



Standard Specification for Electrodeposited Coatings on Threaded Components [Metric]¹

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INTRODUCTION

This specification covers the coating of metric threaded components of steel or copper alloy by electrodeposition of the more common finishes. The properties of the coatings shall conform to the ASTM standards for the individual finishes listed. This specification covers primarily the electrodeposition of externally and internally metric threaded fasteners, and it may also be applied to other components that have metric external and internal threads.

Coating thicknesses are based on the tolerances for M series metric threads having the following tolerance positions: g, f, and e for external threads, and H and G for internal threads. The tolerance positions apply prior to application of the electrodeposited coating. The coating must not cause the basic thread size to be transgressed by either the internal or external threads. This means, that for an internal thread of tolerance position H, a measurable coating thickness can be applied to the threads only if the tolerance zone is not being utilized to the right minimum size.

The sizes of screws and bolts manufactured to the 6e, 6f, and 6g tolerance position which can be electroplated with the coating thicknesses recommended in ASTM standards without risk of undue thread interference on assembly, are specified in 6.2.2. Also specified in 6.2.2 are the sizes of nuts manufactured to the 6G tolerance position which can be electroplated to the recommended coating thicknesses.

With normal methods for depositing metallic coatings from aqueous solutions, there is a risk of delayed failure due to hydrogen embrittlement for fasteners made from steel which have minimum alloy contents or minimum tempering temperatures having property classes 10.9 or greater. This risk can generally be minimized by selecting material especially suitable for the application of electrodeposited surface coatings and by using modern methods of surface treatment including appropriate after-treatment. An increased risk of breaking due to hydrogen embrittlement occurs in the case of spring-loaded accessories having hardnesses exceeding 35 HRC. Therefore, special measures are also necessary concerning the selection of material, heat treatment and surface treatment.

1. Scope

1.1 This specification covers dimensional requirements for electrodeposited coating on threaded fasteners with M metric threads. It establishes a service condition classification for these fasteners and specifies coating thicknesses as well as hydrogen embrittlement relief for high-strength and surface-hardened fasteners.

2. Referenced Documents

2.1 ASTM Standards:

- A 165 Specification for Electrodeposited Coatings of Cadmium on Steel²
 - B 456 Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium²
 - B 602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings²
 - B 633 Specification for Electrodeposited Coatings of Zinc on Iron and Steel²
 - F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric]³
- ### 2.2 ANSI Standard:

¹ This specification is under the jurisdiction of ASTM Committee F-16 on Fasteners and is the direct responsibility of Subcommittee F16.03 on Metal Coatings on Threaded Fasteners.

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² Annual Book of ASTM Standards, Vol 02.05.

³ Annual Book of ASTM Standards, Vol 15.08.

B1.13M Metric Screw Threads—M Profile⁴

3. Terminology

3.1 Definitions:

3.1.1 average coating thickness—average coating thickness is determined as either the value obtained by analytical methods or the mean value of a specified number of local thickness measurements that are evenly distributed over the significant surface.

3.1.2 batch average thickness—the calculated average thickness of a coating if it were uniformly distributed on the surfaces of the items.

3.1.3 local thickness—the mean of the thickness measurements, of which a specified number is made within a reference area.

3.1.4 minimum local thickness—the lowest value of the local thicknesses found on the significant surface of a single article.

3.1.5 reference area—the area within which a specified number of single measurements is required to be made.

3.1.6 significant surface—the part of the article covered or to be covered by the coating and for which the coating is essential for serviceability or appearance, or both.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 measuring area—for the following methods defined as follows:

3.2.2 for analytical methods, the area over which the coating is removed.

3.2.3 for anodic dissolution method, the area enclosed by the sealing ring of the cell.

3.2.4 for microscopical method, the place at which a single measurement is made.

3.2.5 for non-destructive methods, the probe area or the area influencing the reading.

4. Classification

4.1 Coating Material—The coating material and thickness shall be selected and designated in accordance with Specification A 165, B 456, or B 633 and specified in Table 1.

