

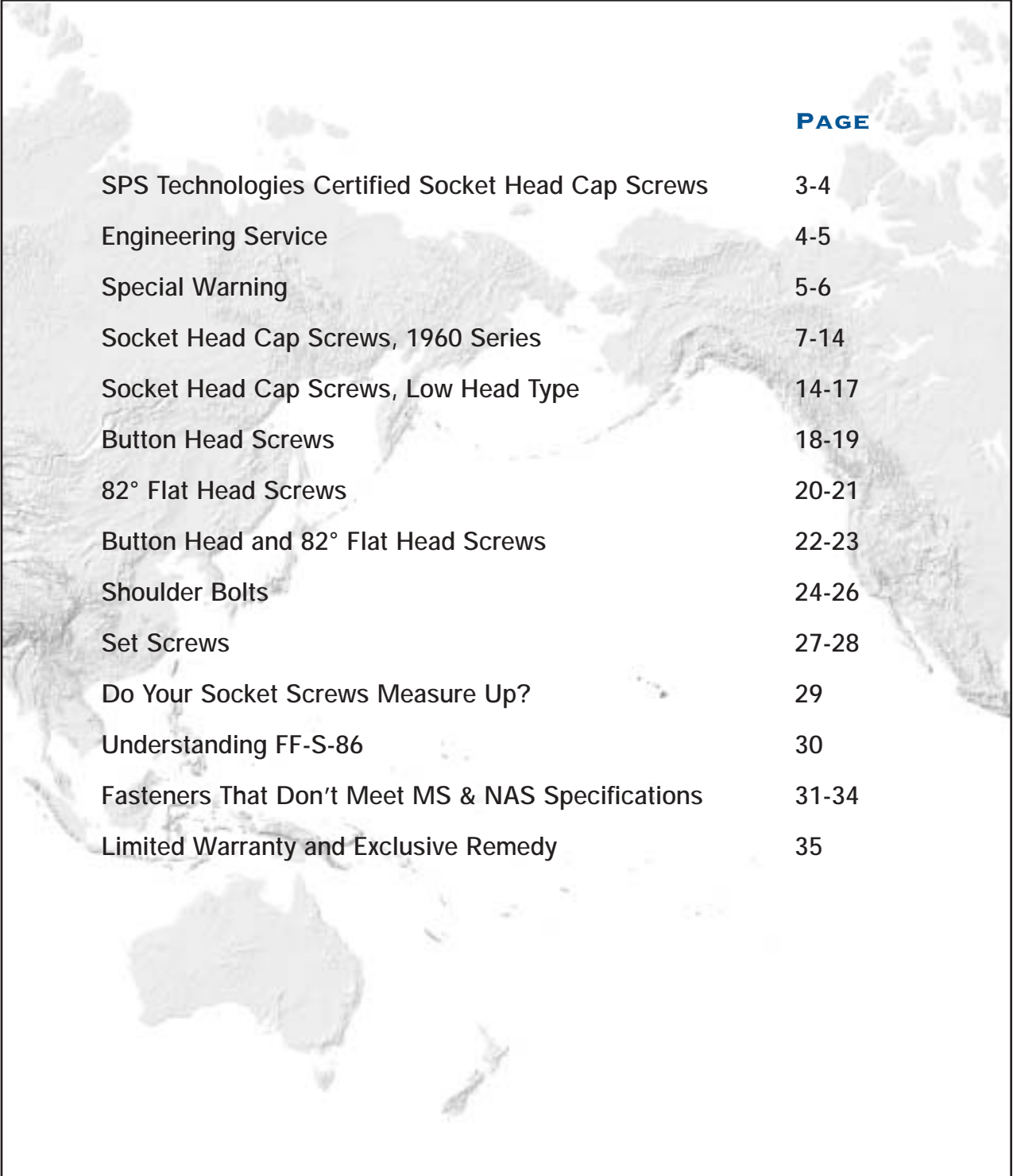
SPS
CERTIFIED



SPS
TECHNOLOGIES
AEROSPACE FASTENERS
A PCC COMPANY



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CAGE NO. 56878

SPS TECHNOLOGIES CERTIFIED SOCKET HEAD CAP SCREWS

The complexity of producing fasteners to the FF-S-86 specification demands absolute control of each process throughout the manufacturing system. The consequences of a breakdown in any area could be part failures and serious losses.



Proper quality assurance standards should substantially reduce the number of flawed parts. But a higher assurance of quality results from statistical process control of a complete “in-house” manufacturing system—from design to the finished part. This provides certifiable control of the quality of each lot of fasteners at every phase of manufacture. SPS Technologies Aerospace Fasteners Group maintains this type of comprehensive “in-house” system.

THE Advantages of SPS Socket Head Cap Screws

- Tensile strength levels maintained at 190,000 and 180,000 psi—higher than current government and industry standards
- Superior fatigue resistance resulting from advanced design, mechanical properties and close control of the manufacturing process
- Deep, accurate socket for high torque wrenching
- Precision forged for symmetrical grain flow, maximum strength
- Fully formed radiused thread increases fatigue life
- Controlled heat treatment produces maximum strength without brittleness

Product Testing and Certification

SPS never takes short-cuts in the manufacture of socket head cap screws to assure that you receive consistently high quality products that meet the FF-S-86 specification.

Product quality control includes:

- Process control from lot to lot to decrease variation and increase consistency
- A larger percentage of fasteners — in many instances — undergo increased inspection control measures
- In-process metallurgical inspections include tests for tensile, hardness, stress corrosion and stress durability on plated parts
- Comprehensive dimensional, discontinuity, mechanical property (hardness and axial tension or wedge tension testing), metallographic (carburization and decarburization examination) testing
- Inspection lots per FF-S-86—screws are same type; same size; same length and threads; made from the same heat of material; have the same heat treatment, protective coating and surface treatment
- Final inspection is performed on dimensions to achieve zero defects. This criteria is much more rigid than that required under the ASME specification

Plating

SPS Technologies' Jenkintown facility maintains a unique, on-site high technology plating facility to ensure complete control of this critical process for socket head cap screws.

Designed and developed by SPS Technologies, this plating facility uses computer-controlled equipment to assure uniform quality from part-to-part and lot-to-lot.

Computer control also provides the ability to maintain exact plating thicknesses and tolerances to preserve precision thread fit and meet specifications. What's more, repeatability is enhanced with the capability to store part history and formulas for subsequent orders.

Plating Highlights...

- The SPS Technologies plating facility can produce four different platings at once and can perform rack & barrel plating
- SPS uses a 23 hour bake within four hours of plating to minimize the embrittlement potential
- Stress durability testing capability to confirm hydrogen embrittlement relief treatment

ENGINEERING SERVICE

SPS Technologies has the experience and resources to meet your most exacting requirements for the application of certified socket head cap screws in critical applications...

- Nearly a century of experience manufacturing high quality, precision fasteners and components
- Unique capabilities to provide total responsibility for all phases of production involved in the precision manufacture of fasteners
- Expertise with special materials, close tolerances and critical dimensions
- Comprehensive testing and design engineering services
- Stringent quality assurance for all products, including Statistical Process Control (SPC)

Special Socket Head Cap Screws

Whether your application requires a slight modification of a socket head cap screw or a completely different configuration, SPS Technologies can meet your requirements. Special materials, sizes and finishes can all be supplied to your specifications. Our engineers, supported by experienced technical staff, are ready to help you solve your fastening problems. Fax a description of your application and special needs for prompt no-obligation assistance.

Telephone: 215-572-3000
Fax: 215-572-3133

SPECIAL WARNING

Failure to provide qualified source controlled parts where specified can result in harsh penalties.

The source controlled parts in question are NAS 1351 and 1352 socket head cap screws. Regardless of who purchases these parts initially, if the end-user is BOEING, then the manufacturer must be listed in the Boeing D590 standards. To assume these parts may not be going into a Boeing program is inadequate and irresponsible.

Harsh Penalties

The temptation to supply parts based solely on price from sources not approved by Boeing is great. However, Boeing has stated that failure to comply with Boeing specifications and the D590 standards page will result in the scrapping of parts at the

seller's expense, cancellation of the purchase order and removal of the subcontractor from the authorized bidders list for a minimum of (30) thirty days. Repeat violations will result in harsher penalties.

SPS IS AN APPROVED SOURCE

SPS Technologies prides itself on our commitment to quality and our ability to meet exacting specifications. Through a major investment of equipment and technology, SPS has the capability to manufacture these parts completely in-house and, for this primary reason, has been named by Boeing as a D590 qualified source for NAS 1351 and 1352 socket head cap screws. Don't confuse these parts with standard socket screws. They are more expensive because their processing requirements are more comprehensive, due to the critical nature of their use.

Don't Jeopardize Your Reputation

Make sure, when you are supplying these parts that you know where they are ultimately going to be used. Even when the purchaser is a subcontractor, keep in mind that the end use for these may be part of a Boeing assembly and therefore must be supplied by a manufacturer listed on the D590. If you or your customer are not certain as to their end-use; you have a policy decision to make. Drawings subject to revision. To assure you have current drawings contact SPS Technologies Aerospace Product Engineering Dept. or reference the SPS Fastener Finder on our web site: www.spstech.com/aero.

Products listed as Military Standards have been manufactured to meet or exceed those standards. To verify latest qualifications status, contact SPS Technologies Aerospace Fasteners Group Customer Service Department.

The products in this catalog have been designed and manufactured to perform to specific standards for the military/aerospace markets.

Reworking, modifying, plating or re-plating, altering or causing the same to be done on

any SPS product as manufactured, certified and supplied by SPS Technologies is prohibited. In the event that such action is taken, product cannot be represented as SPS product.

The standards contained herein take precedence over documents referenced herein. Referenced drawings, standards and documents shall be of the issue in effect on date of invitation to bid. Catalog drawings and part numbers are for ordering purposes only.

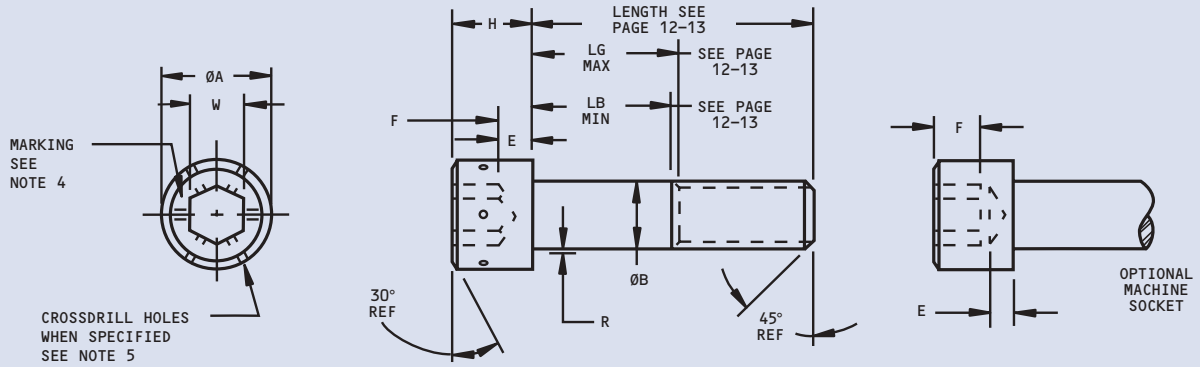
SPS TECHNOLOGIES SOCKET HEAD CAP SCREWS

WARNING: Please use the following important information when selecting fasteners from the following pages:

Recommended seating torques listed serve as guidelines only. Even when using the recommended seating torques, the induced loads obtained may vary as much as $\pm 25\%$ depending upon the uncontrolled variables such as mating material, plating, lubrication,

surface finish, hardness, bolt/joint compliance and method of tightening. The best way to determine the correct torque is to run tests on the particular joint by tightening sample bolts until they reach yield. The optimum torque is 80% of this value.

SOCKET HEAD CAP SCREW, HEXAGON RECESS, ALLOY AND STAINLESS STEEL 1960 SERIES



STANDARDS AND SPECIFICATIONS: FF-S-86

DASH NO.	THREAD SIZE	ØA	ØB	E MIN.	F MIN.	H	R FILLET EXT.	W NOM.
90	.060-80 UNRF-3A	.096	.060	.020	.025	.060	.007	.050
91	.073-64 UNRC-3A	.091	.0568			.057	.003	
	.073-72 UNRF-3A	.118	.073	.025	.031	.073	.007	.062
92	.086-56 UNRC-3A	.112	.0695			.070	.003	
	.086-64 UNRF-3A	.140	.086	.029	.038	.086	.008	.078
93	.099-48 UNRC-3A	.134	.0822			.083	.004	
	.099-56 UNRF-3A	.161	.099	.034	.044	.099	.008	.078
	.099-56 UNRF-3A	.154	.0949			.095	.004	
94	.112-40 UNRC-3A	.176	.1075			.108	.005	
	.112-48 UNRF-3A	.183	.112	.038	.051	.112	.009	.094
	.112-48 UNRF-3A	.176	.1075			.108	.005	
95	.125-40 UNRC-3A	.205	.125	.043	.057	.125	.010	.094
	.125-44 UNRF-3A	.198	.1202			.121	.006	
96	.138-32 UNRC-3A	.218	.1329			.134	.006	
	.138-40 UNRF-3A	.226	.138	.047	.064	.138	.010	.109
	.138-40 UNRF-3A	.218	.1329			.134	.006	
98	.164-32 UNRC-3A	.270	.164	.056	.077	.164	.012	.141
	.164-36 UNRF-3A	.262	.1585			.159	.007	
3	.190-24 UNRC-3A	.303	.184	.065	.090	.185	.009	.156
	.190-32 UNRF-3A	.312	.190			.190	.014	
4	.250-20 UNRC-3A	.375	.250	.095	.120	.250	.014	.188
	.250-28 UNRF-3A	.365	.2435			.244	.009	
5	.312-18 UNRC-3A	.457	.3053			.306	.012	
	.312-24 UNRF-3A	.469	.3125	.119	.151	.312	.017	.250
	.312-24 UNRF-3A	.457	.3053			.306	.012	
6	.375-16 UNRC-3A	.562	.375	.143	.182	.375	.020	.312
	.375-24 UNRF-3A	.550	.3678			.368	.015	
7	.437-14 UNRC-3A	.642	.4294			.430	.018	
	.437-20 UNRF-3A	.656	.4375	.166	.213	.438	.023	.375
	.437-20 UNRF-3A	.642	.4294			.430	.018	
8	.500-13 UNRC-3A	.750	.500	.190	.245	.500	.026	.375
	.500-20 UNRF-3A	.735	.4919			.492	.020	
9	.562-12 UNRC-3A	.827	.5538			.554	.022	
	.562-18 UNRF-3A	.843	.5625	.214	.265	.562	.028	.437
	.562-18 UNRF-3A	.827	.5538			.554	.022	
10	.625-11 UNRC-3A	.938	.625	.238	.307	.625	.032	.500
	.625-18 UNRF-3A	.921	.6163			.616	.024	
12	.750-10 UNRC-3A	1.107	.7406			.740	.030	
	.750-10 UNRC-3A	1.125	.750	.285	.370	.750	.039	.625
	.750-16 UNRF-3A	1.107	.7406			.740	.030	
14	.875-9 UNRC-3A	1.312	.875	.333	.432	.875	.044	.750
	.875-14 UNRF-3A	1.293	.8647			.864	.034	
16	1.000-8 UNRC-3A	1.479	.9886			.988	.040	
	1.000-12 UNRF-3A	1.500	1.000	.380	.495	1.000	.050	.750
	1.000-14 UNRS-3A	1.479	.9886			.988	.040	
18	1.125-7 UNRC-2A	1.665	1.1086			1.111	.045	
	1.125-12 UNRF-2A	1.688	1.125	.428	.557	1.125	.055	.875
	1.125-12 UNRF-2A	1.665	1.1086			1.111	.045	
20	1.250-7 UNRC-2A	1.852	1.2336			1.236	.050	
	1.250-12 UNRF-2A	1.875	1.250	.475	.620	1.250	.060	.875
	1.250-12 UNRF-2A	1.852	1.2336			1.236	.050	
22	1.375-6 UNRC-2A	2.038	1.3568			1.360	.055	
	1.375-12 UNRF-2A	2.062	1.375	.523	.682	1.375	.065	1.000
	1.375-12 UNRF-2A	2.038	1.3568			1.360	.055	
24	1.500-6 UNRC-2A	2.224	1.4818			1.485	.060	
	1.500-12 UNRF-2A	2.250	1.500	.570	.745	1.500	.070	1.000
	1.500-12 UNRF-2A	2.224	1.4818			1.485	.060	
28	1.750-5 UNRC-2A	2.597	1.7295			1.734	.070	
	1.750-12 UNRF-2A	2.625	1.750	.665	.870	1.750	.080	1.250
	1.750-12 UNRF-2A	2.597	1.7295			1.734	.070	
32	2.000-4.5 UNRC-2A	2.970	1.9780			1.983	.075	
	2.000-12 UNRF-2A	3.000	2.000	.760	.995	2.000	.090	1.500
	2.000-12 UNRF-2A	2.970	1.9780			1.983	.075	
36	2.250-4.5 UNRC-2A	3.717	2.4762			2.481	.095	
	2.250-12 UNRF-2A	3.375	2.250	.855	1.120	2.250	.100	1.750
	2.250-12 UNRF-2A	3.344	2.2280			2.232	.085	
40	2.500-4 UNRC-2A	4.090	2.7262			2.730	.105	
	2.500-12 UNRF-2A	3.750	2.500	.950	1.245	2.500	.110	1.750
	2.500-12 UNRF-2A	3.717	2.4762			2.481	.095	
44	2.750-4 UNRC-2A	4.464	2.9762			2.979	.115	
	2.750-12 UNRF-2A	4.125	2.750	1.045	1.370	2.750	.120	2.000
	2.750-12 UNRF-2A	4.090	2.7262			2.730	.105	
48	3.000-4 UNRC-2A	4.464	2.9762			2.979	.115	
	3.000-12 UNRF-2A	4.500	3.000	1.140	1.495	3.000	.130	2.250
	3.000-12 UNRF-2A	4.464	2.9762			2.979	.115	

SOCKET HEAD CAP SCREW, HEXAGON RECESS, ALLOY STEEL, 1960 SERIES

MECHANICAL PROPERTIES FOR ALLOY STEEL

TORQUE VALUES LISTED ARE FOR PLAIN SCREWS. FOR CADMIUM PLATED SCREWS, MULTIPLY RECOMMENDED SEATING TORQUE BY .75; FOR ZINC PLATED SCREWS, MULTIPLY BY 1.40.

