Designation: F837M – 02a

Standard Specification for Stainless Steel Socket Head Cap Screws [Metric][1]

This standard is issued under the fixed designation F837M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification covers the chemical and mechanical requirements for stainless steel metric socket head cap screws (SHCS) with nominal thread M1.6 through M36 and intended for use in applications requiring general corrosion resistance.

1.2 Two groups of stainless steel alloys are covered, austenitic Grade A1 and martensitic Grade C1.

1.3 Four property classes are covered: austenitic A1-50 in an annealed condition at 585 MPa maximum; austenitic A1–55 in a cold worked condition at 550 MPa minimum; austenitic A1-70 in a cold worked condition at 700 MPa minimum, and martensitic C1-110 in a heat treated condition at 1100 MPa minimum.

1.4 This hazard statement pertains only to Section 13, Test Methods: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels [3]

A342/A342M Test Methods for Permeability of Feebly Magnetic Materials [2]

A380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems [2]

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products [2]

A967 Specification for Chemical Passivation Treatments for Stainless Steel Parts [4]

D3951 Practice for Commercial Packaging [5]

E18 Test Methods for Rockwell Hardness of Metallic Materials [5]

E92 Test Method for Vickers Hardness of Metallic Materials [5]

E384 Test Method for Microindentation Hardness of Materials [6]

F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets (Metric) [6]

F738M Specification for Stainless Steel Metric Bolts, Screws, and Studs [6]

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

2.2 *ASME Standard:*

ASME B 18.3.1M Socket Head Cap Screws (Metric Series)[7]

3. Classification

3.1 The designation of the property class for the two materials and conditions of this specification shall be consistent with the stainless steel designations in Specification F738M.

3.2 The austenitic stainless steel socket head cap screw shall be designated F837M A1-50, F837M A1-55, or F837M A1-70.

3.3 The martensitic stainless steel socket head cap screw shall be designated F837M C1-110.

4. Ordering Information

4.1 Orders for socket head cap screws under this specification shall include:

4.1.1 Quantity (number of pieces of each item),

4.1.2 Name of the item (socket head cap screws, SHCS),

4.1.3 Size (nominal diameter, thread pitch, thread class, screw length) or part number,

4.1.4 Property class (A1-50, A1–55, A1-70, or C1-110),

4.1.5 ASTM specification and date of issue. When date of issue is not specified, fasteners shall be furnished to the latest issue,

4.1.6 Supplementary requirements, if any (see S1 through S3),

[1] This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.04 on Nonferrous Fasteners.

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[2] *Annual Book of ASTM Standards,* Vol 01.03.

[3] *Annual Book of ASTM Standards,* Vol 03.04.

[4] *Annual Book of ASTM Standards,* Vol 15.09.

[5] *Annual Book of ASTM Standards,* Vol 03.01.

[6] *Annual Book of ASTM Standards,* Vol 01.08.

[7] Available from Global Engineering Documents, 15 Inverness Way, Englewood, CO 80112.

4.1.7 Additional special requirements, if any, to be specified on the purchase order:

4.1.7.1 Forming (see 5.1),

4.1.7.2 Threading (see 5.2),

4.1.7.3 Surface finish (see 11.1),

4.1.7.4 Alloy selection (see 7.2),

4.1.7.5 Test report (see 11.2),

4.1.7.6 Additional testing (see section 12.3),

4.1.7.7 Inspection (see 13.1),

4.1.7.8 Rejection (see 14.1), and

4.1.7.9 Certification (see 15.1).

4.1.7.10 Special packaging requirements (see section 18.1.2).

5. Material and Manufacture

5.1 *Forging*—Unless otherwise specified, screws in sizes M3 through M20 with lengths up to 10 times the nominal product diameter or 150 mm, whichever is shorter, shall be cold headed except that they may be hot headed or machined by agreement with the purchaser. Larger sizes and lengths may be cold or hot headed. Screws smaller and larger than the M3 through M36 range may be machined. Sockets may be forged or machined at the option of the manufacturer.

