Designation: A 563M – 00
METRIC

Standard Specification for Carbon and Alloy Steel Nuts [Metric][1]

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

1. Scope *

1.1 This specification covers chemical and mechanical requirements for eight property classes of hex and hex-flange carbon and alloy steel nuts for general structural and mechanical uses on bolts, studs, and other externally threaded parts.

NOTE 1—Throughout this specification, the term class means property class.

NOTE 2—Requirements for the four classes 5, 9, 10, and 12 are essentially identical with requirements given for these classes in ISO 898/II, Mechanical Properties of Fasteners, Part II, Nuts With Specified Proof Loads, Requirements for Classes 8S and 10S are essentially identical with requirements to be given for these classes in an ISO standard now under development. Classes 8S3 and 10S3 are not recognized in ISO standards.

1.2 Classes 8S3 and 10S3 nuts have atmospheric corrosion resistance and weathering characteristics comparable to those of the steels covered in Specification A 588/A 588M. The atmospheric corrosion resistance of these steels is substantially better than that of carbon steel with or without copper addition. See 5.2. When properly exposed to the atmosphere, these steels can be used bare (uncoated) for many applications.

1.3 The nut size range for which each class is applicable is given in the table on mechanical requirements.

1.4 Appendix X1 gives guidance to assist designers and purchasers in the selection of a suitable class.

1.5 Appendix X2 gives data on the properties of slotted hex nuts and hex jam nuts.

NOTE 3—This specification is the metric companion of Specification A 563.

2. Referenced Documents

2.1 *ASTM Standards:*

A 153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[2]

A 325M Specification for High-Strength Bolts for Structural Steel Joints [Metric][3]

A 394 Specification for Steel Transmission Tower Bolts, Zinc-Coated and Bare[3]

A 490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric][3]

A 588/A588M Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick[4]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[5]

B 695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel[6]

D 3951 Practice for Commercial Packaging[7]

F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric][3]

F 812/F812M Specification for Surface Discontinuities of Nuts, Inch and Metric Series[3]

G 101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels[8]

2.2 *ANSI Standards:*[9]

B 1.13M Metric Screw Threads—M Profile

B 18.2.4.1M Metric Hex Nuts, Style 1

B 18.2.4.2M Metric Hex Nuts, Style 2

B 18.2.4.3M Metric Slotted Hex Nuts

B 18.2.4.4M Metric Hex Flange Nuts

B 18.2.4.5M Metric Hex Jam Nuts

B 18.2.4.6M Metric Heavy Hex Nuts

3. Ordering Information

3.1 Orders for nuts under this specification shall include the following:

3.1.1 Quantity (number of nuts),

3.1.2 Nominal diameter and thread pitch,

3.1.3 Dimensional style of nut (for example, hex, heavy hex, or hex flange),

[1] This specification is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets, and Washers.

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[2] *Annual Book of ASTM Standards*, Vol 01.06.

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

[4] *Annual Book of ASTM Standards*, Vol 01.04.

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

[6] *Annual Book of ASTM Standards*, Vol 02.05.

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

[8] *Annual Book of ASTM Standards*, Vol 03.02.

[9] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

***A Summary of Changes section appears at the end of this standard.**

3.1.4 Property class of nut,

3.1.5 *Zinc Coating*—Specify the zinc coating process required, hot-dip, mechanically deposited, or no preference (see 4.7),

3.1.6 *Other Finishes*—Specify other protective finish if required,

3.1.7 ASTM designation and year of issue, and

3.1.8 Any special requirements.

3.2 The strength requirements for any class of nut may be satisfied by substituting a nut of a higher class provided that the nut width across flats is the same. With the written approval of the purchaser, the supplier may substitute as follows: Class 12 nuts for Classes 10, 9 and 5; Class 10 nuts for Classes 9 and 5; Class 9 nuts for Class 5; Class 10S for Class 8S; Class 8S3 for Class 8S; and Class 10S3 for Classes 10S, 8S and 8S3.