STANDARDS AND SPECIFICATIONS: FF-S-86

SIZE	TENSILE STRENGTH LBS. MIN.		*RECOMMENDED SEATING TORQUE IN INCH POUNDS PLAIN		ULTIMATE TENSILE STRENGTH PSI MIN.	YIELD STRENGTH PSI MIN.	DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.
	UNRC	UNRF	UNRC	UNRF			
#0	—	340	—	2	190,000	170,000	640
#1	500	530	4	4	190,000	170,000	950
#2	700	750	6	7	190,000	170,000	1,320
#3	930	1,000	10	11	190,000	170,000	1,750
#4	1,150	1,260	15	16	190,000	170,000	2,240
#5	1,510	1,580	20	21	190,000	170,000	2,800
#6	1,730	1,930	28	30	190,000	170,000	3,400
#8	2,660	2,800	49	50	190,000	170,000	4,800
#10	3,330	3,800	64	76	190,000	170,000	6,450
1/4	6,050	6,910	150	170	190,000	170,000	11,200
5/16	9,960	11,000	305	325	190,000	170,000	17,500
3/8	14,700	16,700	545	570	190,000	170,000	25,200
7/16	20,200	22,600	840	900	190,000	170,000	34,200
1/2	27,000	30,400	1,300	1,370	190,000	170,000	44,700
9/16	32,800	36,500	1,860	1,970	180,000	155,000	53,700
5/8	40,700	46,100	2,530	2,660	180,000	155,000	66,300
3/4	60,200	67,100	4,400	4,800	180,000	155,000	95,400
7/8	83,100	91,700	7,000	7,600	180,000	155,000	129,800
1	109,000	119,000	10,400	11,000	180,000	155,000	169,600
1(14)	—	122,000	—	11,600	180,000	155,000	169,600
1-1/8	137,000	154,000	14,900	16,600	180,000	155,000	214,000
1-1/4	175,000	193,000	21,000	22,600	180,000	155,000	265,000
1-3/8	208,000	237,000	27,800	29,300	180,000	155,000	320,000
1-1/2	253,000	285,000	36,500	39,300	180,000	155,000	381,000
1-3/4	342,000	394,000	59,900	68,900	180,000	155,000	519,000
2	450,000	521,000	89,900	104,000	180,000	155,000	678,000
2-1/4	585,000	664,000	131,000	150,000	180,000	155,000	858,000
2-1/2	720,000	828,000	180,000	207,000	180,000	155,000	1,060,000
2-3/4	888,000	1,006,000	244,000	277,000	180,000	155,000	1,282,000
3	1,074,000	1,204,000	322,000	361,000	180,000	155,000	1,526,000

*REFER TO WARNING ON PAGE 6.

SOCKET HEAD CAP SCREW, HEXAGON RECESS, 1960 SERIES

MECHANICAL PROPERTIES FOR AUSTENITIC STAINLESS STEEL

STANDARDS AND SPECIFICATIONS: FF-S-86

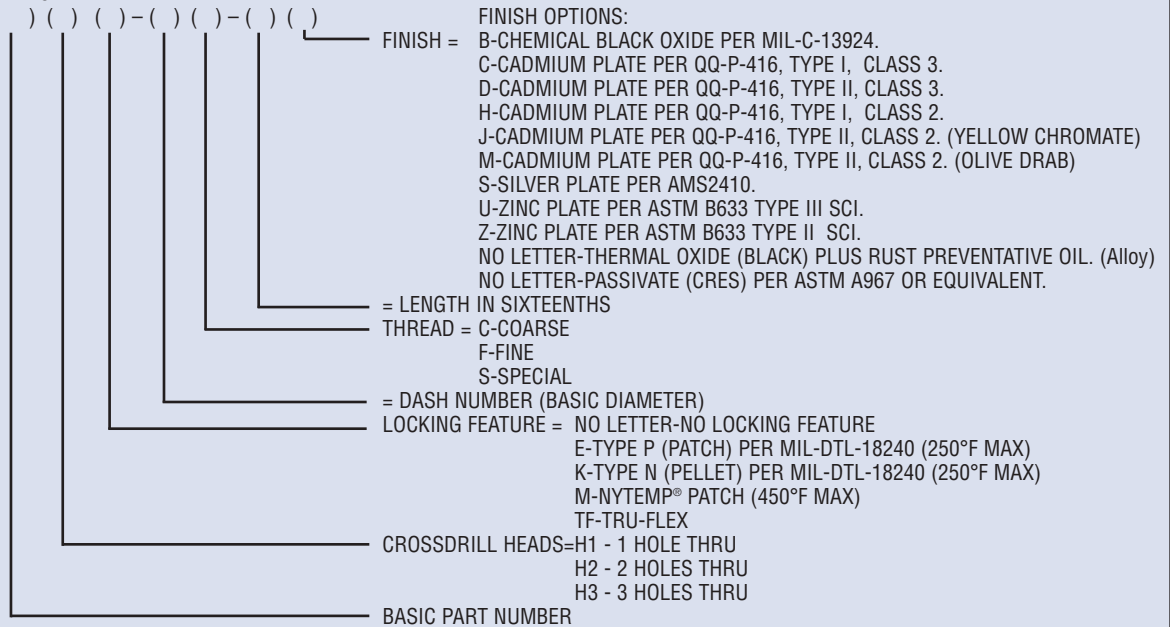
SIZE	AUSTENITIC STAINLESS STEEL TENSILE STRENGTH LBS. MIN.		AUSTENITIC STAINLESS STEEL DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.
	UNRC	UNRF	
#0	—	140	250
#1	210	220	380
#2	300	320	520
#3	390	420	700
#4	480	530	890
#5	640	660	1,100
#6	730	810	1,350
#8	1,120	1,180	1,900
#10	1,400	1,600	2,550
1/4	2,540	2,910	4,420
5/16	4,200	4,640	6,900
3/8	6,200	7,020	9,940
7/16	8,500	9,500	13,500
1/2	11,400	12,800	17,700
9/16	14,600	16,200	22,400
5/8	18,100	20,500	27,600
3/4	26,700	29,800	39,800
7/8	37,000	40,700	54,100
1	48,500	53,000	70,700

THE TENSILE STRENGTH IS BASED ON A STRESS OF 80 KSI AND THE AREA PER ASMEB1.1.
THE SHEAR STRENGTH IS BASED ON A STRESS OF 45 KSI AND THE AREA AT NOMINAL "ØB."

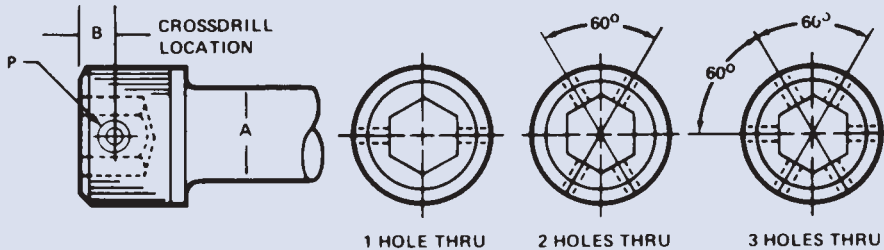
SOCKET HEAD CAP SCREW, HEXAGON RECESS, ALLOY AND STAINLESS STEEL 1960 SERIES

- 1. BASIC PART NUMBERS: 94707 - ALLOY STEEL PER CHEMISTRY OF ASTM A574. HRC 38-43. MAGNETIC PARTICLE INSPECT PER ASTM E1444. ACCEPTANCE CRITERIA PER SPS-I-650.
- 94708 - AUSTENITIC STAINLESS STEEL PER CHEMISTRY OF ASTM A493. FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650.

- 2. FINISH: REFER TO FINISH OPTIONS.
- 3. DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.
- 4. MARK S OR SPS AS APPLICABLE.
- 5. PART NUMBERING: () () () () - () () - () ()



SOCKET HEAD CAP SCREWS • 1960 SERIES CROSS DRILLED DATA



DETAILS

NOTE: Recommended seating torques for screws with cross drilled heads should be reduced by 25%.

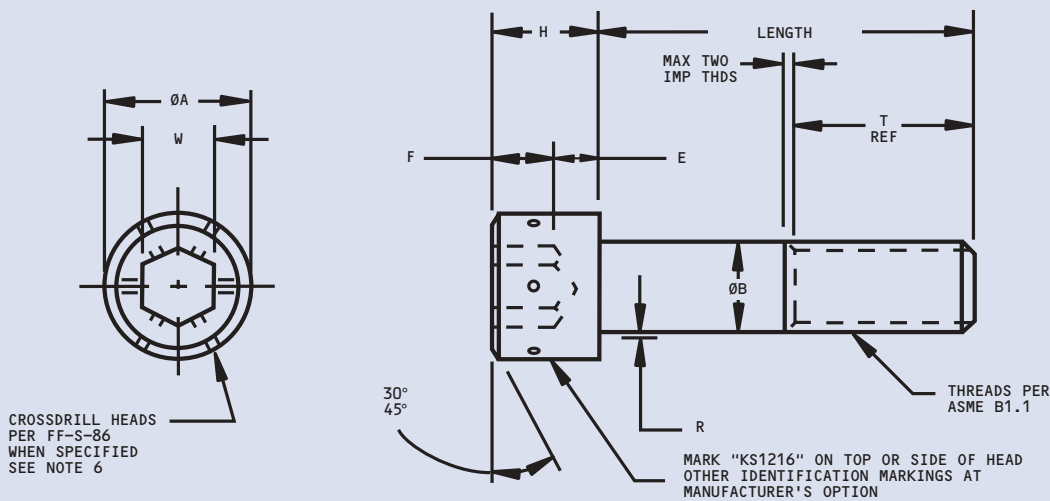
APPLICABLE STANDARDS-MS 24673 thru 24678; NAS1351, 1352; Fed. Spec. FF-S-86, ASTM A574, ASME B18.3

DIAMETER

DIA.	#0	#1	#2	#3	#4	#5	#6	#8	#10	1/4
DASH NO.	90	91	92	93	94	95	96	98	3	4
DIA.	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/8
DASH NO.	5	6	7	8	9	10	12	14	16	18
DIA.	1-1/4	1-3/8	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3	
DASH NO.	20	22	24	28	32	36	40	44	48	

A SCREW SIZE NOM.	B CROSS-DRILL LOCATION		P HOLE DIAMETER		ALIGN- MENT PLUG REF.
	MAX.	MIN.	MAX.	MIN.	
#2	.035	.025	.032	.026	.0210
#3	.035	.025	.032	.026	.0210
#4	.040	.026	.039	.033	.0280
#5	.045	.030	.039	.033	.0280
#6	.050	.035	.039	.033	.0280
#8	.060	.040	.050	.044	.0340
#10	.065	.045	.050	.044	.0340
1/4	.085	.065	.050	.044	.0340
5/16	.104	.084	.050	.044	.0340
3/8	.123	.103	.067	.061	.0510
7/16	.141	.121	.067	.061	.0510
1/2	.160	.140	.067	.061	.0510
9/16	.179	.159	.067	.061	.0510
5/8	.198	.178	.067	.061	.0510
3/4	.235	.215	.097	.091	.0810
7/8	.273	.253	.097	.091	.0810
1	.310	.290	.097	.091	.0810
1 1/8	.348	.328	.127	.119	.1040
1 1/4	.385	.365	.127	.119	.1040
1 3/8	.423	.403	.127	.119	.1040
1 1/2	.460	.440	.127	.119	.1040
1 5/8	.498	.478	.127	.119	.1040
1 3/4	.535	.515	.127	.119	.1040
1 7/8	.573	.553	.127	.119	.1040
2	.610	.590	.127	.119	.1040

