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As part of Manitowoc's on going **Corrosion Prevention Initiative** effective with July 2010 shipments we will be phasing in stainless steel and zinc-flake coated fasteners on the machines built in Shady Grove.

Stainless steel fasteners are made of steel that has been mixed with at least a ten percent compound of chromium, and possibly other metals, so that the steel doesn't rust or corrode.

Zinc-flake coating fasteners have several advantages over other coatings, some of which are:

- Increased corrosion protection by providing a zinc and aluminum flake surface that keeps the corrosive media away from the steel substrate,
- Increased corrosion protection through sacrificial corrosion of the zinc
- Increased corrosion protection by passivation
- The coating is self-repairing by migrating the zinc oxides and carbonates to damaged areas of the coating
- It introduces no hydrogen embrittlement concerns on high strength fasteners
- RoHS compliant: contains no hazardous substances including hexavalent chromium
- Has a specially designed topcoat to provide consistent torque/tension values
- Is resistant to solvents, gasoline and brake fluid
- Extensively tested by external labs for Manitowoc including torque/tension tests and salt spray tests for corrosion resistance
- Has been in use on our GMK products for three years before introduction on our North America products.

These changes in fastener material and coatings will result in a change to the torque requirements over the tradition hardware supplied on Grove Cranes and sold by Manitowoc Crane Care. Attached are the new torquing procedures and tables for the stainless, zinc-flake coating and untreated black fasteners.

1.0 **DESCRIPTION:** Approved Torque Values for Threaded Fasteners

2.0 **SCOPE:**

2.1 This specification covers the approved installation torque for different grades of threaded fasteners for both inch series and for metric threads.

3.0 **General:**

3.1 The Inch thread form in use at Manitowoc is the "Unified" form in both the UNC (coarse) and UNF (fine) threads per ASME B1.1, and to the following Unified Standard class of fit:

3.1.1 Uncoated – 2A/2B, except for socket head cap screws which shall be 3A

3.1.2 Coated – 3A/3B AFTER COATING

3.2 Metric fasteners are specified by diameter in mm and thread pitch per ASME B1.13M or ISO 261. If the thread pitch is omitted the coarse thread designation is assumed. The metric thread class of fit will meet the following:

3.2.1 Uncoated - 6H/6g (Unified equivalent 2A/2B) except for socket head cap screws which shall be 4g6g (Unified equivalent 3A).

3.2.2 Coated - 4H5H/4h6h AFTER COATING (Unified equivalent 3A/3B).

4.0 **Procedure:**

4.1 Properly sized torque wrenches, periodically calibrated shall be used to apply the torque values specified herein.

4.2 All fasteners that use hardened flat washers must be torqued. The max/min values shown as the acceptable range represents the allowable variation in the applied torque.

4.3 Whenever the torque on any fastener combination has been exceeded, the bolt/nut shall be replaced and discarded. If installation is in a tapped hole, that thread shall be checked with a gage and the bolt replaced.

4.4 No gap is permitted between two mating surfaces in the area of the bolt after proper torque has been applied. Paint, primer and finish are not permitted on turntable bearing mounting surfaces, TMS steering box mounting surfaces.

4.5 Previously installed bolts and nuts of Grade 8 or Class 10.9 and higher may NOT be reused.

Those of Grade 5 and Class 8.8 may NOT be reused unless they have not been over-torqued and they meet these requirements:

4.5.1 Bolts/nuts shall be visually inspected for cracks and thread damage and replaced if discontinuities are found.

4.5.2 Bolts/nuts are not to be rethreaded or reworked.

4.6 Torque values for Grade 5 and 8 or Class 8.8, 10.9 and 12.9 bolts threaded into tapped holes are the same as for a nut/bolt combination. Lower grade bolts installed in thin-

sectioned, tapped holes shall be tightened with caution in lieu of using either the turn-of-the-nut or measured torque methods.

4.7 Studs shall be torqued using cap screw figures when grade is known.

5.0 Lubrication:

5.1 When special high pressure lubricants such as Never-Seez, Molybdenum disulphite, etc. are used on non-coated threaded fasteners use the same installation torque values in sections 10.x.1 (zinc-flake coated.)