NOTE 4—Purchasers are cautioned that different classes of nuts have different nut thickness (see 7.2 through 7.5). Dimensional suitability of the nut for the intended application should be considered before approving substitution of a higher class.

NOTE 5—Examples of ordering descriptions are: (*a*) 10 000 M12 × 1.75 hex nuts, Class 9, ASTM A 563M–xx; (*b*) 2500 M24 × 3 heavy hex nuts, Class 10S, hot-dip zinc-coated, ASTM A 563M–xx; and (*c*) 5000 M10 × 1.5 hex flange nuts, Class 10, ASTM A 563M–xx.

4. Materials and Manufacture

4.1 Steel for nuts shall be made by the open-hearth, basic-oxygen, or electric-furnace process.

4.2 Nuts may be made cold or hot by forming, pressing, or punching, or may be machined from bar stock.

4.3 Classes 10, 12, 10S, and 10S3 nuts shall be heat treated by quenching in a liquid medium from a temperature above the transformation temperature and tempering at a temperature of at least 425°C.

4.4 Classes 8S and 8S3 nuts made of any steel permitted for these classes may be heat treated by quenching in a liquid medium from a temperature above the transformation temperature and tempering at a temperature of at least 425°C.

4.5 Class 8S nuts made of steel having a carbon content not exceeding 0.20 %, phosphorus not exceeding 0.04 %, and sulfur not exceeding 0.05 % by heat analysis may be heat treated by quenching in a liquid medium from a temperature above the transformation temperature and need not be tempered. When this heat treatment is used, particular attention shall be paid to the requirements in 6.1.

4.6 Threads shall be formed, tapped, or machined.

4.7 *Zinc Coatings, Hot-Dip and Mechanically Deposited*:

4.7.1 When zinc-coated fasteners are required, the purchaser shall specify the zinc coating process, for example, hot-dip, mechanically deposited, or no preference.

4.7.2 When hot-dip is specified, the fasteners shall be zinc-coated by the hot-dip process in accordance with the requirements of Class C of Specification A 153.

4.7.3 When mechanically deposited is specified, the fasteners shall be zinc-coated by the mechanical-deposition process in accordance with the requirements of Class 50 of Specification B 695.

4.7.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification A 153, Class C, or a mechanically deposited zinc coating in accordance with Specification B 695, Class 50. All components of mating fasteners (bolts, nuts, and washers) shall be coated by the same zinc coating process and the supplier's option is limited to one process per item with no mixed processes in a lot.

4.7.5 Hot-dip zinc coated nuts shall be tapped after zinc coating in accordance with the thread limits in 7.8.

4.7.6 Mechanically deposited zinc-coated nuts for assembly with mechanically deposited zinc-coated bolts shall be tapped oversize in accordance with the thread limits in 7.8 prior to zinc coating and need not be retapped afterwards.

NOTE 6—It is the intent of 4.7 and 4.8 together with the requirements specified in 7.8 that galvanized bolts and nuts will assemble freely, regardless of source of supply.

4.8 Hot-dip and mechanically deposited zinc-coated Class 10S nuts shall be provided with an additional lubricant that shall be clean and dry to the touch.

5. Chemical Composition

5.1 Classes 5, 9, 8S, 10, 10S and 12 shall conform to the chemical composition specified in Table 1.

5.2 Classes 8S3 and 10S3 shall conform to the chemical composition specified in Table 2. See Guide G 101 for methods of estimating corrosion resistance of low alloy steels.

5.3 Resulfurized or rephosphorized steel, or both, are not subject to rejection based on product analysis for sulfur or phosphorus unless misapplication is clearly indicated.

5.4 Application of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted for Classes 10, 12, 10S, and 10S3.

5.5 Chemical analyses shall be performed in accordance with Test Methods A 751.

6. Mechanical Properties

6.1 The hardness of nuts of each class shall not exceed the maximum hardness specified for the class in Table 3. This shall be the only hardness requirement for nuts that are proof load tested.

