NOT MEASUREMENT SENSITIVE

MIL-PRF-32647

25 March 2020

PERFORMANCE SPECIFICATION

ZINC-NICKEL ELECTROPLATING FOR FASTENERS

This specification is approved for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This specification covers requirements for an electrodeposited zinc-nickel (Zn-Ni) alloy plating with a hexavalent chromium-free conversion coating and supplementary top coat or sealant. This MIL specification selects desired options from ASTM F1941/F1941M and details additional requirements, such as plating composition and torque/tension behavior of the plating on surrogate threaded fasteners. Although developed for threaded steel fasteners, this plating may be used on other steel products. While other plating thickness and supplementary treatment options are available for unique applications, the requirements of this specification are limited to the ASTM F1941/F1941M codes specified herein. This specification is intended for use on new fasteners and fasteners which previously may have specified coatings containing cadmium or hexavalent chromium, substances which have been added to the Aerospace and Defense Declarable Substances List ("AD-DSL").

1.2 Plating of internal diameters. When process limitations will not allow adequate plating to be deposited on internal diameters that require corrosion protection, an alternate method of protection should be specified in a drawing or acquisition document.

1.3 Classification. Classification of this zinc nickel plating is consistent with the requirements of ASTM F1941/F1941M (see 3.2) with the addition of a Torque/Tension Type.

AMSC N/A AREA MFFP

Comments, recommendations, additions, deletions, clarifications etc. and any data that may improve this document should be sent to U.S. Army Ground Vehicle System Center, ATTN: FCDD-GVS-IES-SED-STND, MS #267, 6501 E. 11 Mile Road, Detroit Arsenal, MI 48397-5000 or emailed to usarmy.detroit.ccdc-gvsc.mbx.standardization@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST online database at https://assist.dla.mil/.

1.3.1 Type. The Torque/Tension K-factor requirement for the plating, as tested per 4.6, is specified as one of the following types (see 6.3 regarding how the torque/tension type is to be interpreted for fastener assembly):

Type K20: 0.18 – 0.22 K-factor
Type K16: 0.14 – 0.18 K-factor

NOTE: For threaded fasteners without a type specified, K20 is the default type. For all other parts without threads requiring friction control in the plating, the type shall be specified.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.1.1 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract. (see 6.4)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B571	-	Standard Practice for Qualitative Adhesion Testing of Metallic Coatings
ASTM F1470	-	Standard Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
ASTM F1941/F1941M	-	Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric l

(Copies of these documents are available online at https://www.astm.org/.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.24	-	Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

(Copies of this document are available online at https://www.asme.org/.)

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

ISO 4014	-	Hexagon head bolts - Product grades A and B - Fourth Edition
ISO 4032	-	Hexagon regular nuts (style 1) - Product grades A and B - Fourth Edition
ISO 16047	-	Fasteners – Torque/clamp force testing

(Copies of these documents are available online at https://www.iso.org/.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Responsibility for compliance. The inspection set forth in this specification shall become a part of the plating applicator's overall inspection system or quality program. Any changes made to the quality plan or plating process shall be subject for re-approval (see 4.1).

3.2 Plating process. Unless otherwise specified in the contract, the plating shall be electrodeposited in an alkaline process and meet the requirements of ASTM F1941/F1941M Fe/Zn-Ni 8BNS or 8BNSL except additional requirements as specified herein shall take precedence (see 4.2).

3.3 Plating composition. The zinc nickel alloy shall be 12% – 17% nickel by weight (see 4.3).

3.4 Sealant or topcoat. The plating applicator shall apply the sealant or topcoat necessary to achieve the performance requirements of this specification. The friction-modifying lubricant shall be integral to the sealant or topcoat or added as an extra coating material layer. The final finish shall be dry to touch (see 3.9 and 4.9)..

3.5 Corrosion resistance. Corrosion resistance testing shall be conducted in accordance with ASTM F1941/F1941M except as follows (see 4.5):

a. The minimum time to first appearance of zinc alloy corrosion (white rust): 240 hours.
b. The minimum time to first appearance of base metal corrosion (red rust): 1000 hours.