SOCKET HEAD SCREW, HEXAGON RECESS, A286, 1960 SERIES



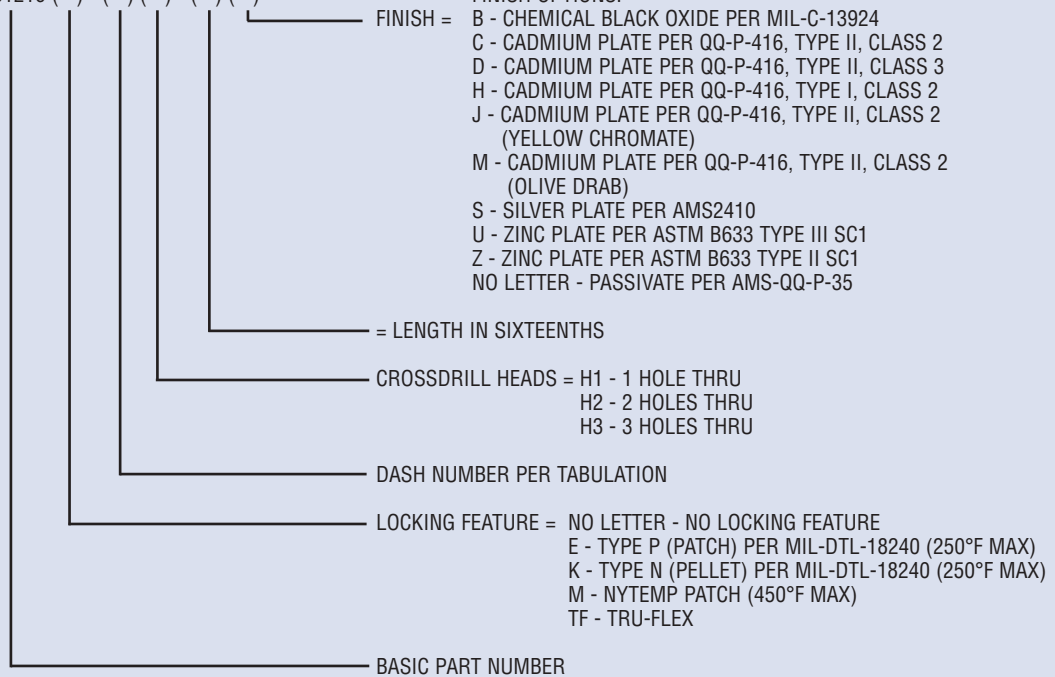
STANDARDS AND SPECIFICATIONS: FF-S-86

DASH NO.	THREADS CLASS 3A	ØA	ØB	E MIN	F MIN	H	R FILLET EXT	T REF	W NOM	TENSILE STRENGTH LBS. MIN
256	.086-56 UNRC	.104	.086	.029	.038	.086	.008	.625	.0781	590
264	.086-64 UNRF	.134	.0822			.083	.004			630
348	.099-48 UNRC	.161	.099	.034	.044	.099	.008	.625	.0781	780
356	.099-56 UNRF	.154	.0949			.095	.004			840
440	.112-40 UNRC	.183	.112	.038	.051	.112	.009	.750	.0937	970
448	.112-48 UNRF	.176	.1075			.108	.005			1,060
540	.125-40 UNRC	.205	.125	.043	.057	.125	.010	.750	.0937	1,270
544	.125-44 UNRF	.198	.1202			.121	.006			1,330
632	.138-32 UNRC	.226	.138	.047	.064	.138	.010	.750	.1093	1,450
640	.138-40 UNRF	.218	.1329			.134	.006			1,620
832	.164-32 UNRC	.270	.164	.056	.077	.164	.012	.875	.1406	2,240
836	.164-36 UNRF	.262	.1585			.159	.007			2,360
1024	.190-24 UNRC	.312	.190	.065	.090	.190	.014	.875	.1562	2,800
1032	.190-32 UNRF	.303	.184			.185	.009			3,200
420	.250-20 UNRC	.375	.250	.095	.120	.250	.014	1.000	.1875	5,090
428	.250-28 UNRF	.365	.2435			.244	.009			5,820
518	.312-18 UNRC	.469	.3125	.119	.151	.312	.017	1.125	.2500	8,380
524	.312-24 UNRF	.457	.3053			.306	.012			9,280
616	.375-16 UNRC	.562	.375	.143	.182	.375	.020	1.250	.3125	12,400
624	.375-24 UNRF	.550	.3678			.368	.015			14,000
714	.437-14 UNRC	.656	.4375	.166	.213	.438	.023	1.375	.3750	17,000
720	.437-20 UNRF	.642	.4294			.430	.018			19,000
813	.500-13 UNRC	.750	.500	.190	.245	.500	.026	1.500	.3750	22,700
820	.500-20 UNRF	.735	.4919			.492	.020			25,600
1011	.625-11 UNRC	.938	.625	.238	.307	.625	.032	1.750	.5000	36,200
1018	.625-18 UNRF	.921	.6163			.616	.024			41,000
1210	.750-10 UNRC	1.125	.750	.285	.370	.750	.039	2.000	.6250	53,500
1216	.750-16 UNRF	1.107	.7406			.740	.030			59,700
1409	.875-9 UNRC	1.312	.875	.333	.432	.875	.044	2.250	.7500	73,900
1414	.875-14 UNRF	1.293	.8647			.864	.034			81,500
1608	1.000-8 UNRC	1.500	1.000	.380	.495	1.000	.050	2.500	.7500	96,900
1612	1.000-12 UNRF									106,000
1614	1.000-14 UNRS	1.479	.9886			.988	.040			109,000
1807	1.125-7 UNRC	1.688	1.125	.428	.557	1.125	.055	2.812	.8750	122,000
1812	1.125-12 UNRF	1.665	1.1086			1.111	.045			137,000
2007	1.250-7 UNRC	1.875	1.250	.475	.620	1.250	.060	3.125	.8750	155,000
2012	1.250-12 UNRF	1.852	1.2336			1.236	.050			171,000
2206	1.375-6 UNRC	2.062	1.375	.523	.682	1.375	.065	3.437	1.0000	185,000
2212	1.375-12 UNRF	2.038	1.3568			1.360	.055			210,000
2406	1.500-6 UNRC	2.250	1.500	.570	.745	1.500	.070	3.750	1.0000	225,000
2412	1.500-12 UNRF	2.224	1.4818			1.485	.060			253,000

LENGTH TOLERANCE

DIAMETER	UP TO 1" INCL.	OVER 1" TO 2-1/2" INCL.	OVER 2-1/2" TO 6" INCL.	OVER 6"
.086 THRU .375	-.030	-.040	-.060	-.120
7/16 THRU 3/4	-.030	-.060	-.080	-.120
7/8 THRU 1-1/8	-.050	-.100	-.140	-.200

1. MATERIAL: A286 PER CHEMISTRY OF AMS 5731, AMS 5737 OR AMS 5853.
2. HEAT TREAT: TO MEET THE MINIMUM ULTIMATE TENSILE REQUIREMENTS OF 160 KSI.
3. MANUFACTURING REQUIREMENTS: HEAD SHALL BE FORGED.
SOCKET MAY BE FORGED OR MACHINED.
THREADS TO BE ROLLED AFTER PRECIPITATION HEAT TREATMENT.
4. DIMENSIONS PER ASME B18. 3.
5. PARTS LONGER THAN "T REF" WILL HAVE A MINIMUM THREAD LENGTH AS TABULATED ON PAGE 10.
PARTS EQUAL TO OR SHORTER THAN "T REF" WILL BE THREADED TO HEAD.
6. PART NUMBERING: KS1216 () - () () - () ()



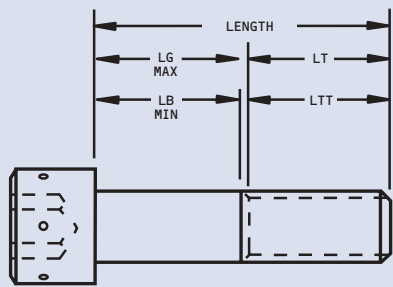
MECHANICAL PROPERTIES AND SEATING TORQUES

NOM. SIZE	BASIC SCREW DIAMETER	TENSILE STRENGTH PSI. MIN.	YIELD STRENGTH PSI. MIN.	DOUBLE SHEAR STR. OF BODY LBS. MIN.	RECOM. SEATING TORQUES INCH-LBS.	
					UNRC	UNRF
#4	.112	160,000	120,000	1,770	15	17
#5	.125	160,000	120,000	2,200	22	23
#6	.138	160,000	120,000	2,700	28	31
#8	.164	160,000	120,000	3,800	51	54
#10	.190	160,000	120,000	5,100	75	85
1/4	.250	160,000	120,000	8,800	152	174
5/16	.312	160,000	120,000	13,800	314	347
3/8	.375	160,000	120,000	19,800	465	527
7/16	.437	160,000	120,000	27,000	743	830
1/2	.500	160,000	120,000	35,300	1140	1,280
5/8	.625	160,000	120,000	55,200	2260	2,560
3/4	.750	160,000	120,000	79,500	4010	4,480
7/8	.875	160,000	120,000	108,000	6460	7,130
1	1.000	160,000	120,000	144,000	9690	10,600

BODY AND GRIP LENGTHS FOR SOCKET HEAD CAP SCREWS

TABLE I

SIZE	#0	#1	#2	#3	#4	#5	#6	#8	#10	1/4
NOM .										
LENGTH	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB
3/4	.250	.190								
7/8	.250	.190	.250	.170	.250	.160	.250	.150		
1	.500	.440	.250	.170	.250	.160	.250	.150	.250	.120
1-1/4	.750	.690	.620	.550	.620	.540	.620	.520	.250	.120
1-1/2		.880	.800	.880	.790	.880	.770	.750	.620	.750
1-3/4			1.120	1.040	1.120	1.020	.750	.620	.750	.620
2					1.380	1.270	1.250	1.120	1.250	1.120
2-1/4							1.250	1.120	1.250	1.120
2-1/2							1.500	1.340	1.380	1.220
2-3/4							2.000	1.840	1.880	1.720
3								1.880	1.720	1.880
3-1/4								2.380	2.220	2.380
3-1/2									2.380	2.170
3-3/4									2.880	2.670
4									2.880	2.670
4-1/4										3.000
4-1/2										3.500
4-3/4										3.500
5										4.000
5-1/4										3.750



THE LENGTH OF COMPLETE THREAD "LT" SHALL BE CONTROLLED BY THE GRIP LENGTH "LG" AS DESCRIBED IN NOTE A). AND THE LENGTH OF TOTAL THREAD "LTT" SHALL BE CONTROLLED BY THE BODY LENGTH "LB" AS SET FORTH IN NOTE B). THE "LT" MINIMUM AND "LTT" MAXIMUM VALUES SHOWN IN TABLE II ARE REFERENCE DIMENSIONS INTENDED FOR CALCULATION PURPOSES ONLY IN ACCORDANCE WITH NOTE C). SEE SKETCH ABOVE.

A) THE GRIP LENGTH "LG" SHALL BE MAXIMUM AND REPRESENTS THE MINIMUM DESIGN GRIP LENGTH OF THE SCREW. IT SHALL BE MEASURED, PARALLEL TO THE AXIS OF SCREW, FROM THE BEARING SURFACE OF THE HEAD TO THE FACE OF A "GO" THREAD RING GAGE, HAVING THE COUNTERSINK AND/OR COUNTERBORE REMOVED, WHICH HAS BEEN ASSEMBLED BY HAND AS FAR AS THE THREAD WILL PERMIT. THE "LG" MAXIMUM LENGTH IS A CRITERION FOR ACCEPTANCE AND SHALL CONFORM TO THE VALUES GIVEN IN TABLE I OR, FOR DIAMETER/LENGTH COMBINATIONS NOT SHOWN THEREIN, SHALL BE AS CALCULATED PER NOTE C).

B) THE BODY LENGTH "LB" SHALL BE MINIMUM AND REPRESENTS THE MINIMUM FULL BODY LENGTH OF THE SCREW. IT SHALL BE MEASURED, PARALLEL TO THE AXIS OF THE SCREW, FROM THE BEARING SURFACE OF THE HEAD TO THE TOP OF THE EXTRUSION ANGLE OR TO THE LAST SCRATCH OF THE THREAD. THE "LB" MINIMUM LENGTH IS A CRITERION FOR ACCEPTANCE AND SHALL CONFORM TO THE VALUES GIVEN IN TABLE I OR, FOR DIAMETER/LENGTH COMBINATIONS NOT SHOWN THEREIN, SHALL BE AS CALCULATED IN ACCORDANCE WITH NOTE C).

C) FOR SCREWS OF THE NOMINAL LENGTH NOT LISTED IN TABLE I AND FOR NOMINAL SIZES LARGER THAN 1 INCH DIAMETER, THE MAXIMUM GRIP LENGTH "LG" AND MINIMUM BODY LENGTH "LB" SHALL BE DETERMINED FROM THE FOLLOWING FORMULAS:

$LG = \text{LENGTH} - LT$
 $LB = \text{LENGTH} - LTT$
 WHERE: LENGTH = NOMINAL SCREW LENGTH; LT = MINIMUM THREAD LENGTH FROM TABLE II; LTT = MAXIMUM TOTAL THREAD LENGTH FROM TABLE II.

SCREWS HAVING NOMINAL LENGTH FALLING BETWEEN THOSE FOR WHICH "LG" AND "LB" VALUES ARE TABULATED IN TABLE II SHALL HAVE "LG" AND "LB" DIMENSIONS CONFORMING TO THOSE OF THE NEXT SHORTER TABULATED NOMINAL LENGTH FOR THE RESPECTIVE SCREW SIZE.

TABLE II

BASIC THREAD DIAMETER	LT THREAD LENGTH MIN	LTT TOTAL THREAD LENGTH MAX
#0	0.50	0.62
#1	0.62	0.77
#2	0.62	0.80
#3	0.62	0.83
#4	0.75	0.99
#5	0.75	1.00
#6	0.75	1.05
#8	0.88	1.19
#10	0.88	1.27
1/4	1.00	1.50
5/16	1.12	1.71
3/8	1.25	1.94
7/16	1.38	2.17
1/2	1.50	2.38
5/8	1.75	2.82
3/4	2.00	3.25
7/8	2.25	3.69
1	2.50	4.12
1-1/8	2.81	4.65
1-1/4	3.12	5.09
1-3/8	3.44	5.65
1-1/2	3.75	6.08
1-3/4	4.38	7.13
2	5.00	8.11
2-1/4	5.62	8.99
2-1/2	6.25	10.00
2-3/4	6.88	10.87
3	7.50	11.75

LENGTH TOLERANCE TABLE

SIZE	UP TO 1" INCL.	OVER 1" TO 2-1/2" INCL.	OVER 2-1/2" TO 6" INCL.	OVER 6"
#0 THRU 3/8"	-0.03	-0.04	-0.06	-0.12
7/16" THRU 3/4"	-0.03	-0.06	-0.08	-0.12
7/8" AND 1-1/2"	-0.05	-0.10	-0.14	-0.20
OVER 1-1/2"	—	-0.18	-0.20	-0.24

SOCKET HEAD CAP SCREW, HEXAGON RECESS, 1960 SERIES

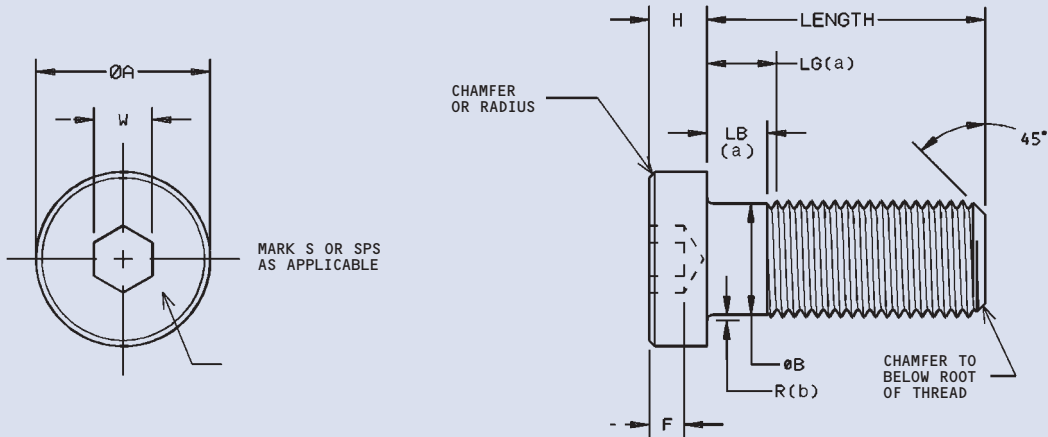
FOR LENGTHS SHORTER THAN LISTED, SCREWS WILL BE THREADED AS CLOSE TO THE HEAD AS PRACTICABLE (APPROX. WITHIN 2 THREAD PITCHES).