5.2 The use of lubricants on zinc flake coated parts shall be prohibited since this will change the required torque stated in the specification.

6.0 Washers:

6.1 Hardened flat washers must be used with all high strength fasteners (Grade 5, Grade 8, Class 8.8, Class 10.9 and higher) that require torquing.

7.0 Identification:

7.1 All Grade 5, Grade 8, Class 8.8, Class 10.9 and Class 12.9 fasteners shall have the grade and manufacturer's identification applied to the fastener per ASTM A563/A563M for nuts and SAE J429/ASTM F568M for bolts as applicable.

8.0 MARKING:

8.1 All fasteners shall be marked with the property class identification symbol and manufacturer's identification symbol in accordance with SAE J1199, or ASTM A563M as applicable. All hex socket cap fasteners shall have markings indented on the top or the side of the head.

9.0 TORQUE VALUES:

9.1 Inch Series with Coarse Threads (UNC)

9.1.1 Torque Values for fasteners with **zinc-flake coating** (Friction Coefficient of 0.12).

9.1.2 Torque Values for fasteners with **untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	Strength GRADE	TORQUE Zinc Coating ft lbf	TORQUE Untreated Finish ft lbf	MAX CLAMP LOAD lbf	MIN CLAMP LOAD lbf
1/4	5	7	9.0 / 7.7	2350	1591
	8	10	12.5 / 11.5	3311	2268
5/16	5	14	19 / 17	3884	2616
	8	20	26 / 24	5475	3727
3/8	5	25	32 / 30	5753	3866
	8	36	48 / 44	8112	5505
7/16	5	40	52 / 48	7895	5301
	8	57	73 / 67	11133	7548
1/2	5	61	78 / 72	10555	7070
	8	86	120 / 110	14884	10064
9/16	5	88	114 / 106	13549	9063
	8	124	161 / 143	19108	12898
5/8	5	121	156 / 144	16832	11252
	8	171	234 / 216	23739	16011
3/4	5	213	270 / 249	24922	16609
	8	301	385 / 355	35155	23626
7/8	5	342	416 / 384	34508	22960
	8	483	615 / 567	48681	32654
1	5	512	606 / 560	45279	30111
	8	723	929 / 857	63876	42821
1 1/8	5		813 / 751		
	8		1342 / 1234		
1 1/4	5	884	1141 / 1053	63143	41872
	8	1433	2043 / 1885	102331	68377
1 1/2	5	1532	2028 / 1865	91603	60692
	8	2488	327 / 3024	148458	99102

9.2 Inch Series with Fine Threads (UNF)

9.2.1 Torque Values for fasteners **with zinc-flake coating** (Friction Coefficient of 0.12).

9.2.2 Torque Values for fasteners **with untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	Strength GRADE	TORQUE Zinc Coating ft lbf	TORQUE Untreated Finish ft lbf	MAX CLAMP LOAD lbf	MIN CLAMP LOAD Lbf
1/4	5	8	10 / 9	2712	1812
	8	11	14.5 / 13.5	3825	2578
5/16	5	15	21 / 19	4328	2884
	8	22	26 / 21	6105	4103
3/8	5	28	36 / 34	6575	4357
	8	39	53 / 49	9277	6193
7/16	5	44	57 / 53	8885	5892
	8	61	85 / 79	12535	8376
1/2	5	66	88 / 81	11997	7925
	8	94	125 / 115	16930	11262
9/16	5	95	126 / 116	15234	10060
	8	134	177 / 163	21498	14295
5/8	5	132	182 / 167	19245	12673
	8	186	250 / 230	27159	18004
3/4	5	229	312 / 287	28069	18453
	8	323	425 / 393	39613	26212
7/8	5	364	458 / 421	38314	25177
	8	514	672 / 620	54074	35761
1	5	543	658 / 606	49891	32800
	8	766	1009 / 931	70412	46591
1 1/8	5		882 / 814		
	8		1500 / 1380		
1 1/4	5	944	1251 / 1155	70509	52984
	8	1530	2092 / 1925	114315	75230
1 ½	5	1654	2288 / 2105	104109	77968
	8	2682	3640 / 3360	168801	110673

