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Superseding AIR6151

(R) Torque, Threaded Application, Electrical Connector, Accessory and Terminal Board Installation

RATIONALE

Revision is required to incorporate torque values for attaching electrical wiring devices to switches, relays, circuit breakers and A-A-59125 type terminal boards. These torque values are currently listed in non-current ARP1928A and need to be in an active document.

1. SCOPE

This SAE Aerospace Information Report (AIR) is intended to provide guidelines to tightening methods and torque values as applied to electrical connectors, related hardware and switches, relays, circuit breakers and A-A-59125 type terminal boards. The connectors and associated hardware discussed herein, are typically manufactured from aluminum alloy, high grade engineering thermoplastics or corrosion resistant steel and typically plated with a protective/conductive coating. These guidelines may be used where no rules have been mandated either contractually or otherwise.

1.1 Purpose

To aid in the proper assembly of electrical connectors, related hardware and switches, relays, circuit breakers and A-A-59125 type terminal boards in order to avoid damage by over torque or the loosening of parts while in service.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS1310 Fastener Torque for Threaded Applications, Definitions of

AS50151 Connectors, Electrical, Circular Threaded, AN Type, General Specification For

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SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AIR6151A

AS81703 Connectors, Electric, Circular, Miniature, Rack and Panel or Push-Pull Coupling, Environment Resisting

AS85049 Connector Accessories, Electrical, General Specification for

AS85049/1 Connector Accessories, Electrical, Backshell, Environmental, Cable Sealing, Straight, Grounding (Without Strain Relief), Category 1C (for AS50151 Solder Type, V Thread of AS310X Classes A, B, C or K Connectors)

AS85049/2 Connector Accessories, Electrical, Backshell, Environmental, Cable Sealing, Straight, Category 1C (for AS50151 Solder Type, V Thread of AS310X Classes A, B, C or K Connectors)

AS85049/41 Connector Accessories, Electrical, Non-Environmental, Strain Relief, Straight, Category 4C (for AS50151 General Duty 'A' Endbell and AS85049 Accessories)

AS85049/42 Connector Accessories, Electrical, Nonenvironmental, Strain Relief, Straight, Category 4A (for AS50151 Solder Type, V Thread of AS310X Classes A, B, C or K Connectors)

2.1.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-9495, https://assist.daps.dla.mil/quicksearch/.

Military

MIL-DTL-22992 Connectors, Plugs and Receptacles, Electrical, Waterproof, Quick Disconnect, Heavy Duty Type, General Specification For

MIL-DTL-26482 Connectors, Electrical (Circular, Miniature, Quick Disconect, Environment Resisting) Receptacles and Plugs

MIL-DTL-26500 Connectors, General Purpose, Electrical, Miniature, Circular, Environment Resisting, General Specification for

MIL-DTL-27599 Connector, Electrical, Miniature, Quick Disconnect (for Weapons Systems), Established Reliability

MIL-DTL-28840 Connectors, Electrical, Circular, Threaded, High Density, High Shock, Shipboard, Class D, General specification for

MIL-DTL-38999 Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment resistant, Removable Crimp and Hermetic Solder Contacts

MIL-C-81511 Connectors, Electrical, Circular, High Density, Quick Disconnect, Environment Resisting and Accessories, General Specification For

MIL-DTL-83723 Connectors, Electrical, Circular (Environment resisting) Receptacles and Plugs

2.2 Definitions

2.2.1 TORQUE

Torque is the result of force times radius. Typically measured in units of inch-ounces, inch-pounds, foot-pounds, Newton-meters, kilogram-centimeters, etc. (see 3.1 and Table 6).

2.2.2 APPLIED TORQUE

The torque transmitted to the thread by the installation tool.

2.2.3 ASSEMBLY SEQUENCE

A method indicating sequence of assembling fasteners in a prescribed pattern. Also; Installation Sequence, Tightening Sequence, Torquing Sequence.

2.2.4 ASSEMBLY TORQUE

This shall be the design torque applied at final assembly. It shall include the net effect of the following;

a. The torque required to overcome kinetic friction between mating bearing faces and between mating threads.

b. The torque required to overcome the self-locking feature (if any).

c. The torque required to apply the desired axial load to a fastener assembly.

2.2.5 BREAKAWAY TORQUE

This is the torque required to initiate relative motion between male and female threads. Breakaway torque can be prefixed with the words maximum or minimum and shall only be measured in the loosening direction.

2.2.6 OVER TORQUE

This shall be the torque required to initially move the wrenched thread from the installed condition. Over torque is always measured in the tightening direction and exceeds the maximum limit of the desired installation torque. Also: Over Tightening Torque.