TABLE I

STANDARDS AND SPECIFICATIONS: FF-S-86

5/16		3/8		7/16		1/2		9/16		5/8		3/4		7/8		1		
LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	
.620	.350	.500	.190															
.620	.350	.500	.190	.620	.270													
1.120	.850	1.000	.690	.620	.270	.750	.360											
1.120	.850	1.000	.690	1.120	.770	.750	.360	.870	.460									
1.620	1.350	1.500	1.190	1.120	.770	.750	.360	.870	.460	.750	.300							
1.620	1.350	1.500	1.190	1.620	1.270	1.500	1.120	.870	.460	.750	.300	1.000	.500					
2.120	1.850	2.000	1.690	1.620	1.270	1.500	1.120	1.620	1.210	.750	.300	1.000	.500	1.000	.440			
2.120	1.850	2.000	1.690	2.120	1.770	1.500	1.120	1.620	1.210	1.500	1.040	1.000	.500	1.000	.440	1.000	.380	
2.620	2.350	2.500	2.190	2.120	1.770	2.250	1.860	1.620	1.210	1.500	1.040	1.000	.500	1.000	.440	1.000	.380	
2.620	2.350	2.500	2.190	2.620	2.270	2.250	1.860	2.370	1.960	1.500	1.040	2.000	1.500	1.000	.440	1.000	.380	
3.120	2.850	3.000	2.690	2.620	2.270	2.250	1.860	2.370	1.960	2.250	1.800	2.000	1.500	2.000	1.440	1.000	.380	
3.120	2.850	3.000	2.690	3.120	2.770	3.000	2.620	2.370	1.960	2.250	1.800	2.000	1.500	2.000	1.440	2.000	1.380	
3.620	3.350	3.500	3.190	3.120	2.770	3.000	2.620	3.120	2.710	2.250	1.800	2.000	1.500	2.000	1.440	2.000	1.380	
3.620	3.350	3.500	3.190	3.620	3.270	3.000	2.620	3.120	2.710	3.000	2.540	3.000	2.500	2.000	1.440	2.000	1.380	
4.120	3.850	4.000	3.690	3.620	3.270	3.750	3.360	3.120	2.710	3.000	2.540	3.000	2.500	3.000	2.440	2.000	1.380	
4.120	3.850	4.000	3.690	4.120	3.770	3.750	3.360	3.870	3.460	3.000	2.540	3.000	2.500	3.000	2.440	3.000	2.380	
4.620	4.350	4.500	4.190	4.120	3.770	3.750	3.360	3.870	3.460	3.750	3.300	3.000	2.500	3.000	2.440	3.000	2.380	
4.620	4.350	4.500	4.190	4.620	4.270	4.500	4.120	3.870	3.460	3.750	3.300	4.000	3.500	3.000	2.440	3.000	2.380	
5.120	4.850	5.000	4.690	4.620	4.270	4.500	4.120	4.620	4.210	3.750	3.300	4.000	3.500	4.000	3.440	3.000	2.380	
		5.000	4.690	5.120	4.770	4.500	4.120	4.620	4.210	4.500	4.040	4.000	3.500	4.000	3.440	4.000	3.380	
		5.500	5.190	5.120	4.770	5.250	4.860	4.620	4.210	4.500	4.040	4.000	3.500	4.000	3.440	4.000	3.380	
		5.500	5.190	5.620	5.270	5.250	4.860	5.370	4.960	4.500	4.040	5.000	4.500	4.000	3.440	4.000	3.380	
		6.000	5.690	5.620	5.270	5.250	4.860	5.370	4.960	5.250	4.800	5.000	4.500	5.000	4.440	4.000	3.380	
		6.000	5.690	6.120	5.770	6.000	5.620	5.370	4.960	5.250	4.800	5.000	4.500	5.000	4.440	5.000	4.380	
				6.120	5.770	6.000	5.620	6.120	5.710	5.250	4.800	5.000	4.500	5.000	4.440	5.000	4.380	
				6.620	6.270	6.000	5.620	6.120	5.710	6.000	5.540	6.000	5.500	5.000	4.440	5.000	4.380	
				7.120	6.270	7.000	6.620	6.870	6.460	6.000	5.540	6.000	5.500	6.000	5.440	6.000	5.380	
				7.620	7.270	7.000	6.620	6.870	6.460	6.750	6.300	7.000	6.500	6.000	5.440	6.000	5.380	
						8.000	7.620	7.620	7.210	6.750	6.300	7.000	6.500	7.000	6.440	7.000	6.380	
						8.000	7.620	7.620	7.210	7.750	7.300	8.000	7.500	7.000	6.440	7.000	6.380	
								9.120	8.710	7.750	7.300	9.000	8.500	8.000	7.440	8.000	7.380	
								10.120	9.710	9.250	8.800	10.000	9.500	9.000	8.440	9.000	8.380	
										10.250	9.800	11.000	10.500	10.000	9.440	10.000	9.380	
												12.000	11.500	11.000	10.440	11.000	10.380	
												13.000	12.500	12.000	11.440	12.000	11.380	
														13.000	12.440	13.000	12.380	
															14.000	13.440	14.000	13.380
															15.000	14.440	15.000	14.380
																16.000	15.380	
																17.000	16.380	

SOCKET HEAD, LOW HEAD TYPE, ALLOY STEEL - 170 KSI U.T.S., AND A286 - 140 KSI U.T.S.



DASH NO.	NOMINAL DIAM.	THREADS PER INCH		CLASS	ØA MAX./MIN.	ØB MAX./MIN.	F MIN.	H MAX./MIN.	R FILLET EXTENSION		W NOM.
		UNRC	UNRF						MAX./MIN.	MAX./MIN.	
-94	#4	40	48	3A	.183/.178	.1120/.1075	.038	.059/.053	.009/.005	.0500	
-95	#5	40	44	3A	.205/.200	.1250/.1202	.044	.065/.059	.010/.006	.0625	
-96	#6	32	40	3A	.226/.221	.1380/.1329	.050	.072/.066	.010/.006	.0625	
-98	#8	32	36	3A	.270/.265	.1640/.1585	.060	.085/.079	.012/.007	.0781	
-3	#10	24	32	3A	.312/.307	.1900/.1840	.072	.098/.092	.014/.009	.0938	
-4	1/4	20	28	3A	.375/.369	.2500/.2435	.094	.127/.121	.014/.009	.1250	
-5	5/16	18	24	3A	.437/.431	.3125/.3053	.110	.158/.152	.017/.012	.1562	
-6	3/8	16	24	3A	.562/.556	.3750/.3678	.115	.192/.182	.020/.015	.1875	
-8	1/2	13	20	3A	.750/.743	.5000/.4919	.151	.254/.244	.026/.020	.2500	
-10	5/8	11	18	3A	.938/.921	.6250/.6163	.225	.316/.306	.032/.024	.3125	
-12	3/4	10	16	3A	1.125/1.107	.7500/.7406	.247	.376/.366	.039/.030	.3750	
-14	7/8	9	14	3A	1.312/1.293	.8750/.8647	.304	.438/.428	.044/.034	.5000	
-16	1	8	12	3A	1.500/1.479	1.0000/.9886	.359	.500/.489	.050/.040	.5620	
-18	1-1/8	7	12	3A	1.6888/1.665	1.1250/1.1086	.396	.565/.554	.055/.045	.6250	

LENGTH TOLERANCE TABLE

DIAMETER	TO 1"	OVER 1" TO 2.5"	OVER 2.5"
ALL	-.03	-.04	-.06

(a) THE MINIMUM USABLE THREAD LENGTH SHALL BE EQUAL TO TWO TIMES THE NOMINAL DIAMETER + .500 INCH. FOR GRIP LENGTHS, SEE TABLE ON NEXT PAGE.

(b) IMPERFECT THREADS NOT TO ENTER INTO FILLET AREA.

- 1. BASIC PART NUMBERS: 94704 - ALLOY STEEL PER CHEMISTRY OF ASTM A574. HRC 38-43. MAGNETIC PARTICLE INSPECT PER ASTM E1444. ACCEPTANCE CRITERIA PER SPS-I-650.
- 95299 - A286 PER CHEMISTRY OF AMS 5731, AMS 5737 OR AMS 5853 - 160 KSI. FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650.

2. DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.

3. FINISH: REFER TO FINISH OPTIONS.

4. MANUFACTURING REQUIREMENTS: HEAD TO BE FORGED.
SOCKET MAY BE FORGED OR MACHINED.
THREADS TO BE ROLLED.

5. PART NUMBERING: () () - () () - () ()

FINISH = B-CHEMICAL BLACK OXIDE PER MIL-C-13924.
C-CADMIUM PLATE PER QQ-P-416, TYPE I, CLASS 3.
D-CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 3.
H-CADMIUM PLATE PER QQ-P-416, TYPE I, CLASS 2.
J-CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 2. (YELLOW CHROMATE)
M-CADMIUM PLATE PER QQ-P-416, TYPE II, CLASS 2. (OLIVE DRAB)
N-NICKEL CADMIUM PLATE PER AMS2416.
S-SILVER PLATE PER AMS2410.
U-ZINC PLATE PER ASTM B633 TYPE III SCI.
Z-ZINC PLATE PER ASTM B633 TYPE II SCI.
NO LETTER-THERMAL OXIDE (BLACK) PLUS RUST PREVENTATIVE OIL. (ALLOY)
NO LETTER-PASSIVATE (CRES)

= LENGTH IN SIXTEENTHS
THREAD = C-COARSE
F-FINE

= DASH NUMBER (PER TABULATION)
LOCKING FEATURE = NO LETTER-NO LOCKING FEATURE
E-TYPE P (PATCH) PER MIL-DTL-18240 (250°F MAX)
K-TYPE N (PELLET) PER MIL-DTL-18240 (250°F MAX)
M-NYTEMP PATCH (450°F MAX)
TF-TRU-FLEX

BASIC PART NUMBER

BODY AND GRIP LENGTHS FOR SOCKET HEAD CAP SCREWS, LOW HEAD TYPE

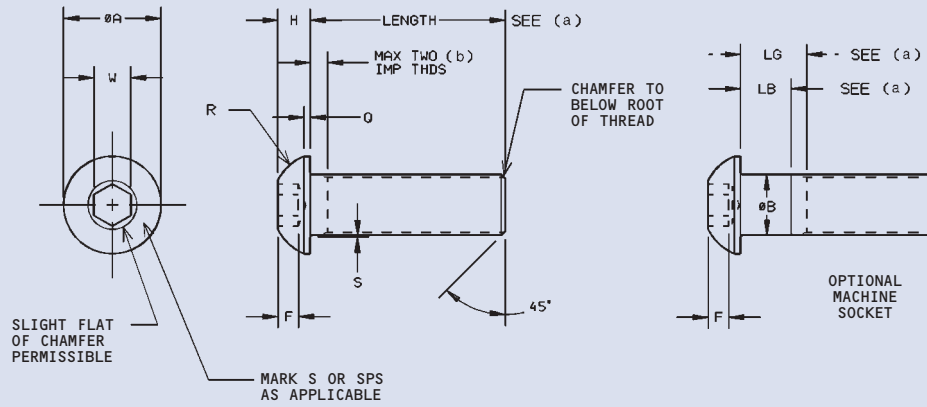
FOR LENGTHS SHORTER THAN LISTED, SCREWS WILL BE THREADED TO WITHIN 2-1/2 THREAD PITCHES OF THE HEAD.

SIZE	#4		#5		#6		#8		#10		1/4	
NOM . LENGTH	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB
1-1/4	0.500	0.380	0.500	0.380	0.500	0.340	0.380	0.220				
1-1/2	0.500	0.380	0.500	0.380	0.500	0.340	0.380	0.220	0.620	0.420		
1-3/4	1.000	0.880	1.000	0.880	1.000	0.840	0.880	0.720	0.620	0.420	0.750	0.500
2	1.000	0.880	1.000	0.880	1.000	0.840	0.880	0.720	1.120	0.920	0.750	0.500
2-1/4	1.500	1.380	1.500	1.380	1.500	1.340	1.380	1.220	1.120	0.920	1.250	1.000
2-1/2					1.500	1.340	1.380	1.220	1.620	1.420	1.250	1.000
2-3/4					2.000	1.840	1.880	1.720	1.620	1.420	1.750	1.500
3							1.880	1.720	2.120	1.920	1.750	1.500
3-1/4							2.380	2.222	2.120	1.920	2.250	2.000
3-1/2									2.620	2.420	2.250	2.000
3-3/4									2.620	2.420	2.750	2.500
4									3.120	2.920	2.750	2.500
4-1/4											3.250	3.000
4-1/2											3.250	3.000
4-3/4											3.750	3.500
5											3.750	3.500
5-1/4											4.250	4.000
5-1/2												
5-3/4												
6												
6-1/4												
6-1/2												
6-3/4												
7												
7-1/4												
7-1/2												
7-3/4												
8												
8-1/2												
9												
9-1/2												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												

SOCKET HEAD CAP BOLT, LOW HEAD TYPE

5/16		3/8		1/2		5/8		3/4		7/8		1	
LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB
0.880	0.600												
0.880	0.600	1.000	0.690										
1.380	1.100	1.000	0.690	1.000	0.620								
1.380	1.100	1.500	1.190	1.000	0.620								
1.880	1.600	1.500	1.190	1.000	0.620								
1.880	1.600	2.000	1.690	1.750	1.360	1.500	1.040						
2.380	2.100	2.000	1.690	1.750	1.360	1.500	1.040	1.500	1.000				
2.380	2.100	2.500	2.190	1.750	1.360	1.500	1.040	1.500	1.000	1.500	0.940		
2.880	2.600	2.500	2.190	2.500	2.120	2.250	1.800	1.500	1.000	1.500	0.940	1.500	0.880
2.880	2.600	3.000	2.690	2.500	2.120	2.250	1.800	1.500	1.000	1.500	0.940	1.500	0.880
3.380	3.100	3.000	2.690	2.500	2.120	2.250	1.800	2.500	2.000	1.500	0.940	1.500	0.880
3.380	3.100	3.500	3.190	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	1.500	0.880
3.880	3.600	3.500	3.190	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	2.500	1.880
3.880	3.600	4.000	3.690	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	2.500	1.880
4.380	4.100	4.000	3.690	4.000	3.620	3.750	3.300	3.500	3.000	2.500	1.940	2.500	1.880
4.380	4.100	4.500	4.190	4.000	3.620	3.750	3.300	3.500	3.000	3.500	2.940	2.500	1.880
4.880	4.600	4.500	4.190	4.000	3.620	3.750	3.300	3.500	3.000	3.500	2.940	3.500	2.880
4.880	4.600	5.000	4.690	4.750	4.360	4.500	4.040	3.500	3.000	3.500	2.940	3.500	2.880
5.380	5.100	5.000	4.690	4.750	4.360	4.500	4.040	4.500	4.000	3.500	2.940	3.500	2.880
		5.500	5.190	4.750	4.360	4.500	4.040	4.500	4.000	4.500	3.940	3.500	2.880
		5.500	5.190	5.500	5.120	5.250	4.800	4.500	4.000	4.500	3.940	4.500	3.880
		6.000	5.690	5.500	5.120	5.250	4.800	4.500	4.000	4.500	3.940	4.500	3.880
		6.000	5.690	5.500	5.120	5.250	4.800	5.500	5.000	4.500	3.940	4.500	3.880
		6.500	6.190	6.250	5.860	6.000	5.540	5.500	5.000	5.500	4.940	4.500	3.880
				6.250	5.860	6.000	5.540	5.500	5.000	5.500	4.940	5.500	4.880
				7.000	6.620	6.750	6.300	6.500	6.000	5.500	4.940	5.500	4.880
				7.000	6.620	6.750	6.300	6.500	6.000	6.750	6.190	6.500	5.880
				8.000	7.620	7.750	7.300	7.500	7.000	6.750	6.190	6.500	5.880
				8.000	7.620	7.750	7.300	7.500	7.000	7.750	7.190	7.500	6.880
						9.250	8.800	9.000	8.500	8.750	8.190	8.500	7.880
						10.250	9.800	10.000	9.500	9.750	9.190	9.500	8.880
								11.000	10.500	10.750	10.190	10.500	9.880
								12.000	11.500	11.750	11.190	11.500	10.880
								13.000	12.500	12.750	12.190	12.500	11.880
										13.750	13.190	13.500	12.880
										14.750	14.190	14.500	13.880
										15.750	15.190	15.500	14.880
												16.500	15.880
												17.500	16.880

BUTTON HEAD SCREW, HEXAGON RECESS, ALLOY STEEL, 160 KSI U.T.S., AND AUSTENITIC STAINLESS STEEL, 80 KSI U.T.S.



STANDARDS AND SPECIFICATIONS: FF-S-86

DASH NO.	SIZE	THREAD DESIGNATION		ØA		ØB		F		H		L	Q	R	S		
		UNRF	CLASS	UNRC	CLASS	MAX.	MIN.	MAX.	MIN.	MIN.	MAX.	MIN.	(a)	REF.	REF.	MAX.	MIN.
90	#0	.060-80	3A			.114	.104	.060	.0568	.020	.032	.026	.500	.010	.070	.010	.005
91	#1	.073-72	3A	.073-64	3A	.139	.129	.073	.0695	.028	.039	.033	.500	.010	.080	.010	.005
92	#2	.086-64	3A	.086-56	3A	.164	.154	.086	.0822	.028	.046	.038	.500	.010	.099	.010	.005
93	#3	.099-56	3A	.099-48	3A	.188	.176	.099	.0949	.035	.052	.044	.500	.010	.110	.010	.005
94	#4	.112-48	3A	.112-40	3A	.213	.201	.112	.1075	.035	.059	.051	.500	.015	.135	.010	.005
95	#5	.125-44	3A	.125-40	3A	.238	.226	.125	.1202	.044	.066	.058	.500	.015	.141	.010	.005
96	#6	.138-40	3A	.138-32	3A	.262	.250	.138	.1329	.044	.073	.063	.625	.015	.158	.010	.005
98	#8	.164-36	3A	.164-32	3A	.312	.298	.164	.1585	.052	.087	.077	.750	.015	.185	.015	.010
3	#10	.190-32	3A	.190-24	3A	.361	.347	.190	.1840	.070	.101	.091	1.000	.020	.213	.015	.010
4	1/4"	.250-28	3A	.250-20	3A	.437	.419	.250	.2435	.087	.132	.122	1.000	.031	.249	.020	.015
5	5/16"	.312-24	3A	.312-18	3A	.547	.527	.3125	.3053	.105	.166	.152	1.000	.031	.309	.020	.015
6	3/8"	.375-24	3A	.375-16	3A	.656	.636	.375	.3678	.122	.199	.185	1.250	.031	.368	.020	.015
8	1/2"	.500-20	3A	.500-13	3A	.875	.851	.500	.4919	.175	.265	.245	2.000	.046	.481	.030	.020
10	5/8"	.625-18	3A	.625-11	3A	1.000	.970	.625	.6163	.210	.331	.311	2.000	.062	.523	.030	.020

(a) SCREW LENGTHS EQUAL TO OR SHORTER THAN LISTED IN COLUMN "L" WILL BE THREADED TO HEAD. FOR SCREWS LONGER THAN LISTED, THE MINIMUM USABLE THREAD LENGTH SHALL EQUAL TWICE THE DIAMETER + .500 INCH.
 (b) IMPERFECT THREADS NOT TO ENTER INTO FILLET AREA.

