Designation: ~~F901 – 01 (Reapproved 2017)~~ F901 – 20

Standard Specification for Aluminum Transmission Tower Bolts and Nuts[1]

This standard is issued under the fixed designation F901; 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.

1. ~~Scope~~ Scope*

1.1 This specification covers aluminum structural bolts and nuts for use in the construction of aluminum transmission towers, substations, and similar aluminum structures.

1.2 Diameters of bolts and nuts furnished to this specification are 5⁄8, 3⁄4, and 7⁄8 in.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B565 Test Method for Shear Testing of Aluminum and Aluminum-Alloy Rivets and Cold-Heading Wire and Rods

D3951 Practice for Commercial Packaging

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys (Withdrawn 2017)[3]

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

E101 Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 1996)[3]

E227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique (Withdrawn 2002)[3]

F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

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

2.2 *ASME Standards:*[4]

B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)

B18.2.1 Square and Hex Bolts and Screws (Inch Series) Addenda A

B18.2.2 Square and Hex Nuts

2.3 *Military Standard:*

MIL-STD-A-8625 Anodic Coatings for Aluminum and Aluminum Alloys[5]

3. Ordering Information

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

3.1.1 Quantity (number of pieces of each item and size);

3.1.2 Name of item;

3.1.3 Size (diameter, threads per inch, length);

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[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] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from IHS, 15 Inverness Way East, Englewood, CO 80112, http://www.global.ihs.com.

[5] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.

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

3.1.4 Alloy number;
3.1.5 Shipment lot testing, as required (see Supplementary Requirements S1);
3.1.6 Source inspection, if required (see Section 14);
3.1.7 Certificate of compliance or test report, if required (see Section 16);
3.1.8 Additional requirements, if any, to be specified on the purchase order (see 4.2.1, 4.2.3, 8.2.1, 8.2.2, 9.2, 12.1, and 13.1);
3.1.9 Supplementary requirements, if any; and
3.1.10 ASTM specification and year of issue.

NOTE 1—*Example*: 10 000 pieces Aluminum Transmission Tower Bolt, 0.750-10 by 2.00 in., Alloy 2024-T4, Furnish Certificate of Compliance, Supplementary Requirement S2, ASTM F901–XX.

4. Materials and Manufacture

4.1 *Materials*—Bolts shall be manufactured from Alloy 2024 and nuts from Alloy 6061 or 6262. The materials chemical composition shall be capable of developing the mechanical properties required by Table 1, when in the finished condition.

4.2 *Manufacture:*
4.2.1 *Forming*—Unless otherwise specified, the bolts and nuts shall be cold formed, hot formed, or machined from suitable material at the option of the manufacturer.
4.2.2 *Condition*—The fasteners shall be furnished in the following conditions:

Alloy	Fastener	Condition
2024-T4	bolts	solution treated and naturally aged
6061-T6	nuts	solution treated and artificially aged
6262-T9	nuts	solution treated, artificially aged, and cold worked

4.2.3 *Threads*—Unless otherwise specified, the threads shall be rolled or cut at the option of the manufacturer.

5. Chemical Composition

5.1 *Chemical Composition Limits*—The bolts and nuts shall conform to the requirements as to chemical composition prescribed in Table 2.

5.2 *Manufacturer's Analysis*—When test reports are required on the inquiry or purchase order (see 3.1.7), the manufacturer shall furnish a certificate of conformance certifying compliance with the chemical limits specified in Table 2.

5.3 *Product Analysis:*
5.3.1 Product analyses may be made by the purchaser from finished products representing each lot. The chemical composition thus determined shall conform to the requirements in Table 2.
5.3.2 In the event of disagreement, a referee chemical analysis shall be performed if agreed upon by both parties. A sample as required by Table 3 shall be selected for each lot. Chemical analysis shall be performed to the requirements of 13.1 and the result shall conform to Table 2.

6. Mechanical Properties

6.1 *Bolts*—Bolts having a length three times the diameter or longer shall be tested full size as specified in 13.2.2. At the manufacturer's option, bolts of less than 3 diameters in length may be tested in full size as specified in 13.2.2. Bolts subjected to tension tests shall meet the tensile strength requirements specified in Table 1. Bolts of less than 3 diameters in length or for other reasons cannot be tested full size in tension, shall be subject to a shear test to be performed in accordance with 12.2.1. The test results shall conform to the following minimum shear-strength requirements: 37 ksi (255 MPa) for 2024-T4.