2.2.7 PREVAILING TORQUE

This shall be the torque required to overcome kinetic friction of mating threads plus the torque required to overcome the locking feature when 100% of the locking feature is engaged and the threads are unseated. The word "prevailing" shall be understood as the average torque when it is not prefixed by the words maximum or minimum. The prevailing torque can be measured in either a loosening or tightening direction. Also: Run Down Torque/ Running Torque.

2.2.8 SINGLE TORQUE

This shall be the installation torque applied once per assembly, usually applied to freely fitting parts, where no interference fits to hinder the seating of mating parts.

2.2.9 TORQUE OUT

This term refers to a general type of torsional failure where any fastener component reacting to the applied torque, disengages or fails. This term is also used when referring to other types of torquing elements such as interference fits.

2.2.10 UNSEATING TORQUE

This shall be the torque required to initially move the fastener from the installation torque condition. The unseating torque shall always be measured in a loosening direction. Also: Breakaway Torque.

3. REQUIREMENTS

3.1 General

Torque is the force or turning moment tending to produce rotation. It is expressed in terms of applied load and the length of the moment arm applying it in inch-pounds (in-lb). The torques specified herein are those commonly used in the aerospace industry and do not represent thread strength values for qualification testing. It is the responsibility of the user/installer to determine the best torque for the application and to select the appropriate tools and holding devices for the work and the user conditions.

It should be noted that the included torque definitions apply equally to both internal and external threaded parts that may or may not have a locking feature. For all the following torque definitions, the threaded components shall be considered;

a. Seated when its bearing surface contacts the material being joined and any additional applied torque will produce a residual axial stress in either the male or female component.

b. Unseated when the application of removal torque disengages the bearing surface of the threaded component from the material being joined, reducing the axial stress to zero.

3.2 Material

Torque requirements specified herein shall apply to threaded component such as couplings, nuts, screws, bolts, studs and inserts. These items may be separate hardware or integral parts of such components as connectors, backshells or clamps. They will usually be made of corrosion-resistant steel, high grade engineering thermoplastic or aluminum alloy coated with a protective coating. Threads may be locked by lockwashers, self-locking inserts, anti decoupling devices or liquid locking componds. Threads that are locked by deformed metal threads in inserts or contain a material compound that provides a locking feature may be coated with a thread lubricant.

3.3 Temperature Effects

For ambient temperatures outside the range of -1 to 93 °C (30 to 200 °F) allowance must be made for mechanical property differences from tabulated room temperatue values. These properties include tensile strength, yield strength, modulus of elasticity, etc. Where bolts and flange materials are generically dissimilar, such as aluminum and corrosion resistant steel or steel and brass, differences in thermal expansion may cause preload increase or decrease with temperature. Allowance must be made for these changes.

4. TORQUE REQUIREMENTS

4.1 Screw Torque

Recommended torque for corrosion resistant or plated steel screws is listed in Table 1. Column 1 is for standard installation into aluminum or corrosion resistant steel. Column 2 is for installation into composite material regardless of thread length or aluminum material with less than 3 full threads of engagement. Column 3 is for installation in high vibration (engine) areas, clinch nuts and ground straps.

TABLE 1 - CORROSION RESISTANT/PLATED STEEL SCREW TORQUE/IN-LB

Screw Size	Column 1 Min/Max	Column 2 Min/Max	Column 3 Min/Max
2-56	1.5/2.5	1.2/2.0	2.0/2.5
4-40	3.5/4.5	2.8/3.6	3.5/4.5
6-32	5.0/7.0	4.0/5.6	5.5/6.5
8-32	7.0/9.0	5.6/7.2	7.5/8.5
10-32	9.0/11.0	7.2/8.8	8.5/10.5
.250-20	11.0/13.0	8.8/10.4	10.5/15.5

4.2 Connector Receptacle Jam Nut Torque

Recommended torque for aluminum, composite and corrosion resistant steel connector jam nuts are listed in Table 2.