5.2 *Threads*—Unless otherwise specified, screws in sizes up to M24 inclusive and product lengths up to 150 mm inclusive shall have threads formed by rolling, except by special agreement with the purchaser. Larger products may be rolled, cut, or ground at the option of the manufacturer.

6. Heat Treatment

6.1 Austenitic alloys class A1-50 screws, following manufacture, shall be annealed by heating to 1040 ± 30°C to obtain maximum corrosion resistance and minimum permeability. The screws shall be held for a sufficient time at temperature and then cooled at a rate sufficient to prevent precipitation of the carbide and to provide the properties specified in Table 1.

6.2 When Condition A1-55 or A1-70 is specified, the austenitic alloys shall be annealed as specified in 6.1 generally by the raw material manufacturer, then cold worked to develop specific properties.

6.3 Martensitic alloy Class C1 110 screws shall be hardened and tempered by heating to 1010 ± 30°C sufficient for austenitization, holding for at least ½ h, rapid air or oil quenching, reheating to 275°C minimum and holding for at least 1 h and then air cooling to provide the properties specified in Table 1.

7. Chemical Composition

7.1 It is the intent of this specification that screws shall be ordered by property class. The chemical composition of the screw material shall conform to the requirements of Table 2.

7.2 Unless otherwise specified in the inquiry and purchase order (see Supplementary Requirement S2) when A1-50, A1-55, or A1-70 property class is specified, the choice of alloy used by the manufacturer shall be clearly identified on all certification required in the purchase order The chemical composition shall conform to the limits specified in Table 2.

7.3 When chemical analysis is performed by the purchaser using finished fasteners representing each lot, the chemical contents obtained shall conform to the limits specified in Table 2 for the specific alloy. Chemical contents shall conform to the tolerances specified in Specification A751.

7.3.1 In the event of discrepancy, a referee analysis as specified in 13.1 of samples for each lot shall be made in accordance with 12.3.1.1.

8. Mechanical Properties

8.1 Screws shall be tested in accordance with the mechanical testing requirements for the property class, nominal thread diameter, length, and specified minimum tensile strength as specified in Table 3 and shall meet the mechanical requirements specified for that product in Table 1.

8.2 For products on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence over low hardness readings (see Table 4).

9. Corrosion Resistance

9.1 *Carbide Precipitation*:

9.1.1 Rod, bar, and wire in the austenitic alloy group A1 (not including the free-machining grade 303) used to make fasteners in accordance with this specification shall be capable of passing the test for susceptibility to intergranular corrosion as specified in Practice E of Practices A262.

9.1.2 As stated in Practices A262, samples may be subjected to the faster and more severe screening test in accordance with Practice A. Failing Practice A, specimens shall be tested to Practice E and be considered satisfactory if passing Practice E.

TABLE 1 Mechanical Property Requirements

Property Class	Nominal Thread Diameter[A]	Full Size Product Tests		Machined Specimen Tests			Core Hardness[B]	
		Tensile Strength, MPa	Minimum Extension[C]	Tensile Strength, MPa	Yield Strength, MPa	Elongation, %	Vickers	Rockwell
A1–50	M1.6 to M36	585 max	0.6*D*	585 max	380 max	40	210 max	95 HRB max
A1-55	M1.6 to M20	550 min	0.4*D*	550 min	270 min	25	160 min	50 HRA min
A1–70	M1.6 to M20	700 min	0.4*D*	600 min	450 min	20	220 min	59 HRA min
C1-110	M1.6 to M5	1100	. . .	. . .	. . .	. . .	350–440	36–45 HRC
	M6 to M36	1100	0.2*D*	1100	820	12	350–440	36–45 HRC

[A] For A1–55 and A1–70 property class fasteners with nominal thread diameter larger than M20, the mechanical properties shall be agreed upon between the user and manufacturer.

[B] Core hardness is only required when full-size product tensile testing cannot be accomplished.