TABLE 1 Tensile Strength of 2024-T4 Bolts and Proof Loads for 6061-T6 and 6262-T9 Nuts[A]

Bolt Size, in.	Tensile Strength, min, lbf (kN)
5/8	12 400 (55)
3/4	18 400 (82)
7/8	25 400 (113)

[A] Based on a tensile unit stress of 55 000 psi (380 MPa) and the thread stress area calculated as follows:

$$A_s = 0.7854\,[D - (0.9743/n)]^2$$

where:
A_s = stress area,
D = nominal diameter, and
n = threads/in.

TABLE 2 Chemical Requirements[A,B]

UNS Designation Number	Alloy	General Name	Aluminum[C]	Chromium	Copper	Iron	Manganese	Silicon	Titanium	Zinc	Magnesium	Other Elements	
												Each	Total
~~A92024~~	~~2024~~	~~Aluminum 2024~~	~~Balance~~	~~0.10~~	~~3.8–4.9~~	~~0.50~~	~~0.30–0.9~~	~~0.50~~	~~0.15~~	~~0.25~~	~~1.2–1.8~~	~~0.05~~	~~0.15~~
A92024	2024	Aluminum 2024	Balance	0.10	3.8–4.9	0.50	0.30–0.9	0.50	0.15	0.25	1.2–1.8	0.05[D]	0.15
A96061	6061	Aluminum 6061	Balance	0.04–0.35	0.15–0.40	0.7	0.15	0.40–0.8	0.15	0.25	0.8–1.2	0.05	0.15
~~A96262~~	~~6262~~	~~Aluminum 6262~~	~~Balance~~	~~0.04–0.14~~	~~0.15–0.40~~	~~0.7~~	~~0.15~~	~~0.40–0.8~~	~~0.15~~	~~0.25~~	~~0.8–1.2~~	~~0.05[D]~~	~~0.15~~
A96262	6262	Aluminum 6262	Balance	0.04–0.14	0.15–0.40	0.7	0.15	0.40–0.8	0.15	0.25	0.8–1.2	0.05[E]	0.15

[A] Limits are in percent, maximum, unless shown as a range or stated otherwise.
[B] Analysis shall regularly be made only for the elements specified in this table. If, however, the presence of other elements is suspected or indicated in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in excess of the specified limits.
[C] Balance shall be arithmetically computed by deducting the sum of the other named elements from 100.
[D] Per UNS A92024: Ti + Zr 0.20% max for extruded and forged products only, when agreed upon.
[E] ~~Lead~~ Per UNS 96262: Lead 0.4–0.7 %; bismuth 0.4-0.7 %.

TABLE 3 Sample Size and Acceptance for Mechanical Property Tests

Number of Pieces in Lot	Acceptance Criteria		
	Number of Tests	Acceptance Number	Rejection Number
50 and under	2	0	1
51 to 500	3	0	1
501 to 35 000	5	0	1
35 001 to 100 000	8	0	1

6.2 *Nuts*—Nuts shall be tested in accordance with the mechanical requirements for the applicable type and shall meet the minimum proof-load requirements in Table 1.

7. Significance of Numerical Limits

7.1 For purposes of determining compliance with the specified limits for requirements of the properties listed in this specification, an observed value or calculated value shall be rounded in accordance with Practice E29.

8. Dimensions

8.1 *Bolts and Nuts:*

8.1.1 *Bolts*—Bolts shall be full-size body in accordance with the requirements of AMSE B18.2.1, except the full-body length listed in Table 4 shall be the basis of manufacture and inspection. Unless otherwise specified, hex bolts shall be furnished. The ends of the bolts need not be chamfered or pointed.