TABLE 2 - CONNECTOR RECEPTACLE JAM NUT TORQUE/IN-LB

Thread Size	Torque Min/Max	Connector Shell Size Reference			
		AS50151	MIL-DTL-26482	MIL-DTL-26500	MIL-DTL-83723 Series I
.500-28UNEF-2B	24/30	8S			
.562-24UNEF-2B	26/32		8		8
.625-24UNEF-2B	28/34	10S - 10SL			
.625-20UN-2B	28/34			8	
.687-24UNEF-2B	30/36		10		10
.750-20UNEF-2B	34/40	12 - 12S		10	
.875-20UNEF-2B	46/50	14 - 14S	12		12
.937-20UNEF-2B	50/55			12	
1.000-20UNEF-2B	55/60	16 - 16S	14	14	14
1.125-20UN-2B	70/75			16	
1.125-18UNEF-2B	70/75	18	16		16
1.250-20UN-2B	80/85			18	18
1.250-18UNEF-2B	80/85	20	18		
1.375-18UNEF-2B	90/95	22	20	20	20
1.500-20UN-2B	105/115			22	
1.500-18UNEF-2B	105/115	24	22		22
1.625-18UNEF-2B	110/120		24	24	24
1.750-18UNS-2B	120/130	28			
2.000-18UNS-2B	150/160	32			
2.250-16UN-2B	170/180	36			
2.500-16UN-2B	200/210	40			
2.750-16UN-2B	220/230	44			
3.000-16UN-2B	240/250	48			

TABLE 2 - CONNECTOR RECEPTACLE JAM NUT TORQUE/IN-LB (CONTINUED)

Thread Size	Torque Min/Max	Connector Shell Size Reference		
		MIL-DTL-83723 Ser. III	MIL-DTL-38999 Ser. I	MIL-DTL-38999 Ser. II
.625-20UN-2B	28/34		9	
.687-24UNEF-2B	30/36	10		
.750-20UNEF-2B	34/40		11	
.812-20UNEF-2B	40/46			8
.875-20UNEF-2B	46/50	12		
.937-20UNEF-2B	50/55	14	13	10
1.000-20UNEF-2B	55/60	16 Bayonet		
1.125-20UN-2B	70/75	16 Threaded	15	12
1.187-18UNEF-2B	75/80	18		
1.250-20UN-2B	80/85	20	17	14
1.250-18UNEF-2B	80/85		19	16
1.437-18UNEF-2B	100/110	22		
1.500-20UN-2B	105/115	24	21	18
1.500-18UNEF-2B	105/115		23	20
1.625-18UNEF-2B	110/120		25	22
1.750-18UNS-2B	120/130			24

TABLE 2 - CONNECTOR RECEPTACLE JAM NUT TORQUE/IN-LB (CONTINUED)

Thread Size	Torque Min/Max	Connector Shell Size Reference			
		MIL-DTL-28840 MIL-PRF-28876	MIL-DTL-27599	MIL-DTL-38999 Series III	MIL-DTL-38999 Series IV
.687-24UNEF-2B	30/36		9		
.750-20UNEF-2B	34/40				
.812-20UNEF-2B	40/46		11		
.875-20UNEF-2B	46/50	11	8		
.937-20UNEF-2B	50/55				
1.000-20UNEF-2B	55/60	13	10 & 13		
1.125-20UN-2B	70/75				
1.125-18UNEF-2B	70/75		12 & 15		
1.187-18UNEF-2B	75/80	15			
1.250-20UN-2B	80/85		14 & 17		
1.250-18UNEF-2B	80/85	17			
1.375-18UNEF-2B	90/95		16 & 19		
1.437-18UNEF-2B	100/110	19			
1.500-20UN-2B	105/115				
1.500-18UNEF-2B	105/115		18 & 21		
1.625-18UNEF-2B	110/120	23	20 & 23		
1.750-18UNS-2B	120/130	25	22 & 25		
1.875-16UN-2B	140/150		24		
1.937-16UN-2B	145/155	29			
2.000-18UNS-2B	150/160				
2.125-16UN-2B	170/180	33			

TABLE 2 - CONNECTOR RECEPTACLE JAM NUT TORQUE/IN-LB (CONTINUED)

Thread Size	Torque Min/Max	Connector Shell Size Reference			
		MIL-DTL-28840 MIL-PRF-28876	MIL-DTL-27599	MIL-DTL-38999 Series III	MIL-DTL-38999 Series IV
M17 x 1-6H	30/36			09	
M20 x 1-6H	40/46			11	
M25 x 1-6H	55/60			13	11
M28 x 1-6H	70/75			15	13
M31 x 1-6h	70/75				15
M32 x 1-6H	80/85			17	
M34 x 1-6H	80/85				17
M35 x 1-6H	90/95			19	
M38 x 1-6H	100/110			21	19
M41 x 1-6H	110/120			23	21
M44 x 1-6H	120/130			25	23
M47 x 1-6H	120/130				25

4.3 Secondary Adapter and AS Cable Clamp Torque

Recommended torque for aluminum and corrosion resistant steel secondary adapters and AS85049/41 and /42 type cable clamps are listed in Table 3. Cable clamps that utilize elastomeric sealing grommets such as AS85049/1 and /2 need adaquate torque applied to assure proper cable sealing but not over torqued to the extent that the sealing grommet extrudes. For all assemblies where metal braided RFI/EMI shielding is terminated using conical metal ferrule(s), the minimum recommended torque is 35 in-lb.