LENGTH TOLERANCE TABLE

UP TO 1" INCL.	OVER 1" TO 2" INCL.	OVER 2"
-.03	-.04	-.06

MECHANICAL PROPERTIES - ALLOY STEEL BUTTON HEAD SOCKET SCREW

STANDARDS AND SPECIFICATIONS: FF-S-86

SIZE	TENSILE STRENGTH LBS. MIN.		*RECOMMENDED SEATING TORQUE IN INCH POUNDS PLAIN (c)		DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.	W NOM.	X (d)
	UNRC	UNRF	UNRC	UNRF			
#0	—	270	—	1.5	540	.035	.005
#1	390	390	2.5	2.5	800	.050	.005
#2	560	560	4.5	4.5	1,110	.050	.005
#3	730	730	7.0	7.0	1,480	.0625	.005
#4	970	1,060	8.0	8.0	1,890	.0625	.005
#5	1,270	1,330	12.0	13.0	2,360	.0781	.005
#6	1,450	1,620	15.0	17.0	2,880	.0781	.005
#8	2,240	2,360	30.0	31.0	4,060	.0937	.006
#10	2,800	3,200	40.0	45.0	5,440	.1250	.007
1/4"	5,090	5,820	100.0	110.0	9,420	.1562	.009
5/16"	8,380	9,280	200.0	220.0	14,720	.1875	.011
3/8"	12,400	14,000	350.0	400.0	21,200	.2187	.013
1/2"	22,700	25,600	850.0	1,000.0	37,700	.3125	.018
5/8"	36,200	41,000	1,700.0	1,900.0	58,900	.3750	.021

(c) TORQUE VALUES LISTED ARE FOR PLAIN SCREWS. FOR CADMIUM PLATED SCREWS, MULTIPLY RECOMMENDED SEATING TORQUE BY .75; FOR ZINC PLATED SCREWS, MULTIPLY BY 1.40.
 (d) RUNOUT- SOCKET TO BODY WITHIN "X" T.I.R.

*REFER TO WARNING ON PAGE 6.

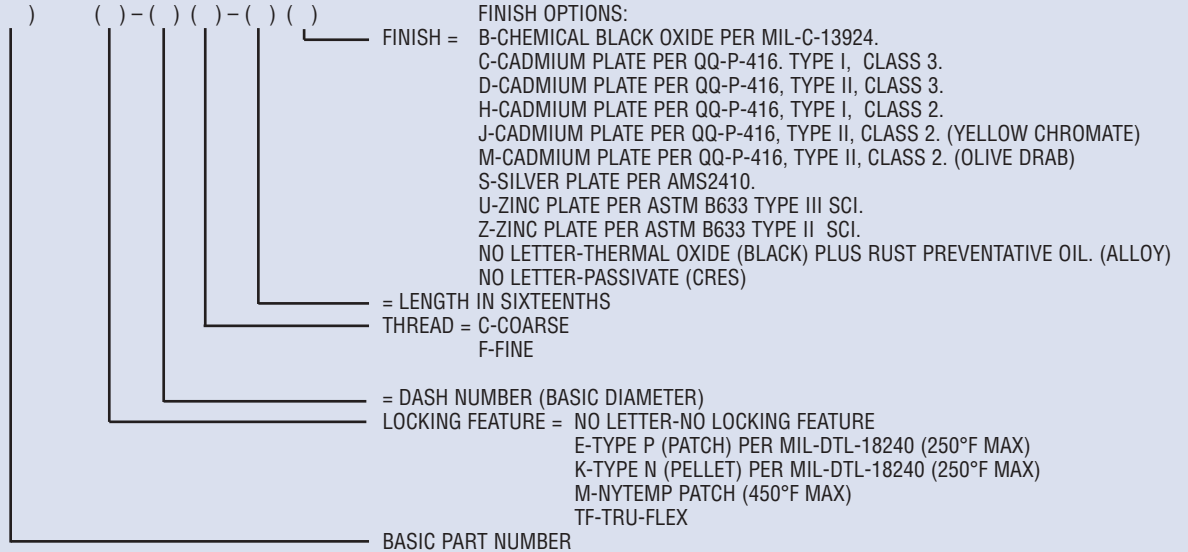
BUTTON HEAD SCREW, HEXAGON RECESS

- 1. BASIC PART NUMBERS: 94702 - ALLOY STEEL PER CHEMISTRY OF ASTM A574. HRC 38-43 — 160 KSI. MAGNETIC PARTICLE INSPECT PER ASTM E1444. ACCEPTANCE CRITERIA PER SPS-I-650.
- 94703 - AUSTENITIC STAINLESS STEEL PER CHEMISTRY OF ASTM A493. 80 KSI. FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650.

2. FINISH: REFER TO FINISH OPTIONS.

3. DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.

4. PART NUMBERING: () () - () () - () ()



MECHANICAL PROPERTIES - AUSTENITIC STAINLESS STEEL, BUTTON HEAD SOCKET SCREW

STANDARDS AND SPECIFICATIONS: FF-S-86

SIZE	TENSILE STRENGTH LBS. MIN. (c)		*RECOMMENDED SEATING TORQUE IN INCH POUNDS PLAIN (d)		DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.	W NOM.	X (e)
	UNRC	UNRF	UNRC	UNRF			
#0	—	100	—	1.0	260	.035	.005
#1	150	160	1.7	1.8	380	.050	.005
#2	210	220	2.8	3.0	520	.050	.005
#3	270	290	4.3	4.5	700	.0625	.005
#4	340	370	6.0	6.6	880	.0625	.005
#5	450	470	8.9	9.3	1,100	.0781	.005
#6	510	570	11.0	12.0	1,340	.0781	.005
#8	790	830	20.0	21.0	1,900	.0937	.006
#10	980	1,120	30.0	34.0	2,560	.1250	.007
1/4"	1,780	2,040	71.0	81.0	4,400	.1562	.009
5/16"	2,940	3,250	123.0	136.0	6,900	.1875	.011
3/8"	4,340	4,920	218.0	247.0	9,940	.2187	.013
1/2"	7,950	8,950	532.0	600.0	17,680	.3125	.018
5/8"	12,700	14,300	1,060.0	1,200.0	27,600	.3750	.021

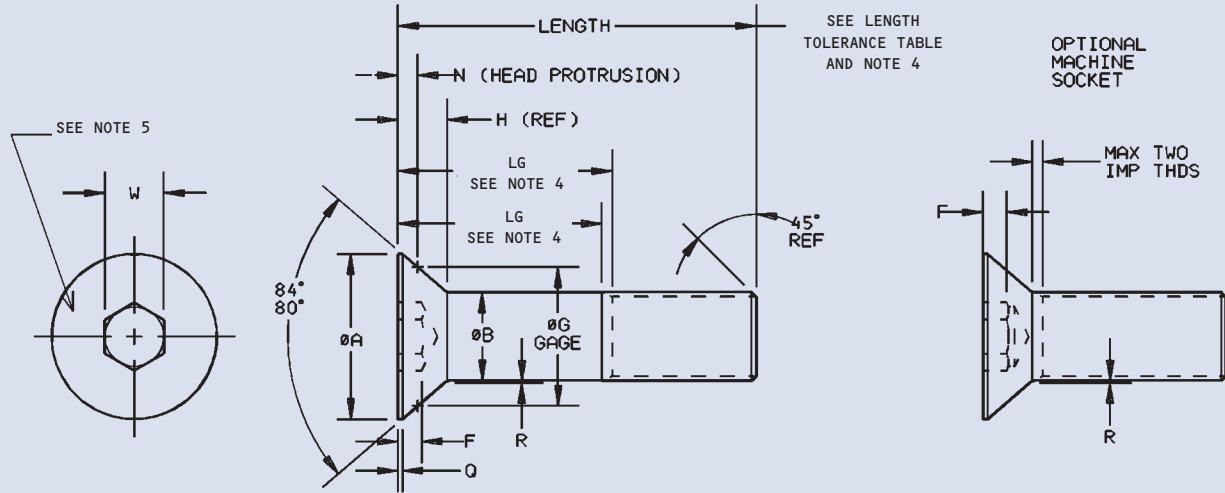
(c) THE TENSILE STRENGTH IS BASED ON 56 KSI AND THE TENSILE STRESS AREA PER ASME B1.1.

(d) TORQUE VALUES LISTED ARE FOR PLAIN SCREWS. FOR CADMIUM PLATED SCREWS, MULTIPLY RECOMMENDED SEATING TORQUE BY .75; FOR ZINC PLATED SCREWS, MULTIPLY BY 1.40.

(e) RUNOUT- SOCKET TO BODY WITHIN "X" T.I.R.

*REFER TO WARNING ON PAGE 6.

82° FLAT HEAD SCREW, HEXAGON RECESS, ALLOY STEEL, 160 KSI U.T.S. AND AUSTENITIC STAINLESS STEEL, 80 KSI U.T.S.



STANDARDS AND SPECIFICATIONS: FF-S-86

DASH NO.	SIZE	THREAD DESIGNATION		ØA		ØB		F	ØG REF.	H REF.	N		Q	R	W
		UNRF CLASS	UNRC CLASS	MAX. ^(a)	MIN. ^(b)	MAX.	MIN.				MAX.	MIN.			
90	#0	.060-80	3A	.138	.117	.060	.0568	.025	.0812	.044	.032	.027	.011	.006	.035
91	#1	.073-72	3A	.168	.143	.073	.0695	.031	.0942	.054	.042	.035	.014	.008	.050
92	#2	.086-64	3A	.197	.168	.086	.0822	.038	.1234	.064	.041	.034	.015	.010	.050
93	#3	.099-56	3A	.226	.193	.099	.0949	.044	.1444	.073	.046	.037	.018	.010	.0625
94	#4	.112-48	3A	.255	.218	.112	.1075	.055	.1652	.083	.051	.041	.021	.012	.0625
95	#5	.125-44	3A	.281	.240	.125	.1202	.061	.1795	.090	.057	.046	.022	.014	.0781
96	#6	.138-40	3A	.307	.263	.138	.1329	.066	.1985	.097	.061	.049	.024	.015	.0781
98	#8	.164-36	3A	.359	.311	.164	.1585	.076	.2400	.112	.067	.055	.026	.015	.0937
3	#10	.190-32	3A	.411	.359	.190	.1840	.087	.2440	.127	.095	.081	.028	.015	.1250
4	1/4"	.250-28	3A	.531	.480	.250	.2435	.111	.3314	.161	.113	.099	.029	.015	.1562
5	5/16"	.312-24	3A	.656	.600	.3125	.3053	.135	.4047	.198	.143	.128	.031	.015	.1875
6	3/8"	.375-24	3A	.781	.720	.375	.3678	.159	.4854	.234	.168	.152	.033	.015	.2187
7	7/16"	.437-20	3A	.844	.781	.4375	.4294	.159	.5698	.234	.155	.140	.034	.015	.2500
8	1/2"	.500-20	3A	.938	.872	.500	.4919	.172	.6500	.251	.162	.147	.034	.015	.3125
9	9/16"	.562-18	3A	1.063	.993	.5625	.5560	.220	.7200	.288	.194	.177	.036	.015	.3125
10	5/8"	.625-18	3A	1.188	1.112	.625	.6163	.220	.8012	.324	.219	.201	.040	.015	.3750
12	3/4"	.750-16	3A	1.438	1.355	.750	.7406	.220	1.1100	.396	.181	.165	.040	.015	.5000
14	7/8"	.875-14	3A	1.688	1.604	.875	.8647	.248	1.2896	.468	.221	.206	.040	.015	.5620
16	1"	1.000-12	3A	1.938	1.841	1.0000	.9886	.297	1.4682	.540	.260	.246	.040	.015	.6250
18	1-1/8"	1.125-12	2A	2.188	2.079	1.1250	1.1086	.325	1.6250	.611	.336	.319	.040	.031	.750
20	1-1/4"	1.250-12	2A	2.438	2.316	1.2500	1.2336	.358	1.6250	.683	.484	.464	.040	.031	.875
22	1-3/8"	1.375-12	2A	2.688	2.553	1.3750	1.3568	.402	1.8026	.755	.510	.485	.040	.031	.875
24	1-1/2"	1.500-12	2A	2.938	2.791	1.5000	1.4818	.435	2.1870	.827	.417	.387	.040	.031	1.000

(a) Maximum - To theoretical sharp corners.

(b) Minimum - Absolute with a flat.

LENGTH TOLERANCE TABLE

SIZE	UP TO 1" INCL.	OVER 1" TO 2-1/2" INCL.	OVER 2-1/2" TO 6" INCL.	OVER 6"
#0 THRU 3/8"	-03	-04	-06	-12
7/16" THRU 3/4"	-03	-06	-08	-12
7/8" AND UP	-05	-10	-14	-20

82° FLAT HEAD SCREW, HEXAGON RECESS, ALLOY STEEL, 160 KSI U.T.S., AND AUSTENITIC STAINLESS STEEL, 80 KSI U.T.S.