[C] *D* denotes nominal thread size.

TABLE 2 Chemical Requirements

Property Class	UNS Designation	Alloy	Composition, % maximum except as shown								
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Copper	Molybdenum
Austenitic Alloys											
A1	S30300	303[A]	0.15	2.00	0.20	0.15 min	1.00	17.0 to 19.0	8.0 to 10.0	. . .	0.60 max[B]
A1	S30400	304	0.08	2.00	0.045	0.030	1.00	18.0 to 20.0	8.0 to 10.5	1.00	. . .
A1	S30403	304L	0.030	2.00	0.045	0.030	1.00	18.0 to 20.0	8.0 to 12.0	1.00	. . .
A1	S30500	305	0.12	2.00	0.045	0.030	1.00	17.0 to 19.0	10.5 to 13.0	1.00	. . .
A1	S38400	384	0.08	2.00	0.045	0.030	1.00	15.0 to 17.0	17.0 to 19.0	. . .	. . .
A1	S20300	XM1[A]	0.08	5.0 to 6.5	0.040	0.18 to 0.35	1.00	16.0 to 18.0	5.0 to 6.5	1.75 to 2.25	0.50 max[B]
A1	S30430	18–9LW	0.10	2.00	0.045	0.030	1.00	17.0 to 19.0	8.0 to 10.0	3.00 to 4.00	. . .
A1	S30433	302HQ	0.03	2.00	0.045	0.030	1.00	17.0 to 19.0	8.0 to 10.0	3.0 to 4.0	. . .
A1	S31600	316	0.08	2.00	0.045	0.030	1.00	16.0 to 18.0	10.0 to 14.0	. . .	2.0 to 3.0
A1	S31603	316L	0.03	2.00	0.045	0.030	1.00	16.0 to 18.0	10.0 to 14.0	. . .	2.0 to 3.0
Martensitic Alloys											
C1	S4100	410	0.15	1.00	0.040	0.030	1.00	11.5 to 13.5	. . .	. . .	. . .

[A] Free machining grades are not recommended for forged product. These grades may be furnished only when approved by the purchaser.
[B] At manufacturer's option, determined only when intentionally added.

TABLE 3 Mechanical Testing Requirements

Item	Product Length	Hardness		Test conducted Using Full Size Product		Test Conducted Using Machined Test Specification		
		max	min	Extension	Axial Tensile Strength	Yield Strength 0.2 % offset	Tensile Strength	Elongation
1	≤3 *D*[A]	[B]	[B]	. . .	. . .	. . .	. . .	. . .
2	3 *D* to 300 mm	[B]	. . .	[B]	[B]	. . .	. . .	. . .
3	Over 300 mm	[B]	. . .	A	A	B	B	B

[A] *D* denotes nominal diameter of product.
[B] Denotes mandatory test. In addition, either all tests denoted by A or all tests denoted by B shall be performed. In case of arbitration, full-size tests, denoted A, shall be decisive.

10. Dimensions

10.1 Unless otherwise specified, the products shall conform to the requirements of ASME B 18.3.1M Hexagon Socket Head Cap Screws (Metric Series).

11. Workmanship, Finish, and Appearance

11.1 *Surface Treatment*—Unless otherwise specified, screws shall be cleaned, descaled and passivated in accordance with Practice A380 or Specification A967 at the option of the manufacturer.

11.2 The surface discontinuities for these products shall conform to Specification F1470 and the additional limitations specified herein.

11.2.1 Forging defects that connect the socket to the periphery of the head are not permissible. Defects originating on the periphery and with a traverse indicating a potential to intersect are not permissible. Other forging defects are permissible provided those located in the bearing area, fillet, and top surfaces shall not have a depth exceeding 0.03 *D* or 0.13 m, whichever is greater. For peripheral discontinuities, the maximum depth may be 0.06 *D* (see Fig. 1).