6.2 Unless proof load testing is specified in the inquiry and purchase order, nuts of all classes in nominal thread diameters

TABLE 1 Chemical Requirements

Property Class of Nut	Composition, %				
	Analysis	Carbon	Manganese, min	Phosphorus, max	Sulfur, max
5, 9, 8S	heat	0.55 max	...	0.04	0.15[A]
	product	0.58 max	...	0.048	...
10, 10S[B]	heat	0.55 max	0.30	0.04	0.05
	product	0.58 max	0.27	0.048	0.058
12[B]	heat	0.20–0.55	0.60	0.04	0.05
	product	0.18–0.58	0.57	0.048	0.058
8S3, 10S3	See Table 2				

[A] For Classes 5 and 9, a sulfur content of 0.23 % max. is acceptable with the purchasers approval.

[B] For Classes 10 and 12, a sulfur content of 0.15 % max. is acceptable provided the manganese is 1.35 % min.

TABLE 2 Chemical Requirements for Classes 8S3 and 10S3 Nuts

Element	Composition, %							
	Steel Analyses for Class 8S3 Nuts[A]							Class 10S3 Nuts
	N	A	B	C	D	E	F	
Carbon:								
Heat analysis	...	0.33–0.40	0.38–0.48	0.15–0.25	0.15–0.25	0.20–0.25	0.20–0.25	0.20–0.53
Product analysis	...	0.31–0.42	0.36–0.50	0.14–0.26	0.14–0.26	0.18–0.27	0.19–0.26	0.19–0.55
Manganese:								
Heat analysis	...	0.90–1.20	0.70–0.90	0.80–1.35	0.40–1.20	0.60–1.00	0.90–1.20	0.40 min
Product analysis	...	0.86–1.24	0.67–0.93	0.76–1.39	0.36–1.24	0.56–1.04	0.86–1.24	0.37 min
Phosphorus:								
Heat analysis	0.07–0.15	0.040 max	0.06–0.12	0.035 max	0.040 max	0.040 max	0.040 max	0.046 max
Product analysis	0.07–0.155	0.045 max	0.06–0.125	0.040 max	0.045 max	0.045 max	0.045 max	0.052 max
Sulfur:								
Heat analysis	0.050 max	0.050 max	0.050 max	0.040 max	0.050 max	0.040 max	0.040 max	0.050 max
Product analysis	0.055 max	0.055 max	0.055 max	0.045 max	0.055 max	0.045 max	0.045 max	0.055 max
Silicon:								
Heat analysis	0.20–0.90	0.15–0.35	0.30–0.50	0.15–0.35	0.25–0.50	0.15–0.35	0.15–0.35	...
Product analysis	0.15–0.95	0.13–0.37	0.25–0.55	0.13–0.37	0.20–0.55	0.13–0.37	0.13–0.37	...
Copper:								
Heat analysis	0.25–0.55	0.25–0.45	0.20–0.40	0.20–0.50	0.30–0.50	0.30–0.60	0.20–0.40	0.20 min
Product analysis	0.22–0.58	0.22–0.48	0.17–0.43	0.17–0.53	0.27–0.53	0.27–0.63	0.17–0.43	0.17 min
Nickel:								
Heat analysis	1.00 max	0.25–0.45	0.50–0.80	0.25–0.50	0.50–0.80	0.30–0.60	0.20–0.40	0.20 min[B]
Product analysis	1.03 max	0.22–0.48	0.47–0.83	0.22–0.53	0.47–0.83	0.27–0.63	0.17–0.43	0.17 min
Chromium:								
Heat analysis	0.30–1.25	0.45–0.65	0.50–0.75	0.30–0.50	0.50–1.00	0.60–0.90	0.45–0.65	0.30 min
Product analysis	0.25–1.30	0.42–0.68	0.47–0.83	0.27–0.53	0.45–1.05	0.55–0.95	0.42–0.68	0.25 min
Vanadium:								
Heat analysis	...	...	...	0.020 min	...	...	...	...
Product analysis	...	...	...	0.010 min	...	...	...	...
Molybdenum:								
Heat analysis	...	...	0.06 max	...	0.10 max	...	...	0.15 min[B]
Product analysis	...	...	0.07 max	...	0.11 max	...	...	0.14 min
Titanium:								
Heat analysis	...	...	...	...	0.05 max	...	...	...
Product analysis	...	...	....	...	...	...	...	...

