT

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TORQUE TIGHTENING THREADED FASTENERS

1. PURPOSE:

1.1 The purpose of this informational report is to provide the aerospace propulsion industry with recommended assembly torque limits for commonly used aircraft propulsion system threaded fasteners when a common torque value per fastener size is the objective.

2. SCOPE:

2.1 To supply information on recommended assembly torque limits for tension type nuts and bolts of the following materials and plating combinations given in Table I.

TABLE I - Combinations of Fastener Materials

Bolt			Nut			Assumed Coefficient Friction
Material	Plating	F_{ty}, ksi	Material	Plating	F_{ty}, ksi	
8740	cadmium	103	8740	cadmium	103	0.12
A286	uplated	85	A286	silver	85	0.13
Inconel 718	unplated	150	A286	silver	85	0.14
Waspaloy	unplated	115	Waspaloy	silver	115	0.14

2.2 For the bolt and nut material and plating combinations in Table I, the following conditions prevail:

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

(b) Torque to be applied to the nut, wherever possible. Where torque is applied to bolt head, no binding should occur between bolt shank and bolt clearance hole that would affect the torque-induced preload.

(c) For the specific bolt and nut material and plating combinations, the average coefficient of friction is assumed as indicated in Table I.

(d) Minimum tensile yield strength at room temperature of bolt and nut is as indicated in Table I.

3. REQUIREMENTS:

3.1 Assembly Torques for Self Locking Nuts, (e.g., AS3068): The assembly torques shown in Table II are for the self locking nut and bolt material and plating combinations listed in Table I. These torques induce a combined tensile stress (axial tensile with torsional shear stresses) for the various material combinations as shown in Table III. The ratio of the combined tensile stress (f_t) to the material tensile yield stress (F_{ty}) is also given in Table III.

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

$$T = F(K_1 + K_2)$$

where T = torque, lb-in.
F = axial load, lb ($F = A \times 60$ ksi, A = ext thd mean stress area)
$K_1 = 0.5/\pi n + (0.5E \times 1.1547 f_1)$, constant for thread friction
$K_2 = 0.25(D + b)f_2$, constant for washer face friction
A = mean stress area $= \pi d^2/4$
$d = 0.5(E\ \text{min} + K_s\ \text{max})$
E = thread basic pitch diameter, inch
E min = ext thread minimum pitch diameter, inch
K_s max = ext thread maximum root diameter, inch
n = number of threads per inch
b = washer face diameter (nut or bolt), minimum, inch
f_1 = coefficient of friction in threads, (0.13 assumed)
f_2 = coefficient of friction at washer face, (0.13 assumed)
D = thread basic major diameter, inch

TABLE II - Assembly Torques for Self Locking Nuts

Nominal Thread Size UNJ	Assembly Torque lb-in.		
	Nom	Min	Max
.164-32	25	24	27
.164-36	26	25	29
.190-32	42	40	44
.250-28	95	90	100
.3125-24	185	175	195
.375-24	330	320	350
.4375-20	530	500	550
.500-20	800	760	840
.5625-18	1150	1090	1200

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

An additional inherent error in the torque wrench may influence the measured torque.

3.1.2 The assembly torque range should be measured within tolerance values shown in Table II when applying the assembly torques.

3.1.3 The Table III values for combined tensile stress (f_t), produced by the nominal assembly torque given in Table II, were derived from the following formula for combining axial tensile and torsional shear stresses:

$$f_t = \sqrt{\sigma^2 + 3\tau^2}$$

where f_t = combined tensile stress, psi

$\sigma = F'/A$, axial tensile stress in thd due to assembly torque, psi

$\tau = T'c/J$, torsional shear stress in thd due to assembly torque, psi

$F' = T_{nom}/(K_1' + K_2')$

K_1' = constant as in 3.1.1, using coefficient of friction in Table I

K_2' = constant as in 3.1.1, using coefficient of friction in Table I

T_{nom} = nominal assembly torque as given in Table II, lb-in.

A = mean stress area as in 3.1.1, $in.^2$

$T' = F'K_1'$ = torque to overcome thd friction, lb-in.

$c/J = 16/\pi d^3$, $1/in.^3$, using $d = 0.5(E_{min} + K_{s\,max})$

TABLE III - Combined Tensile Stress (f_t)

Nominal Thread Size UNJ	Combined Stress (ft) psi	Ratio f_t/F_{ty}
Fastener Material Combination Bolt: 8740, cadmium plated Nut: 8740, cadmium plated		
.164-32	79,000	0.77
.164-36	78,000	0.76
.190-32	78,700	0.76
.250-28	76,500	0.74
.3125-24	76,400	0.74
.375-24	76,500	0.74
.4375-20	76,400	0.74
.500-20	76,000	0.74
.5625-18	75,600	0.73
Bolt: A286, unplated Nut: A286, silver plated		
.164-32	75,500	0.89
.164-36	74,400	0.88
.190-32	75,000	0.88
.250-28	72,800	0.86
.3125-24	72,600	0.85
.375-24	72,600	0.85
.4375-20	72,600	0.85
.500-20	72,000	0.85
.5625-18	71,600	0.84
Bolt: Inconel 718, unplated Nut: A286, silver plated		
.164-32	72,400	0.48
.164-36	71,300	0.48
.190-32	71,800	0.48
.250-28	69,700	0.46
.3125-24	69,400	0.46
.375-24	69,300	0.46
.4375-20	69,200	0.46
.500-20	68,700	0.46
.5625-18	68,200	0.45
Bolt: Waspaloy, unplated Nut: Waspaloy, silver plated		
.164-32	72,400	0.63
.164-36	71,300	0.62
.190-32	71,800	0.62
.250-28	69,700	0.61
.3125-24	69,400	0.60
.375-24	69,300	0.60
.4375-20	69,200	0.60
.500-20	68,700	0.60
.5625-18	68,200	0.59