9.3 Metric Series with Coarse Threads.

9.3.1 Torque Values for fasteners **with zinc-flake coating** (Friction Coefficient of 0.12).

9.3.2 Torque Values for fasteners **with untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	Property Class	TORQUE Zinc Coating Nm	TORQUE Untreated Finish Nm	MAX CLAMP LOAD kN	MIN CLAMP LOAD kN
M4	8.8	2.6	3.1 / 2.8	4.6	3.1
	10.9	3.7	4.5 / 4.1	6.4	4.3
	12.9	4.3	5.4 / 4.9	7.4	5.1
M5	8.8	5.2	6.5 / 5.9	7.4	4.7
	10.9	7.5	9.2 / 8.5	10.7	6.8
	12.9	9.0	11 / 10	12.9	8.2
M6	8.8	9.0	11 / 10	10.5	6.7
	10.9	12.5	16 / 14	14.6	9.3
	12.9	15.0	19 / 17	17.5	11.2
M8	8.8	21.6	27 / 25	19.0	12.1
	10.9	31.5	38 / 35	27.8	17.7
	12.9	36.0	45 / 42	31.8	20.2
M10	8.8	42.4	53 / 49	30.2	19.2
	10.9	62.0	75 / 69	44.1	28.0
	12.9	75.0	89 / 83	53.4	33.9
M12	8.8	73.1	93 / 85	43.9	27.9
	10.9	110	130 / 120	66.1	42.0
	12.9	128	156 / 144	76.9	48.8
M14	8.8	116	148 / 136	60.2	38.2
	10.9	170	212 / 195	87.8	55.7
	12.9	205	248 / 228	105.9	67.2
M16	8.8	178	230 / 212	82.1	51.7
	10.9	265	322 / 298	122.0	76.8
	12.9	315	387 / 357	145.0	91.3
M18	8.8	250	319 / 294	100.5	63.6
	10.9	365	455 / 418	147.0	93.1
	12.9	435	532 / 490	175.2	110.9
M20	8.8	349	447 / 413	128.2	80.8
	10.9	520	629 / 581	191.1	120.4
	12.9	615	756 / 698	226.0	142.4
M22	8.8	467	608 / 562	159.3	100.0
	10.9	700	856 / 790	238.8	149.9
	12.9	830	1029 / 949	283.1	177.8

9.3.1 (*Cont'd*) Torque Values for fasteners **with zinc-flake coating** (Friction Coefficient of 0.12).

9.3.2 (*Cont'd*) Torque Values for fasteners with **untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	Property Class	TORQUE Zinc Coating Nm	TORQUE Untreated Finish Nm	MAX CLAMP LOAD kN	MIN CLAMP LOAD kN
M24	8.8	600	774 / 714	184.6	116.3
	10.9	900	1089 / 1005	277.0	174.6
	12.9	1060	1306 / 1206	326.2	205.6
M27	8.8	877	1134 / 1046	241.4	151.3
	10.9	1325	1591 / 1469	364.8	228.7
	12.9	1550	1910 / 1763	426.7	267.5
M30	8.8	1195	1538 / 1420	294.2	184.8
	10.9	1800	2163 / 1997	443.3	278.5
	12.9	2125	2595 / 2395	523.3	328.7
M33	8.8	1608		364.9	228.3
	10.9	2450		556.1	348.0
	12.9	2850		646.9	404.8
M36	8.8	2072		429.1	269.1
	10.9	3150		652.3	409.0
	12.9	3700		766.2	480.4