[A] Class 8S3 nuts may be made of any of the listed steel analyses. Selection of steel analysis shall be the option of the manufacturer.
[B] Nickel or molybdenum may be used.

M4 and smaller, and nuts of all classes with proof loads greater than 530 kN, as specified in Table 4, may be furnished on the basis of having a hardness not less than the minimum hardness specified in Table 3.

6.3 Nuts of all classes, except those covered in 6.2, shall withstand the proof load stress specified for the diameter and class of nut in Table 3.

NOTE 7—The proof load of a nut is the axially applied load the nut must withstand without thread stripping or rupture. Proof loads (Table 4) are computed by multiplying proof load stress (Table 3) by the nut thread stress area.

7. Dimensions

7.1 Unless otherwise specified, nuts shall be furnished plain (non-coated nor plated).

7.2 Class 5 nuts in nominal thread diameters M36 and smaller shall conform to dimensions for hex nuts, Style 1, given in ANSI B 18.2.4.1M. Class 5 nuts in nominal thread diameters M42 and larger shall conform to dimensions for heavy hex nuts given in ANSI B 18.2.4.6M.

7.3 Class 9 nuts in nominal thread diameters M20 and smaller shall conform to dimensions for hex nuts, Style 2, given in ANSI B 18.2.4.2M or for hex flange nuts given in ANSI B 18.2.4.4M. When the dimensional style of nut is not designated by the purchaser, hex nuts, Style 2, in conformance with ANSI B 18.2.4.2M shall be furnished. Class 9 nuts in nominal thread diameters M24 to M36 inclusive shall conform to dimensions for hex nuts, Style 2, given in ANSI B 18.2.4.2M. Class 9 nuts in nominal thread diameters M42 and larger shall conform to dimensions for heavy hex nuts given in ANSI B 18.2.4.6M.

7.4 Class 10 nuts in nominal thread diameters M20 and smaller shall conform to dimensions for hex nuts, Style 1, given in ANSI B 18.2.4.1M or for hex flange nuts given in ANSI B 18.2.4.4M. When the dimensional style of nut is not

TABLE 3 Mechanical Requirements of Nuts

Nominal Diameter	Property Class: 5 — Proof Load Stress, MPa	5 — Hardness: Rockwell min	5 — Hardness: Rockwell max	5 — Hardness: Vickers min	5 — Hardness: Vickers max	5 (overtapped) — Proof Load Stress, MPa	5 (overtapped) — Hardness: Rockwell min	5 (overtapped) — Hardness: Rockwell max	5 (overtapped) — Hardness: Vickers min	5 (overtapped) — Hardness: Vickers max	9 — Proof Load Stress, MPa	9 — Hardness: Rockwell min	9 — Hardness: Rockwell max	9 — Hardness: Vickers min	9 — Hardness: Vickers max
M1.6 to M2.5											...	...	...	...	...
M3 to M4	520	B70	C30	130	302	...	...	...	...	...	900	B85	C30	170	302
M5 and M6	580	B70	C30	130	302	465	B70	C30	130	302	915	B89	C30	188	302
M8 and M10	590	B70	C30	130	302	470	B70	C30	130	302	940	B89	C30	188	302
M12 to M16	610	B70	C30	130	302	490	B70	C30	130	302	950	B89	C30	188	302
M20 to M36	630	B78	C30	146	302	500	B78	C30	146	302	920	B89	C30	188	302
M42 to M100	630	B70	C30	128	302	500	B70	C30	128	302	920	B89	C30	188	302