4.2 Finish—The coating shall have one of the finish types specified in Specifications A 165, B 456, or B 633.

5. Ordering Information for Electroplating

5.1 When ordering threaded components to be electrodeposit coated in accordance with this specification, the following information shall be supplied to the electroplater:

5.1.1 The ASTM standard for the desired coating and the coating designation.

5.1.2 The requirement, if any, for stress relieving before electroplating, in which case the stress-relieving conditions must be specified.

5.1.3 The requirement, if any, for hydrogen embrittlement relief heat treatment stating the tensile strength of the steel or the baking time and temperature.

5.1.4 Preference, if any, for local or batch average thickness measurement.

TABLE 1 Recommended Coating Thickness Type for Service Conditions

NOTE 1—Guidance on the interpretation of these conventional categories of service condition is described in the appropriate ASTM specification. Service condition 0 is intended only for use in a dry condition to give protection against corrosion in handling, or for various decorative purposes. In standard conditions, for service condition 0, the normal coating thickness is 3 µm.

Service Condition	Cadmium, Specification A 165	Zinc, Specification B 633	Copper, Nickel, Chromium, Specification B 456
SC 0, very mild	...	Fe/Zn 3	
SC 1, mild	Ts 5 µm	Fe/Zn 5	Fe/Ni 10b Cr r Cu/Ni 5b Cr r Fe/Cu 10 Ni 5b Cr r
SC 2, moderate	Os 8 µm	Fe/Zn 8	Fe/Ni 20b Cr r Cu/Ni 10b Cr r
SC 3, severe	Ns 12 µm	Fe/Zn 13	Fe/Ni 30d Cr r
SC 4, very severe		Fe/Zn 25	Fe/Ni 30d Cr r

5.1.5 Any requirement for selective electroplating or reduction of thread dimensions by chemical means.

5.1.6 Fasteners must be specified in accordance with the appropriate product standards, including the type of coating metal, coating thickness, and appropriate surface treatments.

6. Requirements

6.1 Coating Requirements—The electrodeposited coating shall comply with the provisions of Specifications A 165, B 456, and B 633, or other standards for the coating selected with respect to the appearance, adhesion, ductility, corrosion resistance, or other requirements.

6.2 Thickness—The coating requirements are selected based on the environment service conditions designated SC 0 through SC 4 in Table 1 and corresponding to ASTM electrodeposit standards. Electrodeposited coatings meeting SC 4, and in many cases also SC 3, are not applicable to a standard screw thread unless special before-coating dimensions are adopted (see Annex A1). Unless otherwise specified, either batch average thickness or local thickness may be measured.

6.2.1 Applicability to Wood Screws and Self-Tapping Screws—All recommended coatings may be applied to screws that cut or form their own threads. The maximum value for batch average thickness shown in Table 2 may be ignored unless otherwise specified.

6.2.2 Applicability to M Series Threads—The applicability of the recommended coatings to M series metric threads is limited by the basic deviation of the threads, and hence limited by the pitch and tolerance positions. The least (smallest) pitch that will accommodate a coating thickness is tabulated for standard thread tolerance classes in Table 3 and Table 4. If a coating that is thicker than listed is required for a particular thread pitch, then special thread allowances must be provided as specified in Annex A1.

6.2.2.1 The thickness of coating on an individual screw or bolt tends to be greatest at the end of the thread and on the head. This end build-up phenomenon is greater for screws or bolts with larger length-to-diameter ratios. In the table, short screws and bolts are those with a ratio equal to or less than 5.