9.4 **Metric Series with Fine Threads.**

9.4.1 Torque Values for fasteners **with zinc-flake coating** (Friction Coefficient of 0.12).

9.4.2 Torque Values for fasteners with **untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	Property Class	TORQUE Zinc Coating Nm	TORQUE Untreated Finish Nm	MAX CLAMP LOAD kN	MIN CLAMP LOAD kN
M8x1	8.8	23	29 / 27	20.5	13.8
	10.9	34	41 / 38	30.9	20.7
	12.9	41	49 / 45	36.8	24.6
M10x1	8.8	46	57 / 53	34.0	22.6
	10.9	71	81 / 75	52.5	34.9
	12.9	84	96 / 90	62.2	41.4
M10x1.25	8.8	44	57 / 53	32.1	21.5
	10.9	66	81 / 75	47.7	32.0
	12.9	79	96 / 90	57.5	38.6
M12x1.5	8.8	75	100 / 92	46.1	30.9
	10.9	113	140 / 130	69.2	46.4
	12.9	135	168 / 156	82.7	55.4
M14x1.5	8.8	123	160 / 147	65.5	43.7
	10.9	188	229 / 211	100.4	66.9
	12.9	220	268 / 246	117.5	78.3
M16x1.5	8.8	185	248 / 229	88.2	58.6
	10.9	285	348 / 322	136.3	90.5
	12.9	335	418 / 386	160.2	106.4
M18x1.5	8.8	270	345 / 318	114.4	75.7
	10.9	415	491 / 451	176.0	116.4
	12.9	485	575 / 529	205.7	136.1
M20x1.5	8.8	374	483 / 446	143.9	94.9
	10.9	575	679 / 627	221.5	146.2
	12.9	675	816 / 754	260.0	171.6
M22x1.5	8.8	496	657 / 607	176.8	116.4
	10.9	770	924 / 853	274.4	180.7
	12.9	900	1111 / 1025	320.7	211.2

9.4.1 (*Cont'd*) Torque Values for fasteners **with zinc-flake coating** (Friction Coefficient of 0.12).

9.4.2 (*Cont'd*) Torque Values for fasteners with **untreated (black) finish** (Friction Coefficient of 0.14)

SIZE	**Property Class**	**TORQUE** Zinc Coating **Nm**	**TORQUE** Untreated Finish **Nm**	**MAX CLAMP LOAD kN**	**MIN CLAMP LOAD kN**
M24x2	8.8	635	836 / 771	203.3	134.5
	10.9	980	1176 / 1085	313.7	207.6
	12.9	1145	1410 / 1302	366.5	242.5
M27x2	8.8	922	1225 / 1130	262.8	173.3
	10.9	1425	1718 / 1587	406.3	268.0
	12.9	1675	2063 / 1904	477.6	315.0
M30x2	8.8	1279	1661 / 1534	329.9	217.1
	10.9	2025	2336 / 2157	522.5	343.8
	12.9	2375	2800 / 2590	612.8	403.3
M33x2	8.8	1707		404.6	265.7
	10.9	2500		592.6	389.2
	12.9	2900		687.4	451.5
M36x3	8.8	2299		483.8	320.0
	10.9	3590		755.6	499.8
	12.9	4200		884.0	884.0

9.5 Metric Series Screws of STAINLESS STEEL A2-70/A4-70 with Coarse Threads.

9.5.1 Torque Values for fasteners **with oil lubrication** (Friction Coefficient of 0.1) These torque and preload values result in a 80% utilization of the yield strength.

SIZE	Friction Coefficient	TORQUE w/ Oil Lubrication Nm	CLAMP LOAD kN
M2.5	0.1	0.4	0.8
M3	0.1	0.9	0.9
M4	0.1	1.5	2.67
M5	0.1	3.1	4.36
M6	0.1	5.3	6.16
M8	0.1	13.0	11.3
M10	0.1	27.0	18.0
M12	0.1	45.0	26.2
M14	0.1	71.1	36
M16	0.1	109	50
M18	0.1	157	62
M20	0.1	220	80

9.5.2 Note: Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads with oil or molybdenum disulfide and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