MECHANICAL PROPERTIES - ALLOY STEEL AND AUSTENITIC STAINLESS STEEL

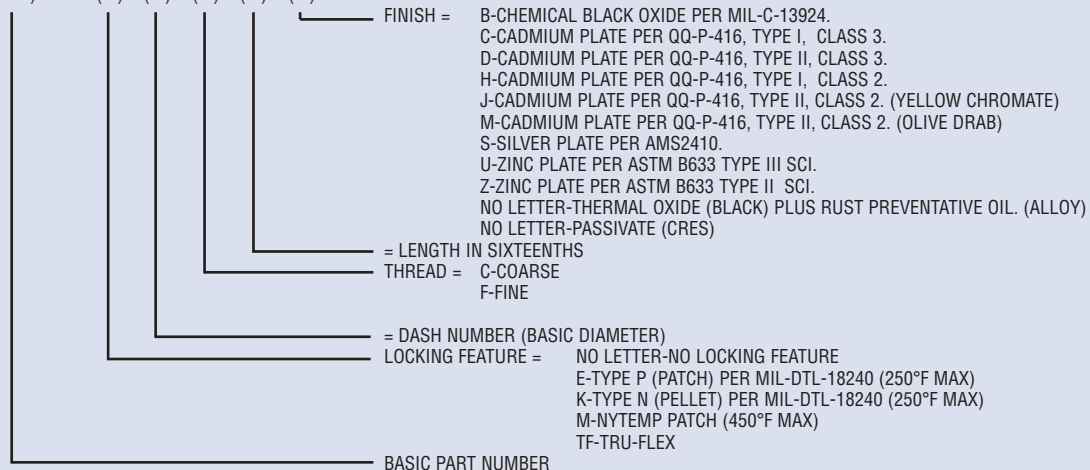
STANDARDS AND SPECIFICATIONS: FF-S-86

SIZE	X (d)	ALLOY STEEL					AUSTENITIC STAINLESS STEEL				
		TENSILE STRENGTH LBS. MIN.		*RECOMMENDED SEATING TORQUE IN INCH POUNDS PLAIN (c)		DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.	TENSILE STRENGTH LBS. MIN.		*RECOMMENDED SEATING TORQUE IN INCH POUNDS PLAIN (c)		DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.
		UNRC	UNRF	UNRC	UNRF		(e)	UNRF	UNRC	UNRF	
#0	0.005	—	270	—	1.5	540	—	100	—	1.0	260
#1	0.005	390	390	2.5	2.5	800	150	160	1.7	1.8	380
#2	0.005	560	560	4.5	4.5	1,110	210	220	2.8	3.0	520
#3	0.005	730	730	7	7	1,480	270	290	4.3	4.5	700
#4	0.005	970	1,060	8	8	1,890	340	370	6.0	6.6	880
#5	0.005	1270	1,330	12	13	2,360	450	470	8.9	9.3	1,100
#6	0.005	1450	1,620	15	17	2,880	510	570	11.0	12.0	1,340
#8	0.006	2,240	2,360	30	31	4,060	790	830	20.0	21.0	1,900
#10	0.007	2,800	3,200	40	45	5,440	980	1,120	30.0	34.0	2,560
1/4"	0.009	5,090	5,820	100	110	9,420	1,780	2,040	71.0	81.0	4,400
5/16"	0.011	8,380	9,280	200	220	14,720	2,940	3,250	123.0	136.0	6,900
3/8"	0.013	12,400	14,000	350	400	21,200	4,390	4,920	218.0	247.0	9,940
7/16"	0.015	17,000	19,000	560	625	28,800	5,950	6,650	349.0	388.0	13,520
1/2"	0.018	22,700	25,600	850	1,000.00	37,700	7,950	8,950	532.0	600.0	17,680
9/16"	0.019	29,100	32,500	1,200.00	1,360.00	47,800	10,200	11,400	767.0	856.0	22,400
5/8"	0.021	36,200	41,000	1,700.00	1,900.00	58,900	12,700	14,300	1,060.0	1,200.0	27,600
3/4"	0.026	53,400	59,700	3,000.00	3,200.00	84,800	18,700	20,900	1,880.0	2,100.0	39,800
7/8"	0.030	73,900	81,400	5,000.00	5,400.00	115,400	25,900	28,500	3,030.0	3,340.0	54,200
1"	0.035	97,000	106,000	7,200.00	7,600.00	150,800	33,900	37,100	4,550.0	5,000.0	70,600
1-1/8"	0.035	122,000	137,000	9,700.00	10,800.00	191,000					
1-1/4"	0.038	155,000	172,000	13,600.00	14,700.00	236,000					
1-3/8"	0.041	185,000	210,000	18,100.00	19,000.00	285,000					
1-1/2"	0.045	225,000	253,000	23,700.00	25,600.00	339,000					

(c) TORQUE VALUES LISTED ARE FOR PLAIN SCREWS. FOR CADMIUM PLATED SCREWS, MULTIPLY RECOMMENDED SEATING TORQUE BY .75; FOR ZINC PLATED SCREWS, MULTIPLY BY 1.40.
 (d) RUNOUT - SOCKET TO BODY WITHIN "X" T.I.R.
 (e) THE TENSILE STRENGTH IS BASED ON 56KSI AND THE TENSILE STRESS AREA PER ASMEB1.1

*REFER TO WARNING ON PAGE 6.

- BASIC PART NUMBERS: 94700 - ALLOY STEEL PER CHEMISTRY OF ASTM A574. HRC 36-43 — 160 KSI. MAGNETIC PARTICLE INSPECT PER ASTM E1444. ACCEPTANCE CRITERIA PER SPS-I-650.
 94701 - AUSTENITIC STAINLESS STEEL PER CHEMISTRY OF ASTM A493 — 56 KSI U.T.S..
 FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650.
- FINISH: REFER TO FINISH OPTIONS.
- DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3. THREADS PER ASME B1.1.
- THREAD LENGTHS: THE MINIMUM USABLE THREAD LENGTH SHALL BE EQUAL TO TWO TIMES THE NOMINAL DIAMETER +.500 INCH. FOR GRIP LENGTHS, SEE TABLE PP 22-23.
- MARK S OR SPS AS APPLICABLE.
- PART NUMBERING: () () - () () - () ()



BUTTON HEAD AND 82° FLAT HEAD SCREW, HEXAGON RECESS, ALL MATERIALS

BODY AND GRIP LENGTHS FOR FLAT HEAD SOCKET SCREWS

SIZE	#0		#1		#2		#3		#4		#5		#6		#8		#10		1/4	
NOM.																				
LENGTH	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB
3/4	0.250	0.190																		
7/8	0.250	0.190	0.250	0.170	0.250	0.160	0.250	0.150												
1	0.500	0.440	0.250	0.170	0.250	0.160	0.250	0.150												
1-1/4	0.750	0.690	0.620	0.550	0.620	0.540	0.620	0.520	0.500	0.380	0.500	0.380	0.500	0.340	0.380	0.220				
1-1/2			0.880	0.800	0.880	0.790	0.880	0.770	0.500	0.380	0.500	0.380	0.500	0.340	0.380	0.220	0.620	0.420		
1-3/4					1.120	1.040	1.120	1.020	1.000	0.880	1.000	0.880	1.000	0.840	0.880	0.720	0.620	0.420	0.750	0.500
2							1.380	1.270	1.000	0.880	1.000	0.880	1.000	0.840	0.880	0.720	1.120	0.920	0.750	0.500
2-1/4									1.500	1.380	1.500	1.380	1.500	1.340	1.380	1.220	1.120	0.920	1.250	1.000
2-1/2													1.500	1.340	1.380	1.220	1.620	1.420	1.250	1.000
2-3/4													2.000	1.840	1.880	1.720	1.620	1.420	1.750	1.500
3															1.880	1.720	2.120	1.920	1.750	1.500
3-1/4															2.380	2.222	2.120	1.920	2.250	2.000
3-1/2																	2.620	2.420	2.250	2.000
3-3/4																	2.620	2.420	2.750	2.500
4																	3.120	2.920	2.750	2.500
4-1/4																			3.250	3.000
4-1/2																			3.250	3.000
4-3/4																			3.750	3.500
5																			3.750	3.500
5-1/4																			4.250	4.000
5-1/2																				
5-3/4																				
6																				
6-1/4																				
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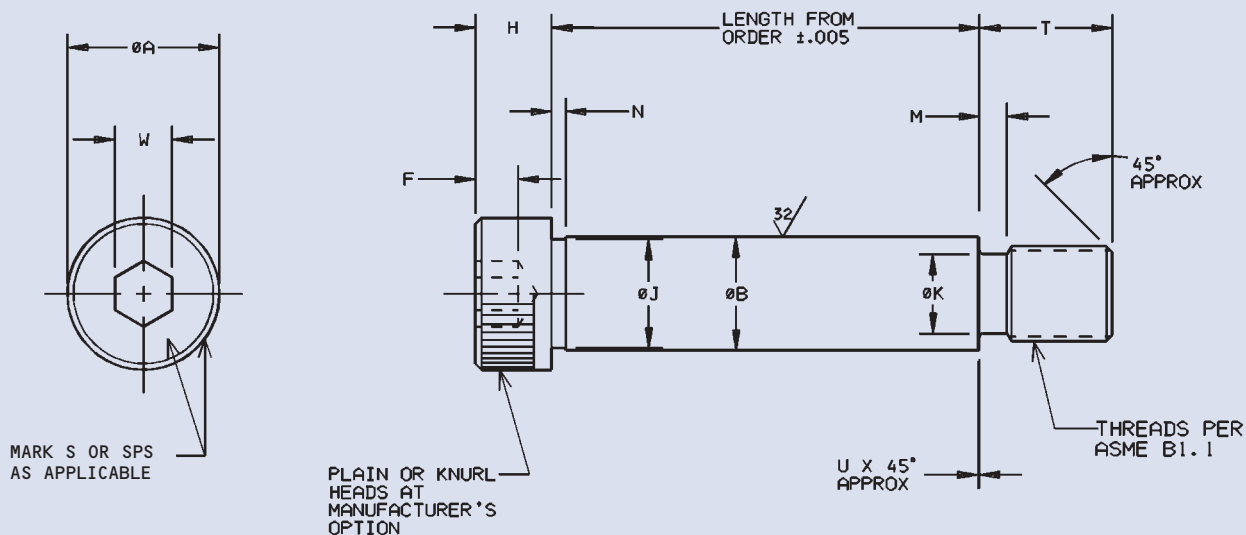
BUTTON HEAD AND 82° FLAT HEAD SCREW, HEXAGON RECESS, ALL MATERIALS

FOR LENGTHS SHORTER THAN LISTED, SCREWS WILL BE THREADED AS CLOSE TO THE HEAD AS PRACTICABLE (APPROX. WITHIN 3 THREAD PITCHES).

STANDARDS AND SPECIFICATIONS: FF-S-86

5/16		3/8		7/16		1/2		5/8		3/4		7/8		1	
LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB	LG	LB
0.880	0.600														
0.880	0.600	1.000	0.690												
1.380	1.100	1.000	0.690	1.120	0.770	1.000	0.620								
1.380	1.100	1.500	1.190	1.120	0.770	1.000	0.620								
1.880	1.600	1.500	1.190	1.620	1.270	1.000	0.620								
1.880	1.600	2.000	1.690	1.620	1.270	1.750	1.360	1.500	1.040						
2.380	2.100	2.000	1.690	2.120	1.770	1.750	1.360	1.500	1.040	1.500	1.000				
2.380	2.100	2.500	2.190	2.120	1.770	1.750	1.360	1.500	1.040	1.500	1.000	1.500	0.940		
2.880	2.600	2.500	2.190	2.620	2.270	2.500	2.120	2.250	1.800	1.500	1.000	1.500	0.940	1.500	0.880
2.880	2.600	3.000	2.690	2.620	2.270	2.500	2.120	2.250	1.800	1.500	1.000	1.500	0.940	1.500	0.880
3.380	3.100	3.000	2.690	3.120	2.770	2.500	2.120	2.250	1.800	2.500	2.000	1.500	0.940	1.500	0.880
3.380	3.100	3.500	3.190	3.120	2.770	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	1.500	0.880
3.880	3.600	3.500	3.190	3.620	3.270	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	2.500	1.880
3.880	3.600	4.000	3.690	3.620	3.270	3.250	2.860	3.000	2.540	2.500	2.000	2.500	1.940	2.500	1.880
4.380	4.100	4.000	3.690	4.120	3.770	4.000	3.620	3.750	3.300	3.500	3.000	2.500	1.940	2.500	1.880
4.380	4.100	4.500	4.190	4.120	3.770	4.000	3.620	3.750	3.300	3.500	3.000	3.500	2.940	2.500	1.880
4.880	4.600	4.500	4.190	4.620	4.270	4.000	3.620	3.750	3.300	3.500	3.000	3.500	2.940	3.500	2.880
4.880	4.600	5.000	4.690	4.620	4.270	4.750	4.360	4.500	4.040	3.500	3.000	3.500	2.940	3.500	2.880
5.380	5.100	5.000	4.690	5.120	4.770	4.750	4.360	4.500	4.040	4.500	4.000	3.500	2.940	3.500	2.880
		5.500	5.190	5.120	4.770	4.750	4.360	4.500	4.040	4.500	4.000	4.500	3.940	3.500	2.880
		5.500	5.190	5.620	5.270	5.500	5.120	5.250	4.800	4.500	4.000	4.500	3.940	4.500	3.880
		6.000	5.690	5.620	5.270	5.500	5.120	5.250	4.800	4.500	4.000	4.500	3.940	4.500	3.880
		6.000	5.690	6.120	5.770	5.500	5.120	5.250	4.800	5.500	5.000	4.500	3.940	4.500	3.880
		6.500	6.190	6.120	5.770	6.250	5.860	6.000	5.540	5.500	5.000	5.500	4.940	4.500	3.880
				6.620	6.270	6.250	5.860	6.000	5.540	5.500	5.000	5.500	4.940	5.500	4.880
				7.120	6.770	7.000	6.620	6.750	6.300	6.500	6.000	5.500	4.940	5.500	4.880
				7.620	7.270	7.000	6.620	6.750	6.300	6.500	6.000	6.750	6.190	6.500	5.880
				8.120	7.770	8.000	7.620	7.750	7.300	7.500	7.000	6.750	6.190	6.500	5.880
						8.000	7.620	7.750	7.300	7.500	7.000	7.750	7.190	7.500	6.880
								9.250	8.800	9.000	8.500	8.750	8.190	8.500	7.880
								10.250	9.800	10.000	9.500	9.750	9.190	9.500	8.880
										11.000	10.500	10.750	10.190	10.500	9.880
										12.000	11.500	11.750	11.190	11.500	10.880
										13.000	12.500	12.750	12.190	12.500	11.880
												13.750	13.190	13.500	12.880
												14.750	14.190	14.500	13.880
												15.750	15.190	15.500	14.880
														16.500	15.880
														17.500	16.880

**SHOULDER BOLT, HEXAGON RECESS, ALLOY STEEL, 95 KSI ULTIMATE SHEAR STRENGTH,
AUSTENITIC STAINLESS STEEL, 45 KSI USS AND A286, 95 KSI USS**



STANDARDS AND SPECIFICATIONS: NASM21472

DASH NO.	NOM. SHLDRØ	THREAD SERIES		ØA	ØB	F MIN.	H	ØJ MIN.	ØK UNRC UNRF	N MAX.	M MAX.	T		U MAX.	W NOM.
		UNRC-3A	UNRF-3A									+ .000	- .020		
4	.250	.1900-24	.1900-32	.375	.248	.094	.188	.227	.142	.156	.093	.083	.375	.005	.125
				.357	.247		.182		.133	.147					
5	.312	.2500-20	.2500-28	.438	.3105	.117	.219	.289	.193	.210	.093	.100	.437	.005	.156
				.419	.3095		.213		.182	.201					
6	.375	.3125-18	.3125-24	.562	.373	.141	.250	.352	.249	.265	.093	.111	.500	.005	.187
				.543	.372		.244		.237	.256					
8	.500	.3750-16	.3750-24	.750	.498	.188	.313	.477	.304	.327	.093	.125	.625	.008	.250
				.729	.497		.306		.291	.318					
10	.625	.5000-13	.5000-20	.875	.623	.234	.375	.602	.414	.443	.093	.154	.750	.008	.312
				.853	.622		.368		.397	.432					
12	.750	.6250-11	.6250-18	1.000	.748	.281	.500	.727	.521	.561	.093	.182	.875	.008	.375
				.977	.747		.492		.502	.549					
14	.875	.7500-10	.7500-16	1.125	.873	.375	.625	.852	.638	.678	.093	.200	1.000	.008	.500
				1.000	.872		.616		.616	.665					
16	1.000	.7500-10	.7500-16	1.312	.998	.375	.625	.977	.638	.678	.125	.200	1.000	.008	.500
				1.287	.997		.616		.616	.665					
20	1.250	.8750-9	.8750-14	1.750	1.248	.469	.750	1.227	.750	.796	.125	.222	1.125	.008	.625
				1.723	1.247		.741		.726	.778					
24	1.500	1.1250-7	1.1250-12	2.125	1.498	.656	1.000	1.478	.964	1.022	.125	.286	1.500	.008	.875
				2.095	1.496		.980		.934	1.014					
28	1.750	1.2500-7	1.2500-12	2.375	1.748	.750	1.125	1.728	1.089	1.147	.125	.286	1.750	.008	1.000
				2.345	1.746		1.105		1.059	1.139					
32	2.000	1.5000-6	1.5000-12	2.750	1.998	.937	1.250	1.978	1.307	1.397	.125	.333	2.000	.008	1.250
				2.720	1.996		1.230		1.277	1.389					

SHOULDER BOLT, HEXAGON RECESS

MECHANICAL PROPERTIES - ALLOY STEEL

STANDARDS AND SPECIFICATIONS: FF-S-86

DASH NO.	NOMINAL SHLDRØ	THREAD SERIES		TENSILE STRENGTH LBS. MIN.		DOUBLE SHEAR STRENGTH OF BODY LBS., MIN.	*RECOMMENDED SEATING TORQUE INCH POUNDS	
		UNRC-3A	UNRF-3A	UNRC-3A	UNRF-3A		UNRC	UNRF
4	.250	.1900-24	.1900-32	2,220	2,720	9,100	45	52
5	.312	.2500-20	.2500-28	4,160	5,080	14,300	112	128
6	.375	.3125-18	.3125-24	7,060	8,240	20,700	230	255
8	.500	.3750-16	.3750-24	10,640	12,710	36,900	388	441
10	.625	.5000-13	.5000-20	19,810	23,450	57,700	990	1,115
12	.750	.6250-11	.6250-18	31,670	37,880	83,300	1,975	2,236
14	.875	.7500-10	.7500-16	47,680	55,570	113,500	3,490	3,900
16	1.000	.7500-10	.7500-16	47,680	55,570	148,300	3,490	3,900
20	1.250	.8750-9	.8750-14	66,230	76,060	232,000	5,610	6,200
24	1.500	1.1250-7	1.1250-12	110,000	129,000	334,000	12,000	12,500
28	1.750	1.2500-7	1.2500-12	141,000	163,000	455,000	16,000	17,500
32	2.000	1.5000-6	1.5000-12	205,000	242,000	595,000	30,000	30,800

THE TENSILE STRENGTH IS BASED ON A STRESS OF 160 KSI MINIMUM AND THE AREA AT MINIMUM NECK "ØK". THE SHEAR STRENGTH IS BASED ON A STRESS OF 95 KSI MINIMUM AND THE AREA AT MINIMUM SHOULDER "ØB".