⁴ Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE 2 Thickness Limits

Coating Thickness Specified, μm	Minimum Local Thickness, μm	Coating Thickness, Batch Average Thickness	
		Minimum, μm	Maximum, μm
3	3	3	5
5	5	4	6
8	8	7	10
10	10	9	12
13	13	11	15
15	15	14	18
20	20	18	23
25	25	23	28
30	30	27	35

TABLE 3 Coating Accommodation Tolerances—Class 6g

Pitch of Thread, mm	Coarse Thread ^A	Basic Deviation, μm	Coating Thicknesses ^B	
			Short Screws and Bolts, μm	Long Screws and Bolts, μm
0.35	M1.6	-19	3	3
0.4	M2	-19	3	3
0.45	M2.5	-20	3	3
0.5	M3	-20	3 or 5	3
0.6	M3.5	-21	3 or 5	3
0.7	M4	-22	3 or 5	3
0.8	M5	-24	3 or 5	3
1	M6	-26	3 or 5	3 or 5
1.25	M8	-28	3 or 5	3 or 5
1.5	M10	-32	3, 5, or 8	3 or 5
1.75	M12	-34	3, 5, or 8	3 or 5
2	M14, M16	-38	3, 5, 8, or 10	3, 5, or 8
2.5	M20	-42	3, 5, 8, or 10	3, 5, or 8
3	M24	-48	3, 5, 8, 10, or 13	3, 5, 8, or 10
3.5	M30	-53	3, 5, 8, 10, or 13	3, 5, 8, or 10
4	M36	-60	3, 5, 8, 10, 13, or 15	3, 5, 8, 10, or 13
4.5	M42	-63	3, 5, 8, 10, 13, or 15	3, 5, 8, 10, or 13
5	M48	-71	3, 5, 8, 10, 13, or 15	3, 5, 8, 10, or 13
5.5	M56	-75	3, 5, 8, 10, 13, or 15	3, 5, 8, 10, 13, or 15
6	M64, M72, M80, M90, M100	-80	3, 5, 8, 10, 13 or 15	3, 5, 8, 10, 13, or 15

^A Listed for information. The thread allowance is a function of the thread pitch and not influenced by the diameter.

^B May be specified.

The long screws and bolts have length-to-diameter ratios greater than 5 but less than 10. Special processing is normally required for longer bolts on which the coating at the center of a bolt may be considerably thinner than the batch average.

6.2.3 Restriction of Coating Thickness—In order to reduce the risk of interference on assembly of threads with electrodeposited coatings, limits to the maximum as well as the minimum thicknesses of coatings are specified in this specification. The local and batch average thicknesses corresponding to the coating thicknesses recommended in ASTM electrodeposited coating standards are shown in Table 2.

6.2.4 Local Thickness—The local thickness shall be not less than the minimum local thickness specified in Table 2 and shall be measured using one of the methods specified in Specifications A 165, B 456, or B 633. The appropriate thickness class for the specified coating shall be selected from the coating standard in accordance with Table 1. Local thickness shall be measured only on the test surfaces indicated in Fig. 1.

6.2.5 Batch Average Thickness—The batch average thickness measured by the method in Annex A2 and shall conform to the limits of Table 2. Exceeding the maximum batch average thickness shall not cause rejection if the coated threads are accepted by appropriate GO thread gages.

6.3 Embrittlement Relief.

6.3.1 Coated fasteners made from steel heat treated to

property class 10.9, case-hardened steel fasteners, and fasteners with captive washers made from hardened steel shall be baked to relieve hydrogen embrittlement for a minimum of 4 h from 180 to 230°C (350 to 450°F). Upon agreement between the user and the manufacturer, other conditions of duration and temperature may be specified and used. For relief time, the duration of baking applies from when the parts have reached the minimum temperature. Fasteners must not be embrittled relieved above their tempering temperature.

6.3.2 For coated fasteners made from steel heat treated to property class 12.9 or harder, special pretreatments are necessary. Avoid the use of acid and only high efficiency-type electroplating solutions should be used. In these circumstances the embrittlement relief times and temperatures shall be determined by experiment. No stress relieving times or temperatures are therefore given for fasteners with hardnesses equal or above property class 12.9.

6.3.3 The baking to relieve hydrogen embrittlement must be performed as soon as possible after electroplating. It is recommended that relief be carried out no later than 4 h after electroplating.

6.3.4 Coated fasteners made from steel heat treated to property class 10.9 or harder shall be embrittlement tested in accordance with 8.2 and 9.3. All coated fasteners having a surface hardness of HRC 35 (or equivalent) or harder shall be