	Property Class: 10 — Proof Load Stress, MPa	10 — Hardness: Rockwell min	10 — Hardness: Rockwell max	10 — Hardness: Vickers min	10 — Hardness: Vickers max	12 — Proof Load Stress, MPa	12 — Hardness: Rockwell min	12 — Hardness: Rockwell max	12 — Hardness: Vickers min	12 — Hardness: Vickers max	12 (Overtapped) — Proof Load Stress, MPa	12 (Overtapped) — Hardness: Rockwell min	12 (Overtapped) — Hardness: Rockwell max	12 (Overtapped) — Hardness: Vickers min	12 (Overtapped) — Hardness: Vickers max
M1.6 to M2.5						...	...	...	...	...	...	...	...	...	
M3 to M4	1040	C26	C36	272	353	1150	C26	C36	272	353					
M5 and M6											920	C26	C36	272	353
M8 and M10						1160	C26	C36	272	353	930	C26	C36	272	353
M12 to M16	1050	C26	C36	272	353	1190	C26	C36	272	353	950	C26	C36	272	353
M20 to M36	1060	C26	C36	272	353	1200	C26	C36	272	353	960	C26	C36	272	353
M42 to M100	...	...	...	...	...	1200	C26	C36	272	353	960	C26	C36	272	353

	Property Class: 8S and 8S3 — Proof Load Stress, MPa	8S and 8S3 — Hardness: Rockwell min	8S and 8S3 — Hardness: Rockwell max	8S and 8S3 — Hardness: Vickers min	8S and 8S3 — Hardness: Vickers max	10S and 10S3 — Proof Load Stress, MPa	10S and 10S3 — Hardness: Rockwell min	10S and 10S3 — Hardness: Rockwell max	10S and 10S3 — Hardness: Vickers min	10S and 10S3 — Hardness: Vickers max	10 S (Overtapped) — Proof Load Stress, MPa	10 S (Overtapped) — Hardness: Rockwell min	10 S (Overtapped) — Hardness: Rockwell max	10 S (Overtapped) — Hardness: Vickers min	10 S (Overtapped) — Hardness: Vickers max
M12 to M36	1075	B89	C38	188	372	1245	C26	C38	272	372	1165	C26	C38	272	372

designated by the purchaser, hex nuts, Style 1, in conformance with ANSI B 18.2.4.1M shall be furnished. Class 10 nuts in nominal thread diameters from M24 to M36 inclusive shall conform to dimensions for hex nuts, Style 1 given in ANSI B 18.2.4.1M.

7.5 Class 12 nuts in nominal thread diameters M20 and smaller shall conform to dimensions for hex nuts, Style 2, given in ANSI B 18.2.4.2M or for hex flange nuts given in ANSI B 18.2.4.4M. When the dimensional style of the nut is not designated by the purchaser, hex nuts, Style 2, in conformance with ANSI B 18.2.4.2M shall be furnished. Class 12 nuts in nominal thread diameters M24 to M36 inclusive shall conform to dimensions for hex nuts, Style 2, given in ANSI B 18.2.4.2M. Class 12 nuts in nominal thread diameters M42 and larger shall conform to dimensions for heavy hex nuts given in ANSI B 18.2.4.6M.

7.6 Classes 8S, 8S3, 10S, and 10S3 in nominal thread diameters M12 to M36 inclusive shall conform to dimensions for heavy hex nuts given in ANSI B 18.2.4.6M.

7.7 Unless otherwise specified, threads in nuts shall be the metric coarse thread series as specified in ANSI B 1.13M, and shall have grade 6H tolerances.

7.8 This requirement applies to nuts hot-dip and mechanically zinc-coated that are to be used on bolts, screws, or studs that have metric coarse threads with Grade 6g tolerances before zinc-coating and then are hot-dip or mechanically zinc-coated, except as noted in 7.9, in accordance with 4.7.2 and 4.7.3. Such nuts shall be tapped over-size to have internal threads with maximum and minimum limits which exceed the maximum and minimum limits specified for metric coarse internal threads with Grade 6H tolerances by the following diametral allowances:

Nut Diameter	Diametral Allowance, µm
M5	156
M6	200
M8	255
M10	310
M12	365
M14 and M16	420
M20 and M22	530
M24 and M27	640
M30	750
M36	860
M42	970
M48	1080
M56	1190
M64 to M100	1300