3.6 Torque/tension. K-factor shall be within the range indicated by Type on surrogate parts (see 1.3.1 and 4.6).

3.7 Adhesion. There shall be no blistering, peeling, flaking, or other separation of the zinc nickel plating from the base metal (see 4.7).

3.8 Toxic chemicals, hazardous substances, and ozone-depleting chemicals. The final product shall contain no chemicals labelled “R1” or “R2” on the AD-DSL list. The valid AD-DSL will be the current English version on http://www.iaeg.com/chemicalrpt/addsl/. The content of the AD-DSL and its application does not relieve the plating applicator from obligation to comply with all existing relevant regional and national regulations (see 4.8).

3.9 Dry-to-touch. After application of the protective coating the coated product shall be dry-to-touch (see 4.9).

4. VERIFICATIONS

4.1 Responsibility for compliance. All verifications in section 4 shall be the responsibility of the plating applicator (see 3.1 and Table I).

Table I. Quality conformance verifications.[1]

	Req’mt	Verification	Plating Line Verification	Initial Part Verification	Production Control
Compliance	3.1	4.1	N/A	N/A	N/A
Plating process – Coating appearance & thickness	3.2	4.2	X	X	X
Plating process – HE Relief[3]	3.2	4.2	X	X	X
Plating Composition	3.3	4.3	X	X	X
Sealant or topcoat	3.4	4.4	N/A	N/A	N/A
Corrosion Resistance	3.5	4.5	X	X	X[2]
Torque/Tension (K-factor)	3.6	4.6	X	X[4]	X[4]
Adhesion	3.7	4.7	X	N/A	N/A
Toxic chemicals	3.8	4.8	X	N/A	N/A
Dry-to-touch	3.9	4.9	X	N/A	N/A

Note 1: X indicates mandatory verification. N/A indicates verification is not required for the indicated approval level, but the requirement shall still be met.
Note 2: Use of surrogate parts testing each plating line weekly, is acceptable.
Note 3: If required per ASTM F1941/F1941M hardness threshold guidelines
Note 4: Threaded product only

4.1.1 Control records. The plating applicator shall maintain a record of the history of each processing bath and the results of all chemical analyses performed.

4.1.2 Lot sampling inspection. Sampling shall be per ASTM F1470. Exceptions to the lot sampling (see 6.4) inspection are as follows:

a. For Appearance, use ASTM F1470 sample level C.
b. For Plating Composition, use ASTM F1470 sample level D.
c. For Torque/Tension (K-factor), sample per section 4.6

4.2 Plating process. The plating applicator shall document the alkaline electrodeposited coating meets the requirements of ASTM F1941/F1941M Fe/Zn-Ni 8BNS or 8BNSL. The coating thickness and hydrogen embrittlement relief, if applicable, shall also be documented (see 3.2 and Table I).

4.3 Plating composition. To determine alloy content, utilize X-Ray Fluorescence (XRF), spot- mode Energy Dispersive X-Ray (EDS), Atomic Absorption (AA), or other methods capable of measuring the stated composition weight requirement (see 3.3).

4.4 Sealant or topcoat. The presence of sealant or topcoat shall be verified by the torque/tension performance verification on surrogate parts (see 3.4 and 4.6)

4.5 Corrosion resistance. Corrosion resistance verification shall be conducted in accordance with ASTM F1941/F1941M (see 3.5).

4.6 Torque/tension. Ten surrogate test parts shall be processed along with production parts through the entire plating and post-treatment process. These surrogate parts shall be processed and tested once per plating line, for every shift that is running any parts to this MIL specification. After processing, the K-Factor shall be determined for the ten surrogate parts per ISO 16047, with the following clarifications (see 3.6 and 6.4):

a. Surrogate test bolts shall be property class 10.9 and meet the requirements of ISO 4014. The bolts shall be M10-1.5 X 60 or other length which allows for at least two full threads within the clamped length and at least two threads protruding through the test nut. Do not wash or pre-condition the surrogate test bolts after the coating application process and before torque/tension testing.
b. Test washers or test bearing plate shall be according to ISO 16047 Type HH, plain (uncoated) surface, cleaned and degreased within 2 hours of the test. Surface roughness shall be less than Ra 0.8.
c. Test nut shall be an M10-1.5 according to ISO 4032 class 10, plain (uncoated) surface, cleaned and degreased within 2 hours of the test.
d. Speed of installation shall be 30 ± 5 RPM.