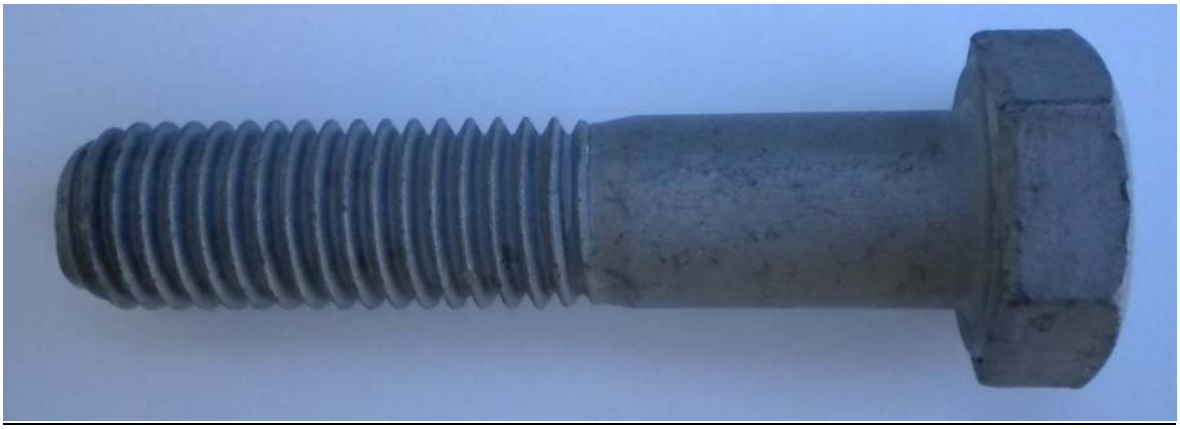
9.6 Inch Series Screws of STAINLESS STEEL 300 (18-8) with Coarse Threads.

9.6.1 Torque Values for fasteners **with oil lubrication** (Friction Coefficient of 0.1) These torque and preload values result in a 80% utilization of the yield strength.

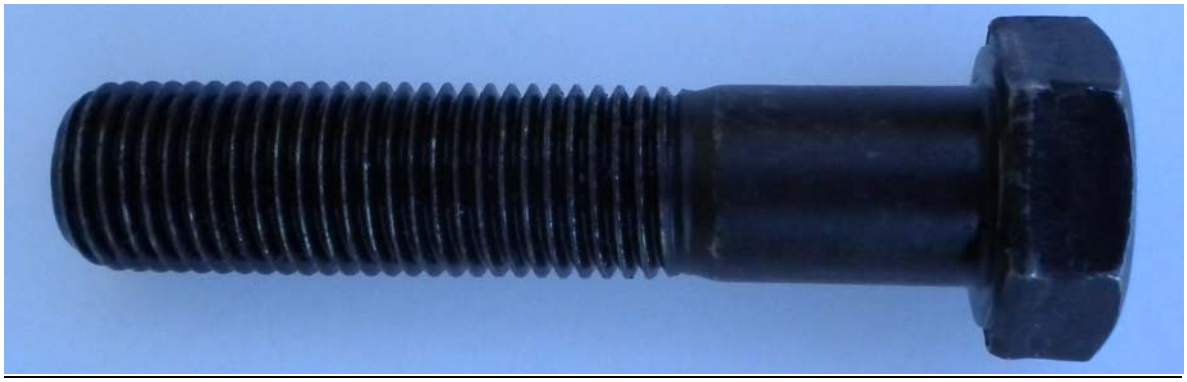
SIZE	Friction Coefficient	TORQUE w/ Oil Lubrication		CLAMP LOAD
		lb-in	lb-ft	lb
#5 (0.125)	0.1	6.9	-	313
#8 (0.164)	0.1	18	-	540
#10 (0.190)	0.1	21	-	540
1/4	0.1	68	-	1350
5/16	0.1	120	(10)	1900
3/8	0.1	(210)	17.5	2830
7/16	0.1	(340)	28	3880
1/2	0.1	-	39	4640
5/8	0.1	-	74	7080
3/4	0.1	-	114	9140

9.6.2 Note: Stainless steel fasteners tend to gall while being tightened. To reduce this risk, lubricate the threads with oil or molybdenum disulfide and torque at low speeds without interruptions. Do not use excessive pressure. Impact wrenches are not recommended.

Hardware Examples



Zinc-flake coating
Matte Finish



Untreated (black) finish

Stainless Steel
Shiny