TABLE 4 Length of Full Body for Bolts[A]

Length of Bolt, in.	Color Code	Bolt Diameter, in.		
		5/8	3/4	7/8
1	Red	. . .	3/16	. . .
1 1/4	Blue	1/16	3/16	. . .
1 1/2	Gold	1/4	1/4	. . .
1 3/4	Green	1/2	1/2	7/16
2	Red	3/4	3/4	11/16
2 1/4	Blue	1	1	15/16
2 1/2	Gold	1 1/4	1 1/4	1 3/16
2 3/4	Green	1 1/2	1 1/2	1 7/16
3	Red	1 3/4	1 3/4	1 11/16
3 1/4	Blue	2	2	1 15/16
3 1/2	Gold	2 1/4	2 1/4	2 3/16
3 3/4	Green	2 1/2	2 1/2	2 7/16
4	Red	2 3/4	2 3/4	2 11/16

[A] The length of full body is the distance from the underside of the head to the first scratch of thread on bolts with machine-cut threads, or top of the extrusion angle for bolts with rolled threads with a tolerance of ± 1/32 in. for 5/8- and 3/4-in. size bolts, and ± 1/16 in. for 7/8-in. size bolts.

8.1.2 *Nuts*—The dimensions of the nuts shall be in accordance with the requirements of ASME B 18.2.2. Unless otherwise specified, nuts are to be either the regular hex series or a recessed hex series that allows penetration of the bolt threads into the nut recess area.

8.2 *Threads:*

8.2.1 *Bolts*—Unless otherwise specified, the bolts shall be Class 2A threads in accordance with ASME B1.1.

8.2.2 *Nuts*—Unless otherwise specified, the nuts shall be Class 2B threads in accordance with ASME B1.1.

9. Workmanship, Finish, and Appearance

9.1 *Workmanship*—Bolts and nuts shall have a workmanlike finish free of injurious burrs, seams, laps, irregular surfaces, and other imperfections affecting serviceability.

9.2 *Finish:*

9.2.1 *Bolts*—Unless otherwise specified, bolts shall be furnished anodized per MIL-STD-A-8625, Type II, Class 2 and color coded for length as indicated in Table 4.

9.2.2 *Nuts*—Unless otherwise specified, nuts shall be furnished waxed.

10. Sampling

10.1 A lot, for the purposes of selecting test specimens, shall consist of no more than 100 000 pieces offered for inspection at one time having the following common characteristics:

10.1.1 One type of item (that is, bolts or nuts),

10.1.2 Same alloy and temper,

10.1.3 One nominal diameter and thread series, and

10.1.4 One nominal length or thickness.

11. Number of Tests and Retests

11.1 *Tests*—The requirements of this specification shall be met in continuous mass production for stock. The manufacturer shall make sample inspections, as specified in Table 3, to ensure that the product conforms to the specified requirements. When tests of individual shipments are required, Supplementary Requirement S1 must be specified.

11.2 *Retests:*

11.2.1 When tested in accordance with the required sampling plan, a lot shall be subject to rejection if any of the test specimens fails to meet the applicable test requirement.

11.2.2 If the failure of a test specimen is due to improper preparation of the specimen or to incorrect testing technique, the specimen shall be discarded and another specimen substituted.

12. Specimen Preparation

12.1 *Chemical Tests*—When required, samples for chemical analysis shall be taken in accordance with Practice E55 by drilling, sawing, milling, turning, clipping, or other such methods capable of producing representative samples.

12.2 *Mechanical Tests:*

12.2.1 *Bolts*—Machined shear test specimens, when required, shall be taken in accordance with Test Method B565.

12.2.2 *Nuts*—Nuts shall be tested in full section.

13. Test Methods

13.1 *Chemical Analysis*—The chemical composition may be determined by any recognized commercial test method. In the event of disagreement, the following test methods shall be used for referee purposes: E34, E101, or E227.

13.2 *Mechanical:*

13.2.1 Tests shall be conducted in accordance with Test Methods B565 and F606/F606M.

13.2.2 Bolts that can be tested full size shall be tested using the wedge tension test specified in Test Methods F606/F606M. Fracture shall be in the body or threaded portion of the bolt without any failure at the junction of the head and body.

13.2.3 When machined specimens for shear tests are necessary (see Section 6), determine the shear strength on each sample in accordance with Test Method B565.

13.2.4 Nuts shall be proof-load or proof-stress tested as specified in Test Methods F606/F606M.

14. Inspection

14.1 When specified on the inquiry or purchase order, the product shall be subject to inspection by the purchaser at the place of manufacture prior to shipment. The inspector representing the purchaser shall have controlled entry only to those parts of the manufacturer's operations that concern the manufacturer of the ordered product and only when and where work on the contract of the purchaser is being performed. The manufacturer shall afford the inspector all reasonable facilities to satisfy that the product