*REFER TO WARNING ON PAGE 6.

SHOULDER BOLT, HEXAGON RECESS

MECHANICAL PROPERTIES-CORROSION RESISTANT

STANDARDS AND SPECIFICATIONS: FF-S-86

SIZE	AUSTENITIC STAINLESS STEEL TENSILE STRENGTH LBS. MIN.		AUSTENITIC STAINLESS STEEL DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.	A286 TENSILE STRENGTH LBS. MIN.		A286 DOUBLE SHEAR STRENGTH OF BODY LBS. MIN.
	UNRC-3A	UNRF-3A		UNRC-3A	UNRF-3A	
4	1,110	1,360	4,300	2,220	2,720	9,100
5	2,080	2,540	6,800	4,160	5,080	14,300
6	3,530	4,120	9,800	7,060	8,240	20,700
8	5,320	6,350	17,500	10,640	12,710	36,900
10	9,900	11,700	27,300	19,810	23,450	57,700
12	15,800	18,900	39,400	31,670	37,880	83,300
14	23,800	27,800	53,700	—	—	—
16	23,800	27,800	70,300	—	—	—
20	33,100	38,000	110,000	—	—	—
24	54,800	64,600	158,000	—	—	—
28	70,500	81,500	215,000	—	—	—
32	102,000	121,000	282,000	—	—	—

AUSTENITIC STAINLESS STEEL — THE TENSILE STRENGTH IS BASED ON A STRESS OF 80 KSI MINIMUM AND THE AREA AT MINIMUM NECK "ØK". THE SHEAR STRENGTH IS BASED ON A STRESS OF 45 KSI ULTIMATE SHEAR STRENGTH AND THE AREA AT MINIMUM SHOULDER "ØB".

A286 — THE TENSILE STRENGTH IS BASED ON A STRESS OF 160 KSI MINIMUM AND THE AREA AT MINIMUM NECK "ØK". THE SHEAR STRENGTH IS BASED ON A STRESS OF 95 KSI MINIMUM AND THE AREA AT MINIMUM SHOULDER "ØB".

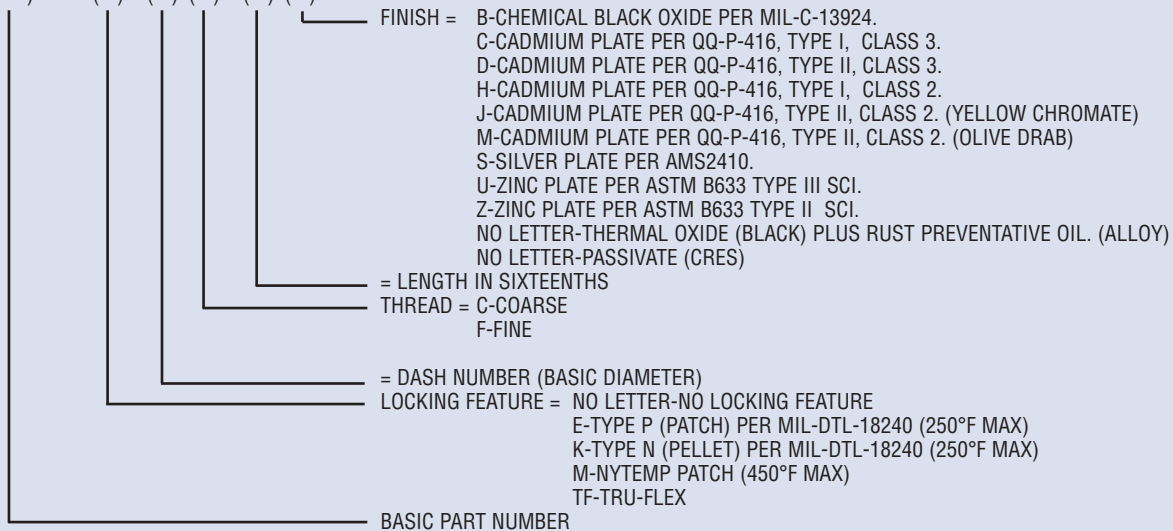
SHOULDER BOLT, HEXAGON RECESS

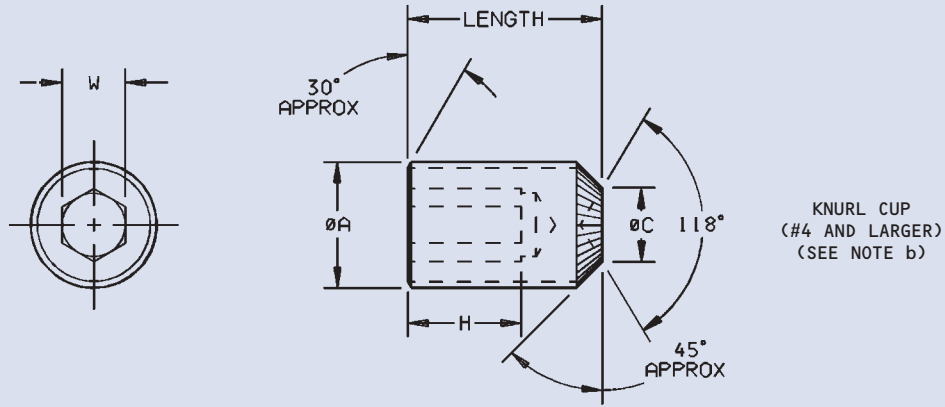
1. BASIC PART NUMBERS: 94705 - ALLOY STEEL PER CHEMISTRY OF ASTM A574. HRC 36-43. MAGNETIC PARTICLE INSPECT PER ASTM E1444. ACCEPTANCE CRITERIA PER SPS-I-650.
- 94706 - AUSTENITIC STAINLESS STEEL PER CHEMISTRY OF ASTM A493. FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650. DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.
- 95224 - A286 PER CHEMISTRY OF AMS 5853. HRC 36-48. FLUORESCENT PENETRANT INSPECT PER ASTM E1417. ACCEPTANCE CRITERIA PER SPS-I-650.

2. DIMENSIONS AND GEOMETRIC TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.

3. FINISH: REFER TO FINISH OPTIONS.

4. PART NUMBERING: () () - () () - () ()





LENGTH TOLERANCE TABLE

UP TO .630	OVER .630 TO 2.0"	OVER 2.0" TO 6.0"	OVER 6.0"
±.01	±.02	±.03	±.06

FLAT	PLAIN CUP SEE NOTE (b)	CONE SEE NOTE (a)	FULL DOG	OVAL	HALF DOG

(a) WHEN LENGTH EQUALS NOMINAL DIAMETER OR LESS, INCLUDED ANGLE IS 118°. (#4 X 1/8 AND #8 X 3/16 ALSO HAVE 118° ANGLE)
 (b) WHEN LENGTH EQUALS NOMINAL DIAMETER OR LESS, INCLUDED ANGLE IS 130°.

STANDARDS AND SPECIFICATIONS: FF-S-200

THREAD SIZE		A UNRC		A UNRF		C	D		F		G		H **		W	R
UNRC-3A	UNRF-3A	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	NOM.	RAD.
	#0-80			.0600	.0568	.033	.027	.040	.037	.017	.013	.033	.027	.035	.028	.047
#1-64	#1-72	.0730	.0692	.0730	.0695	.040	.033	.049	.045	.021	.017	.040	.034	.035	.035	.055
#2-56	#2-64	.0860	.0819	.0860	.0822	.047	.039	.057	.053	.024	.020	.047	.039	.035	.035	.062
#3-48	#3-56	.0990	.0945	.0990	.0949	.054	.045	.066	.062	.027	.023	.054	.046	.060	.050	.078
#4-40	#4-48	.1120	.1069	.1120	.1075	.061	.051	.075	.070	.030	.026	.060	.052	.075	.050	.084
#5-40	#5-44	.1250	.1199	.1250	.1202	.067	.057	.083	.078	.033	.027	.064	.056	.075	.0625	.093
#6-32	#6-40	.1380	.1320	.1380	.1329	.074	.064	.092	.087	.038	.032	.074	.066	.075	.0625	.109
#8-32	#8-36	.1640	.1580	.1640	.1585	.087	.076	.109	.103	.043	.037	.084	.076	.075	.0781	.125
#10-24	#10-32	.1900	.1828	.1900	.1840	.102	.088	.127	.120	.049	.041	.095	.085	.105	.0937	.141
1/4-20	1/4-28	.2500	.2419	.2500	.2435	.132	.118	.156	.149	.0665	.0585	.130	.120	.105	.125	.188
5/16-18	5/16-24	.3125	.3038	.3125	.3053	.172	.156	.203	.195	.082	.074	.164	.148	.140	.1562	.234
3/8-16	3/8-24	.3750	.3656	.3750	.3678	.212	.194	.250	.241	.0987	.0887	.1955	.1795	.140	.1875	.281
7/16-14	7/16-20	.4375	.4272	.4375	.4294	.252	.232	.296	.287	.114	.104	.2267	.2107	.190	.2187	.328
1/2-13	1/2-20	.5000	.4891	.5000	.4919	.291	.270	.343	.334	.130	.120	.260	.240	.210	.250	.375
9/16-12	9/16-18	.5625	.5511	.5625	.5538	.332	.309	.390	.379	.1456	.1356	.291	.271	.265	.250	.422
5/8-11	5/8-18	.6250	.6129	.6250	.6163	.371	.347	.468	.456	.164	.148	.3225	.3025	.265	.3125	.468
3/4-10	3/4-16	.7500	.7371	.7500	.7406	.450	.425	.562	.549	.1955	.1795	.385	.365	.330	.375	.562
7/8-9	7/8-14	.8750	.8611	.8750	.8647	.530	.502	.656	.642	.2267	.2107	.4475	.4275	.450	.500	.656
1-8	1-12	1.0000	.9850	1.0000	.9897	.609	.579	.750	.734	.260	.240	.510	.490	.550	.5625	.750
1-1/8-7	1-1/8-12	1.1250	1.1086	1.1250	1.1136	.689	.655	.843	.826	.291	.271	.5775	.5475	.650	.5625	.844
1-1/4-7	1-1/4-12	1.2500	1.2336	1.2500	1.2386	.767	.733	.937	.920	.3225	.3025	.640	.610	.700	.625	.938
1-3/8-6	1-3/8-12	1.3750	1.3568	1.3750	1.3636	.848	.808	1.031	1.011	.3537	.3337	.7025	.6725	.700	.625	1.032
1-1/2-6	1-1/2-12	1.5000	1.4818	1.5000	1.4886	.926	.886	1.125	1.105	.385	.365	.765	.735	.750	.750	1.125

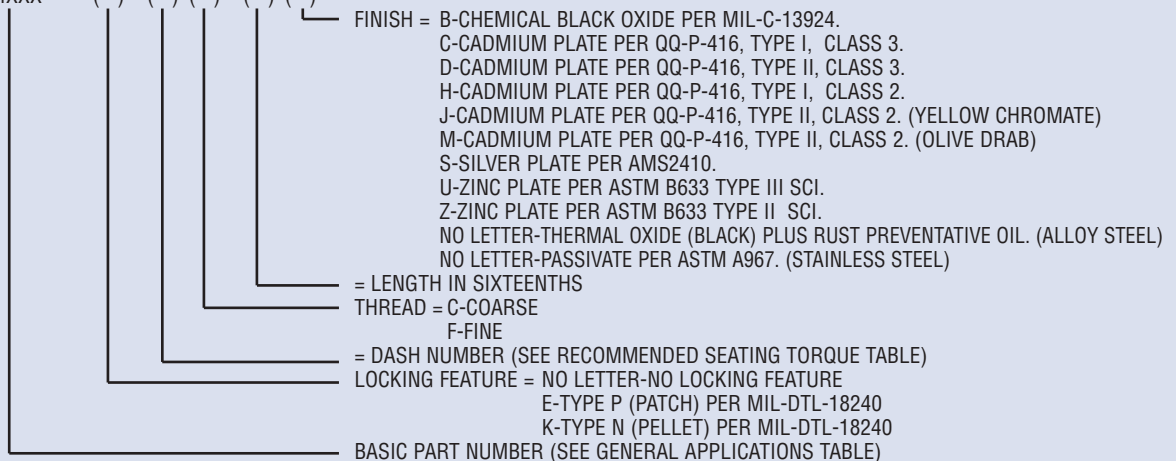
** VALUES SHOWN IN COLUMN H ARE FOR MINIMUM STOCK LENGTH CUP POINT SCREWS.

BASIC PART NUMBER	POINT TYPE	BASIC PART NUMBER	STAINLESS STEEL	GENERAL APPLICATIONS
94709	FLAT	94947		USE WHERE PARTS MUST BE FREQUENTLY RE-SET; HARDENED SHAFTS, ADJUSTING SCREW.
94710	PLAIN CUP	94948		USE WHERE HIGH TIGHTENING TORQUES ARE IMPRACTICAL; ZINC, DIE CASTINGS.
94711	CONE	94950		USE WHERE PERMANENT LOCATION IS NECESSARY; PIVOTS, FINE ADJUSTMENTS.
94712	FULL DOG	94974		USE WHERE PERMANENT LOCATION IS NECESSARY; HOLLOW TUBE, REPLACES DOWEL PIN.
94713	KNURL CUP	94949		USE FOR QUICK AND PERMANENT LOCATION; GEARS, COLLARS. RESISTS SCREW LOOSENING.
94714	OVAL	94951		USE FOR FREQUENT ADJUSTMENT WITHOUT DEFORMATION AND AGAINST ANGULAR SURFACES.
94946	HALF DOG	94975		USE WHERE PERMANENT LOCATION IS NECESSARY; HOLLOW TUBE, REPLACES DOWEL PIN.

SIZE	DASH NUMBER	*RECOMMENDED SEATING TORQUE IN POUNDS	
		ALLOY STEEL	STAINLESS STEEL
#0	90	1	.4
#1	91	1.8	1.2
#2	92	1.8	1.2
#3	93	5	4
#4	94	5	4
#5	95	10	7
#6	96	10	7
#8	98	20	16
#10	3	36	26
1/4	4	87	70
5/16	5	165	130
3/8	6	290	230
7/16	7	430	340
1/2	8	620	500
9/16	9	620	500
5/8	10	1325	980
3/4	12	2400	1700
7/8	14	3600	3000
1	16	5000	4000
1-1/8	18	7200	5600
1-1/4	20	9600	7700
1-3/8	22	9600	7700
1-1/2	24	11,230	9100

*REFER TO WARNING ON PAGE 6.

1. MATERIAL: ALLOY STEEL PER AISI 4032, 4037, 40L37SE, 4137, 4140, 8630, 8740 OR EQUIVALENT. 300 SERIES AUSTENITIC STAINLESS STEEL.
2. HEAT TREAT: 45-53 HRC FOR ALLOY STEEL ONLY. FOR ALLOY STEEL PARTS WITH NYLON PLUG - 28 HRC MINIMUM.
3. FINISH: SEE NOTE 5.
4. DIMENSIONS AND TOLERANCING PER ASME B18.3, THREADS PER ASME B1.1.
5. PART NUMBERING: 94XXX ()-() ()-() ()



DO YOUR SOCKET SCREWS MEASURE UP?