11.2.2 Forging defects located in the socket wall within 0.1 times the actual key engagement, *T*, from the bottom of the socket are not permissible. Discontinuities located elsewhere in the socket shall not have a length exceeding 0.25 *T*, or a maximum depth of 0.03 *D* not to exceed 0.13 mm (see Fig. 2).

11.2.3 Seams in the shank shall not exceed a depth of 0.03 *D* or 0.2 mm, whichever is greater.

11.2.4 No transverse discontinuities shall be permitted in the head-to-shank fillet area.

TABLE 4 Tensile Strength Values for Full Size Fasteners, kN

Nominal Size and Thread Pitch	Stress Area, mm^2 [A]	Property Classes			
		A1-50	A1-55	A1-70	C1-110
		Tensile Strength, kN[B]	Tensile Strength, kN[C]	Tensile Strength, kN[D]	Tensile Strength, kN[E]
M1.6 × 0.35	1.27	0.74	0.70	0.89	1.40
M2 × 0.4	2.07	1.21	1.14	1.45	2.28
M2.5 × 0.45	3.39	1.98	1.87	2.37	3.73
M3 × 0.5	5.03	2.94	2.77	3.52	5.53
M3.5 × 0.6	6.78	3.97	3.73	4.75	7.46
M4 × 0.7	8.78	5.14	4.83	6.15	9.66
M5 × 0.8	14.2	8.30	7.80	9.93	15.6
M6 × 1	20.1	11.8	11.1	14.1	22.1
M8 × 1.25	36.6	21.4	20.1	25.6	40.3
M10 × 1.5	58.0	33.9	31.9	40.6	63.8
M12 × 1.75	84.3	49.3	46.3	59.0	92.7
M14 × 2	115	67.5	63.5	80.8	126.5
M16 × 2	157	91.7	86.2	110	173
M20 × 2.5	245	143	135	171	270
M24 × 3	353	206	. . .	. . .	388
M30 × 3.5	561	328	. . .	. . .	617
M36 × 4	817	478	. . .	. . .	899

[A] Stress Area = $0.7854 (D - 0.9382P)^2$
where:
D = nominal thread diameter, mm, and
P = thread pitch, mm.
[B] Tensile based on stress area and 585 MPa maximum.
[C] Tensile based on stress area and 550 MPa minimum through M20
[D] Tensile based on stress area and 700 MPa minimum through M20.
[E] Tensile based on stress area and 1100 MPa minimum.