4.7 Adhesion. Test and analyze using the Heat/Quench test per ASTM B571. If this method is not available, the choice of test method shall be one suitable for zinc or zinc alloy plating per ASTM B571 (see 3.7).

4.8 Toxic chemicals, hazardous substances, and ozone-depleting chemicals. Upon request, the plating applicator (and their supplier(s), if any) shall certify the final product meets the requirement (see 3.8).

4.9 Dry-to-touch. After holding product with hand pressure for 5 to 10 seconds in a paper coffee filter or equivalent, there shall be no visible staining, as perceived with the unaided eye.

5. PACKAGING

This section is not applicable to this specification.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful but, is not mandatory.)

6.1 Intended use. The electrodeposited plating covered by this specification is intended for use as a corrosion protective coating. Color is NOT a requirement of this specification. However, yellow plating appearance is discouraged as this color implies the presence of hexavalent chromium in industry. Sealants or top coats may affect the underlying plating and conversion coating appearance. Typical color will range from gray to silver. Processes used for cleaning and deposition on parts heat-treated to, or having ultimate tensile strength of 160 KSI (or HRC 36) or greater, should be such that hydrogen embrittlement is minimized. Guidance is provided in the referenced ASTM F1941/F1941M.

6.2 General usage.

6.2.1 Temperatures. This plating should not be used on parts for Space applications or on parts which in service reach a temperature of 450°F (232°C) or higher or come in contact with other parts which reach those temperatures.

6.2.2 Acquisition requirements. Acquisition documents must specify the following:

Title, number, and Plating Type (see 1.2)
Example: “Zinc Nickel Electroplate, MIL-PRF-XXXX, Type K20”

6.3 Torque/Tension. The torque/tension requirements listed are meant to provide the plating applicator with friction requirements for the plating system under specific conditions. In

general, K-factors cannot be used to calculate torque values for production joints because K-Factors change with fastener diameter, head type, mating parts, and other factors. Torque/tension testing is needed to determine the torque for a required clamp load of a production joint. Type K20 was originally established to provide similar torque/tension behavior as parts with zinc plating and a conversion coating containing hexavalent chromium. Type K20 is the suggested direct replacement. Type K16 was originally established as a direct replacement of cadmium plated parts. It is recommended that actual joint production assembly behavior be compared when making finish changes on any clamp load applications that are critical.

6.4 Non-Government publications. The year of issue of the specified publications at the time of publication of this standard is shown below. Any conflict between this standard and a subsequent revision of a referenced publication may be brought to the attention of the Preparing Activity.

ASME B18.24 – 2004 (R2011)
ASTM B117 – 2019
ASTM B571 – 2018
ASTM F1470 – 2019
ASTM F1941/F1941M – 2016
ISO 4014 – 2011
ISO 4032 – 2012
ISO 16047 – 2005

6.5 Definitions:

Lot	A lot consist of plated articles of the same basis metal composition, class, and type plated and treated under the same conditions and submitted for inspection at one time.
K-factor	A dimensionless torque coefficient as described in ISO 16047.

6.6 Subject term (key word) listing.

Adhesion
Alkaline
Electroplate
K-factor
Plating
Torque
Tension

MILITARY INTEREST:

Custodian:
Army – AT
Air Force – 70
Navy – SH
DLA – GS

Review Activity:
Army –AR
Air Force – 11, 19,
20 Navy – AS, MC

Civil agency:
GSA – FAS

Preparing Activity
Army – AT

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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.