TABLE 3 - SECONDARY AND AS CABLE CLAMP TORQUE/IN-LB

AS Clamp Size	Torque Min/Max
3	30/40
4	30/40
6	35/55
8	35/55
10	35/55
12	40/60
16	40/60
20	40/60
24	80/100
28	80/100
32	80/100
40	80/100

4.4 Connector Accessory Recommended Torque

Recommended torque for accessories such as those defined in SAE AS85049 to connector rear threads are listed in Table 4.

Column 1 is for aluminum medium and light duty accessories including connector series;

AS50151 (AS31001 Series)
MIL-DTL-26482 Series 1
MIL-DTL-26500
MIL-DTL-27599
MIL-DTL-38999 Series I and II
MIL-C-81511 Series 1, 2, 3, 4
AS81703 Series 1

Column 2 is for aluminum heavy duty accessories including connector series;

AS50151 (AS34001 Series)
MIL-DTL-22992
MIL-DTL-26482 Series 2
MIL-DTL-28840
MIL-DTL-38999 Series III and IV
AS81703 Series 3
MIL-DTL-83723 Series I, II, III

Column 3 is for accessories with composite (high grade engineering thermoplastic) material coupling threads.

Column 4 is for accessories with aluminum coupling threads used in high vibration (engine) applications.

Column 5 is for accessories with corrosion resistant steel coupling threads used in high vibration (engine) applications.

TABLE 4 - CONNECTOR ACCESSORY TORQUE/IN-LB

Connector Shell Sizes	Column 1 Min/Max	Column 2 Min/Max	Column 3 Min/Max	Column 4 Min/Max	Column 5 Min/Max
8,9,A	30/40	51/61	20/25	66-77	91-101
3,10,10SL, 11, B	30/40	71/81	20/30	103-113	115-125
7,12,12S,13,C	35/45	103/113	25/35	115-125	115-125
14,14S,15,D	35/45	111/121	25/35	139-149	139-149
16,16S,17,E	35/45	111/121	30/40	139-149	139-149
18,19,27,F	35/45	111/121	30/40	139-149	175-185
20,21,37,G	75/85	131/141	35/45	175-185	199-209
22,23,H	75/85	131/141	35/45	175-185	223-233
24,25,61,J	75/85	131/141	35/45	175-185	259-269
28,29	115/125	143/153	115/125	187-197	307-317
32,33	115/125	143/153			
36	115/125	142/153			
40	155/165	159/169			
44	155/165	159/169			
48	155/165	159/169			

4.5 Connector to Connector (Plug to Receptacle) Coupling Torque

Recommended torques for coupling threaded plug and receptacle connectors are shown in Table 5.

TABLE 5 – CONNECTOR TO CONNECTOR TORQUE/IN-LB

Connector Series Shell Size					
Connector Torque Max/in-lb	MIL-DTL-28840 MIL-PRF-28876	MIL-DTL-38999 Series III	MIL-DTL-83723 Series II	MIL-DTL-83723 Series III	AS50151
8		A (9)			
11				8	
12	A (11)	B (11)	8S		8S
13				10	
14			10S & 10SL	12	10S & 10SL
16	B (13)	C (13)	12 & 12S		12 & 12S
18				14	
20	C (15)	D (15)	14 & 14S		14 & 14S
21				16	
24	D (17)	E (17)	16 & 16S		16 & 16S
27				18	
28	E (19)	F (19)			
30			18		18
31				20	
32		G (21)		22	
36	F (23)	H (23)			
40	G (25)	J (25)	20		20
46			22	24	22
47	H (29)				
53	J (33)				
55			24		24
66			28		28
78			32		32
93			36		36
106			40		40

4.6 Torque for switches, relays, circuit breakers and A-A-59125 type terminal boards.

Recommended Application Torques for switches, relays, circuit breakers and A-A-59125 type terminal boards are as shown in Table 6.