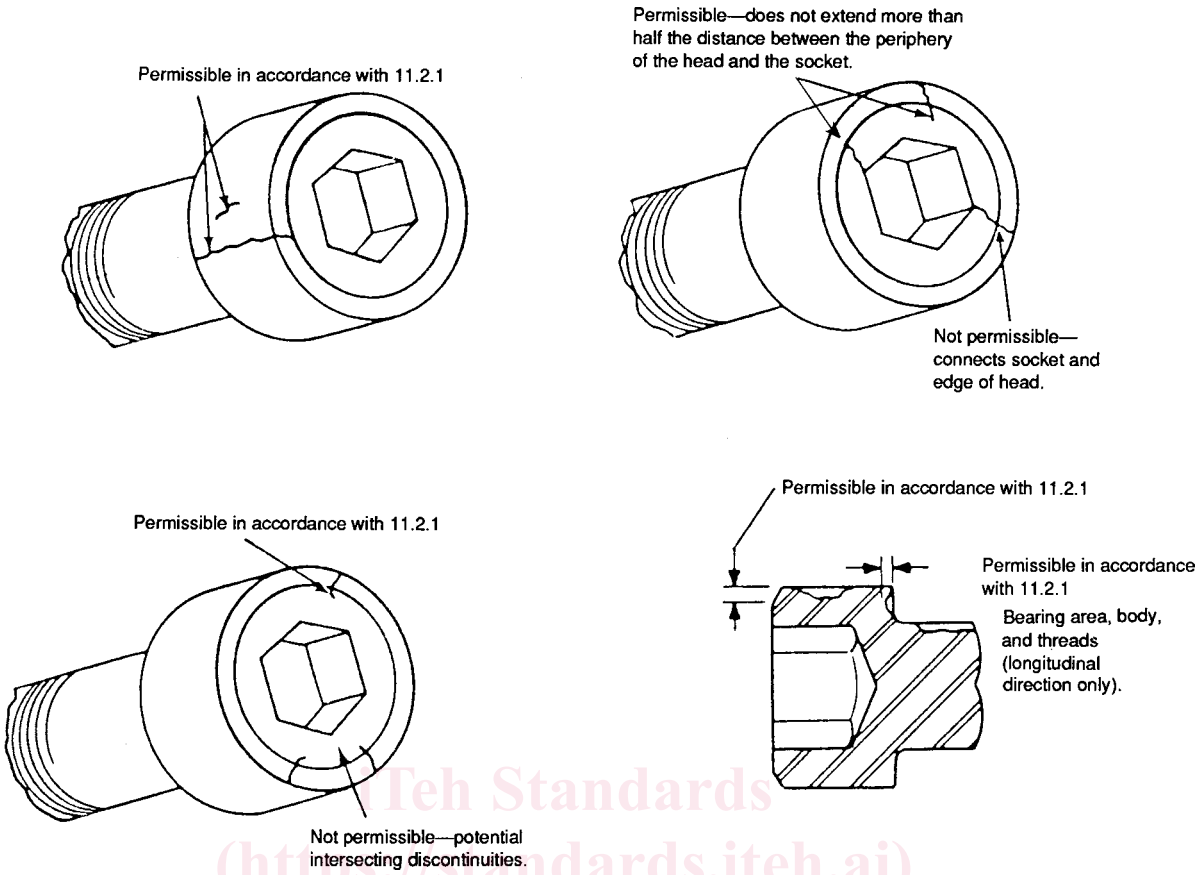

FIG. 1 Head and Body Discontinuity Location and Limits

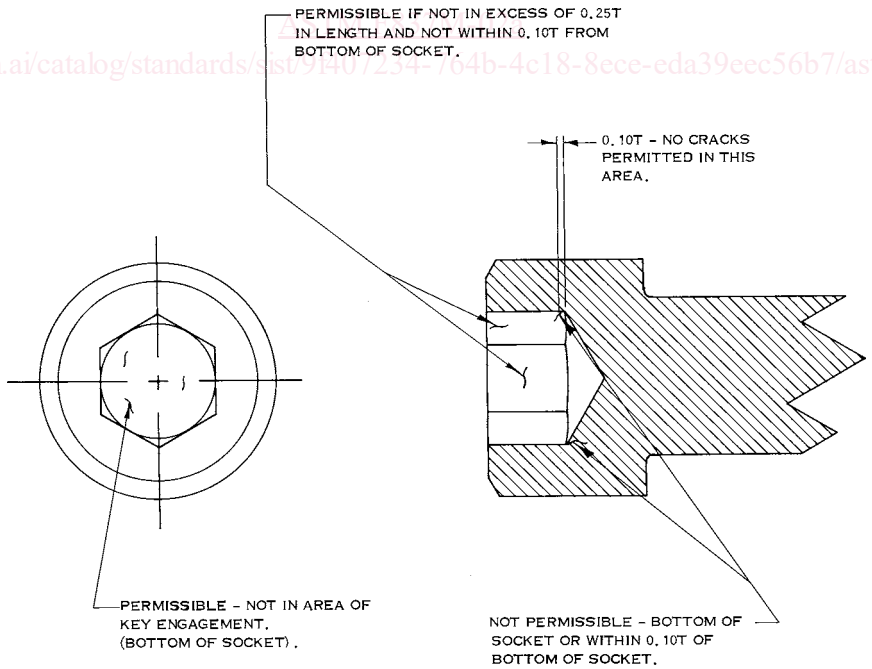

FIG. 2 Socket Discontinuity Location and Limits