Do the fasteners you are currently using meet the FF-S-86 procurement specification for military/government socket screws?

Why do I need SPS certified fasteners?

Reliability is a crucial issue among aerospace and defense industry suppliers and contractors. Fasteners are used in airplanes, aerospace vehicles, satellites, missiles, military vehicles, weapons and other applications where failure cannot be tolerated. MS (Military Standard) and NAS (National Aerospace Standards) fasteners help assure reliability for these critical uses.

Specifications

The FF-S-86 specification covers socket screws, including shoulder button head and flat head styles. Numerous MS and a number of NAS fastener standards are governed by this specification. This specification helps assure reliable part performance.

The Socket Screw Checklist

Unfortunately, sub-standard fasteners represented as MS and NAS parts are being supplied. This is why it's vital that every time you purchase socket screws for critical applications, you should ask the following questions about the product and its source:

- Do they manufacture the socket screws they sell?
- Do they certify socket screws to FF-S-86?
- Are they experienced working with special materials, close tolerances and critical requirements?
- Do they control their manufacturing processes?

- Do they maintain stringent quality assurance for all products?
- Do they maintain statistical monitoring of all manufacturing phases?
- Do they have in-house capabilities for plating, post plating bake and stress durability testing?
- Do they certify plated parts to QQ-P-416?
- Do they have in-house magnetic particle and fluorescent penetrant inspection facilities?
- Are they approved on the Boeing D590 standards?
- Do they offer product engineering assistance with design, materials and finishes?

SPS Technologies

SPS Technologies Aerospace Fasteners Group maintains all of the capabilities and resources to meet these exact requirements and certify fasteners for critical applications.

Fatigue Failure

An estimated 85% of fastener failures are caused by fatigue. While FF-S-86 includes a number of quality requirements, it does not specify fatigue failure safeguards. SPS Technologies manufactures socket screw products that exhibit high fatigue resistance to assure maximum joint reliability and safety. To achieve the highest degree of safety and reliability, you should consider including fatigue requirements in your specifications.

Why parts do not meet standards

Assuring compliance with the procurement specification is everyone's concern. However, ignorance, confusion, laxity, even disregard have all played a part in the rise in the number of parts which do not meet standards.

Price sensitivity, delivery pressures and government sourcing constraints are also factors. The results are part failures, lower safety standards, downtime, repair expenses and extra manhour costs.



What else can I do?

As discussed in the Socket Screw Checklist, you should require parts certification from your source. Setting up incoming quality control inspections can also help.

The most important step is acquiring a full understanding of the FF-S-86 requirements and the problems that can result when sub-standard parts are introduced into full production schemes.

UNDERSTANDING FF-S-86

FF-S-86 is the procurement specification for both MS and NAS socket head cap screws. Federal Specification QQ-P-416 (cadmium plating) and ASME B18.3 (socket cap, shoulder and set screws) also form a part of this specification.

Within these documents other specifications are referenced. General topics under the specification include material, mechanical properties, dimensions, tolerances, thread laps, plating, carburization/decarburization limitations, discontinuity limitations, hydrogen embrittlement, quality assurance and testing.

One significant problem with parts which are represented as MS or NAS fasteners, but are not, is that suppliers fail to recognize or adhere to the secondary specifications, such as QQ-P-416 (when plating is required), or even the basic

dimensional requirements of the American National Standards Institute (ASME B18.3).

Manufacturing Requirements

Stringent control of all manufacturing processes is critical to the production of fasteners that meet specifications. Doubtless, certain manufacturing practices produce better products than others. Properly forged heads and rolled threads produce the strongest, most reliable fasteners.

Forging forms the metal and actually makes the heads stronger. Machined heads and cut or ground threads are less satisfactory. Machining—actually cutting the metal—weakens fasteners, inviting fatigue failure.

More Considerations

Design is another important element in meeting specifications. Heads must be designed with proper bearing area, correct upset and controlled fillet radius. Socket depth must conform to dimensional requirements in order to develop proper tightening characteristics.

Proper selection of material, proper heat treating, control of critical plating procedures and well-equipped quality control and testing facilities are all important, too.

Failures Result

Failure to correctly control any of these and other manufacturing processes can allow fasteners which do not meet specification to find their way into the MS and NAS systems. These substandard fasteners can lead to premature failures and attendant problems in the field.



FASTENERS THAT DON'T MEET MS & NAS SPECIFICATIONS

What to Look for...What Can Happen

Generally, specification-related problems can be classed in one of four areas: dimensions, mechanical/physical, plating and quality assurance. The following is a discussion of the various problems.

Dimensional

Problem Areas - What to Look For

- Insufficient socket depth causes inadequate key engagement
- Excessive socket depth reduces the amount of material in the head, lowering screw strength
- Undersize threads can lead to stripping
- Undersize fillet may promote stress failure
- Poorly formed thread runout may cause fatigue failure

All MS and NAS socket screw products must conform to the dimensional requirements of ASME B18.3. This is the overall inch standard for socket screw products and keys related to the following requirements...

Dimensional Basics

- Body and head diameter
- Head height
- Head side height
- Socket width
- Fillet radius
- Wall thickness
- Key engagement
- Chamfer
- Basic thread length

Problem Scenarios - What Can Happen

1. Excessive socket depth caused premature fatigue in this part (pictured at right). Full screw strength was not achieved because the socket depth exceeded the maximum allowed and the wall thickness between the bottom of the socket and the head bearing surface was inadequate. When socket depth is under minimum requirements, limited key engagement can prevent maximum tightening and reduce load carrying capacity. Limited key engagement in this case can also lead to screw failure at low wrenching torques.

Undersize threads can cause thread stripping. Insufficient material in the screw blank or improper adjustment of the thread dies are two possible causes. (Ref. MS 24678)

2. This fastener failed prematurely because of a high stress concentration in the fillet area (pictured at right). An undersize fillet and machining marks were the cause. Fillet must be smooth and within the minimum/maximum dimensions of ASME B18.3. (Ref. MS 24678)

3. A poorly formed thread runout (last thread) caused this fastener to fail in fatigue (pictured at right). When a thread runout is not properly radiused, a high stress concentration is created and premature fatigue failures can occur.



1.



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3.

Mechanical Properties

Problem Areas - What to Look For

- Improper material selection lowers part quality, causes inconsistent hardness
- Poor control of heat treating lowers tensile strength values
- Carburization which can reduce fatigue life and promote hydrogen embrittlement
- Decarburization which can degrade fastener strength and performance

The procurement specification requires that fasteners exhibit specific strength and hardness properties. Material choice, heat treatment practices, hardenability and carburization/decarburization limitations all play a part in achieving these mechanical properties.

Problem Scenarios - What Can Happen

1. Start with the right material - Specifications call for heat-treatable alloy steel, corrosion resistant steel or specific non-ferrous materials. Any material deviation could result in parts failure.

2. Heat treatment - Parts are heat treated to develop the desired strength and hardness levels. Poor heat treatment practices can result in an inferior product. Proper heat treatment requires...

- Controlled furnace atmospheres to prevent carburization and decarburization
- Close temperature control to prevent detrimental microstructural changes
- Proper quenching medium to prevent cracking and ensure through-hardening

The ability of a part to be through-hardened upon quenching also depends on the hardenability of the alloy selected, which is a function

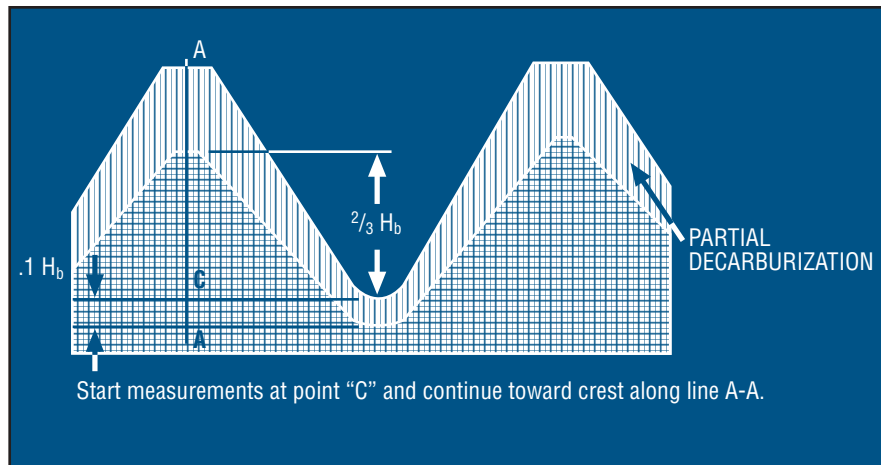


Figure 1
Definition of Partial Decarburization Limits
(federal Specification, FF-S-86, screw, cap, socket head)



of chemical composition. Improper alloy selection can result in undesirable hardness variations within the part.

Carburization is an increase in surface carbon content, which makes the surface harder than the core. Carburized fasteners tend to exhibit reduced fatigue performance, are less able to withstand bending stresses and are more susceptible to environmentally-assisted failure (i.e., stress corrosion cracking and hydrogen embrittlement). If a part is being plated,

carburization can increase susceptibility of the part to hydrogen embrittlement.

Decarburization is a decrease in surface carbon content, which makes the surface softer than the core. Decarburized fasteners tend to exhibit reduced fatigue performance.

Carburization and total decarburization must not be present on the thread surface according to the requirements of FF-S-86.

Plating

Problem Areas - What to Look For

- Cold work without stress relief, heavy chemical cleaning and improper control of plating or baking processes can cause hydrogen embrittlement and delayed fracture failures
- Plating of off-the-shelf parts can result in unacceptable plating thickness
- “Flash” plating of off-the-shelf fasteners can reduce corrosion resistance

Poor plating practice is one of the major reasons fasteners fail to satisfy MS and NAS specification requirements. To avoid problems, good plating practices must be followed: proper cleaning, stress relief, plating thickness control, post plating bake to specification and rigorous quality control.

Failure to carefully monitor any of these criteria can result in hydrogen embrittlement problems, out-of-tolerance thread dimensions, uneven plating thickness or inadequate corrosion resistance.

Problem Scenarios - What Can Happen

1. Hydrogen Embrittlement - Classic hydrogen embrittlement occurs in three steps:

- Hydrogen present in metal under load diffuses to the points of highest stress
- Hydrogen then migrates to interfaces (i.e., boundaries)
- Discrete crack growth occurs until the cross-sectional area of the metal is sufficiently reduced for over-stress failure to ensue

Hydrogen embrittlement is a serious concern with fasteners supplied to MS/NAS specification because their higher tensile strengths make them more susceptible. Preventative measures rely on the use of plating and post plating bake practices that minimize the potential for hydrogen pick-up.

Cold Work

Cold work—machining, grinding, cold forming and cold straightening—which follows heat treating can cause residual surface tensile stresses and thus promote hydrogen embrittlement. cold worked parts must undergo a stress relief operation before plating. Stress relief is required under QQ-P-416.

Cleaning

Heavy acid cleaning to remove heat treat scale and foreign matter can add large amounts of hydrogen to parts and encourage hydrogen embrittlement. Cleaning methods must be controlled according to type and material of fastener. Aggressive acid solutions should be avoided.

Post Plating

Baking

The FF-S-86 specification requires alloy steel cap screws be baked to minimize the embrittlement potential that results from the plating process. Specifications call for a 23 hour bake at $375 \pm 25^\circ\text{F}$ within four hours of plating.

Certification

MS and NAS coated alloy steel screws must be furnished with certification of hydrogen embrittlement relief treatment and, when specified, must be subjected to a stress durability test. Manufacturers and sub-contracted platers often are not equipped to perform this and other important testing.

2. Plating Thickness - Plating thickness seems simple enough. However, because of the thread configuration, a screw's pitch diameter is increased by four times the plating thickness (see diagram, Fig. 2). To maintain the pitch diameter within specified limits, part tolerances must be controlled to allow for the extra thickness added by plating.

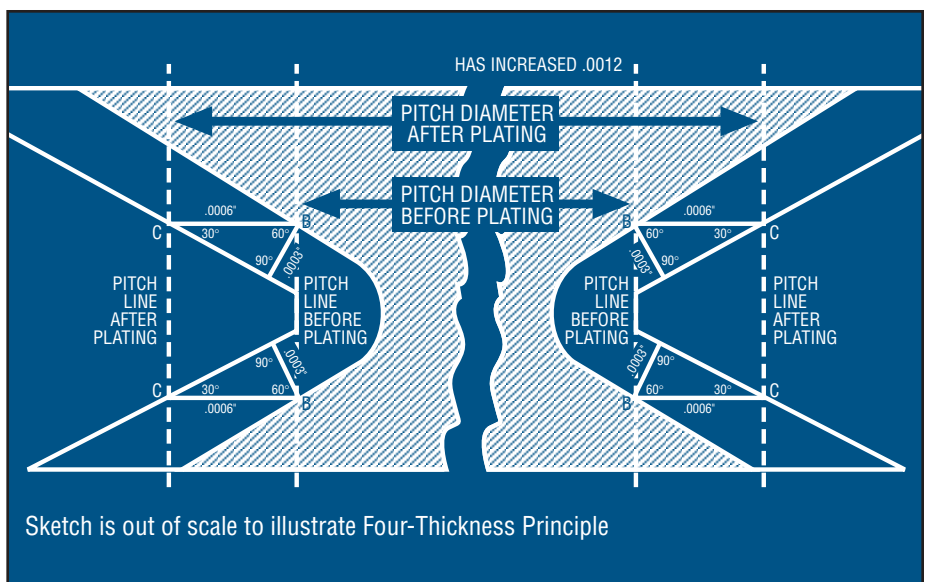


Figure 2

If off-the-shelf fasteners are supplied for plating, statistical analysis shows that, on-average, 16% of the plated screws will be oversize. Only by making the fasteners properly undersize will 100% of the finished plated parts fall within tolerance.

Often, off-the-shelf fasteners are “flash” plated to avoid the pitch diameter thickness problem. This short-cut can result in reduced corrosion resistance.

Carelessness in the plating procedure can also lead to uneven plating thickness and inadequate protection against corrosion. Poor control of the plating current can cause a too-rapid deposit of plating and an uneven build-up on the threads. The plating thickness will tend to be greater on the crests, meeting gage limits, but the deposit on the flanks and roots of threads may be too thin to provide the necessary protection.

Quality Assurance

Problem Areas - What to Look For

- Flawed parts reach users because of lax quality control
- Breakdowns in process control can result in defective fasteners

Comprehensive quality assurance procedures are obvious prerequisites in the manufacture of MS and NAS fasteners. Specific and thorough testing is required under the procurement specification. It would be virtually impossible to maintain the high standard required with these products without such control.

Under the specification requirements, lot sampling must be performed for defects, mechanical and metallographic properties and protective coatings.

Specific test procedures and quality standards must be adhered to for MS and NAS fasteners. Testing must be performed by the manufacturer or an independent facility.

Even the simplest inspections often are not performed. Many parts with discontinuities unacceptable under the standards are put into use. A close final inspection would have screened out sub-standard parts.

Problem Scenarios - What Can Happen

1. Parts from this lot failed in fatigue (pictured at right). Thread laps below the pitch diameter may be caused by broken, chipped or misaligned dies. The discontinuities are in an area of the screw thread that is the most critical and most highly stressed area of the fastener in dynamic applications.

2. These forging cracks were caused by poor manufacturing practices (pictured at right). Their location is in an area of the head that is unacceptable under the requirements of FF-S-86 and may cause the socket to split under the stress of installation.

Process control is another important aspect of quality assurance. Without careful monitoring at every step of the manufacturing process, problems such as this can arise. (Ref. MS 24678)

3. This socket reamed at well below the recommended seating torque (pictured at right). To facilitate cross drilling the lockwire hole, the screw was annealed after the heat treatment procedure. However, the part was never re-heat treated. Cross drilling must always be performed either before heat treatment or in the heat treated condition.

Specifications

FF-S-86

Federal Specification, screw, cap, socket head (Superintendent Of Documents, U.S. Government Printing Office, Washington, DC 20402)

ASME B18.3

Socket cap, shoulder and set screws (American National Standards Institute, 1430 Broadway, New York, NY 10018)

QQ-P-416

Federal Specification, plating, cadmium (electrodeposited) (Superintendent Of Documents, U.S. Government Printing Office, Washington, DC 20402)



1.



2.



3.

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