TABLE 6 - RECOMMENDED APPLICATION TORQUE

Screw Size	Material	
	Steel (55 000 psi Tensile Strength Minimum)	Brass/Aluminum (60 000 psi Tensile Strength Minimum)
	Recommended Torque Values 1/	Recommended Torque Values 1/
#6 (0.138 in) -32 UNC	8-10	7-9
#6 (0.138 in) -40 UNF	8-11	8-10
#8 (0.164 in) -32 UNC	11-17	11-17
#8 (0.164 in) -36 UNF	11-19	11-18
#10 (0.190 in) -24 UNC	20-25	18-23
#10 (0.190 in) -32 UNF	20-29	20-25
1/4 in -20 UNC	55-62	50-58
1/4 in -28 UNF	60-70	58-66
5/16 in -18 UNC	80-105	70-80
5/16 in -24 UNF	90-140	80-90
3/8 in -16 UNC	110-145	85-105
3/8 in -24 UNF	115-175	90-110
7/16 in -14 UNC	125-160	100-125
7/16 in -20 UNF	130-190	120-150
1/2 in -13 UNC	135-175	115-150
1/2 in -20 UNF	150-200	150-200
9/16 in -12 UNC	195-215	195-215
9/16 in -18 UNF	210-275	210-275
5/8 in -11 UNC	270-300	230-300
5/8 in -18 UNF	300-400	300-400
3/4 in -10 UNC	475-530	400-530
3/4 in -16 UNF	525-700	525-700
7/8 in -9 UNC	770-850	650-850
7/8 in -14 UNF	835-1100	835-1100

1/ All values are in inch-pounds and believed to be applicable to switches, relays, circuit breakers and A-A-59125 type terminal boards.

4.6.1 Purpose

The purpose of table 6 is to provide recommended torque values for attaching electrical devices to receiving members by means of screws, bolts, studs and nuts, i.e., standard mounting hardware.

The values provided in the table cover selected steel, brass and aluminum materials used for standard mounting hardware. These values were based upon safe mechanical strengths as defined by general industry practices and existing aerospace requirements.

These recommendations are general guidelines. Safety factors for any unusual mounting applications or operating conditions, such as vibration, impact, shear, and fatigue, should be given special consideration by the designer.

The specified values are not intended to be design criteria for the minimum torque values that switches, relays, circuit breakers and A-A-59125 type terminal boards should be able to withstand without failure.

Also, these values are not intended to supersede those recommended by equipment manufacturers or required by the equipment designer.

5. APPLICATION INFORMATION

5.1 Do not use tightening or gripping tools with metal jaws or grippers such as pliers and wrenches on electrical connectors, jam nuts, accessories or backshells. Non-marring tools such as strap wrenches, soft jaw pliers, lined ring grippers, and similar tools shall be used to avoid damage to plating and the integrity of the connector/accessory surfaces.

5.2 When mating connectors, dummy connectors, and special tools configured to engage the connector keys for holding while applying torque are used, multiple keys shall be engaged (with exception of connectors conforming to AS50151). Care must also be taken not to damage spring (grounding) fingers, sealing components, plating or other features of connectors (plugs or receptacles) when these holding devices are being used.

5.3 When tightening multi-stage backshells or connector accessories, the holding point must be moved one stage from the components being tightened to assure even tightening of each stage.

5.4 When tightening thin coupling rings and similar threaded components on electrical connectors, avoid gripping tools that apply force to two points (such as soft jaw pliers). Devices which apply a uniform load around the circumference of the coupling ring (such as strap wrenches and lined circular ring pliers) are preferred.

5.5 Torque is measured with a calibrated torque wrench or torque meter (Figure 1). The distance between the center of the torque drive and the center of the point where rotational force is applied establishes the basis of the calibration. Applying extensions (such as strap wrenches, crowfoot, or clamping grips) will increase the applied torque and cause an error in the registered torque on the wrench or meter. A correction table or calculation as shown below shall be used to correct the torque reading.

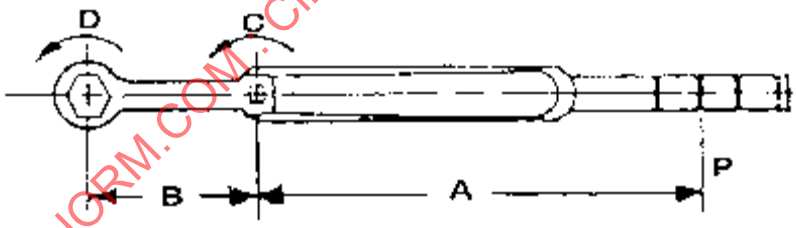

FIGURE 1 – TORQUE WRENCH

When an adapter or extension is used on a torque wrench it increases the torque range of the wrench. The formula for computing torque when using an adapter or extension is explained below

A = (Length) Distance from the center of torque wrench square drive to center of the puller's hand grip.

B = Distance from center of torque wrench square drive to center of drive at end of extension.

C = (Torque) Torque wrench setting.

D = Torque desired at drive on end of extension.

P = (Force) Pull applied.

To determine torque wrench setting; $C=(D \cdot A) / (A+B)$