

INCH-POUND

MIL-DTL-14538D

16 June 1999

SUPERSEDING

MIL-C-14538C

3 August 1983

DETAIL SPECIFICATION

CHROMIUM PLATING, BLACK (ELECTRODEPOSITED)

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

1. SCOPE

1.1 Scope. This specification covers an electrodeposited black chromium finish. It is generally applied to steels but may be used as a plating for other metals such as brass, copper, iron and chromium (see 6.1, 6.3 and 6.4).

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 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 documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

STANDARDS

FEDERAL

FED-STD-595 Colors Used In Government Procurement

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, ATTN: AMSRL-WM-M, Aberdeen Proving Ground, MD 21005-5069 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

AREA MFFP

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2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B117 Operating Salt Spray (Fog) Apparatus (DoD adopted)

ASTM F22 Hydrophobic Surface Films by the Water-Break Test

ASTM F519 Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

2.4 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 Materials. Materials shall be selected by the contractor and they shall be of a quality consistent with the end result and performance specified herein.

3.2 Basis metal. The basis metal shall be free from visible defects that will be detrimental to the utility, appearance, or protective value of the plating.

3.2.1 Preplating operations. The contractor shall ascertain, prior to plating, that the items to be plated have undergone all required heat treatments and mechanical operations (machining, welding, brazing, forming, punching, grinding and similar operations). Unless otherwise specified in the contract (see 6.2), no operations of the foregoing nature shall be performed on the items after plating nor shall the plated items be further processed in any way, except in cases where threading operations are required after plating.

3.2.2 Stress relief. Steel parts to be plated, having a hardness in excess of 40 HRC shall be stress relieved prior to plating by heating in an oven or in oil for one hour or more at a temperature of 300°F to 500°F (149°C to 260°C). When this operation is omitted (see 6.2), the contractor shall furnish or make available objective evidence that the operation has been performed previously. After stress relief the hardness shall not be less than the initial hardness within the limit of error in taking hardness readings.

3.3 Cleaning. All items to be plated shall be cleaned thoroughly. The cleaned surfaces shall pass the water break test described in ASTM F22. Cleaning materials and methods shall be at the option of the contractor. The cleaning operations shall be performed without measurable abrasion of the surface and without contributing in any way to a defective end item.

3.4 Processing. The processing for the application of the black chromium finish shall be as determined by the contractor. A solution that can be used for general application is outlined in 6.5.

3.4.1 Hydrogen embrittlement relief treatment. Steel parts that are surface or through hardened at 40 HRC and higher shall be given a hydrogen embrittlement relief treatment after the plating application.

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Plated springs and other parts subject to flexure shall not be flexed prior to the embrittlement relief treatment.

3.4.2 Test to determine adequacy of hydrogen embrittlement relief treatment. Unless otherwise specified (see 6.2), the adequacy of the hydrogen embrittlement relief treatment shall be determined by applying the test in 4.6.

3.5 Finish.

3.5.1 Uniformity. The black chromium finish shall be applied to the basis metal in such a manner as to be smooth and fine grained. It shall completely and uniformly cover all surfaces to be plated.

3.5.2 Luster. The finish shall be uniformly "dull" and without luster. Examination under controlled light shall show no "bright" spots due to wax, oil, or other causes.

3.5.3 Color. Unless otherwise specified (see 6.2), the color of the deposit shall be a dark gray approaching black. It shall approximate color plate 37038 of FED-STD-595. When a color sample is provided by the procuring agency it shall be matched for color. Solutions shall be so regulated and controlled as to give a smooth and uniform color as specified on all plated surfaces on the same order or contract (see 6.6).

3.5.4 Corrosion resistance. After exposure to the salt spray fog for four hours as specified in paragraph 4.4.1, the specimens shall show no basis metal corrosion products when examined at normal reading distance. The presence of black streaks or stains shall not be cause for rejection.

3.6 Workmanship. The workmanship shall be of a quality to accomplish a thoroughly clean and contaminant free metal surface prior to the application of the black chromium finish together with a uniform and clean finish of the applied coating. Any evidence on the surface of discoloration, mottled effect, rainbowing, inadequate coverage, powdery deposits, blisters, pits, nodules or indications of burning shall be considered as defective workmanship.

4. VERIFICATION

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.2 Lot. Unless otherwise specified (see 6.2), a lot shall consist of plated articles of the same material and condition, and of approximately the same size and shape, plated under similar conditions and submitted for inspection at the same time.

4.3 Sampling.

4.3.1 Sampling for inspection. The number of random samples selected for nondestructive tests from each inspection lot shall be determined by the procuring activity (see 6.2). For destructive tests a random sample of four items shall be selected from each inspection lot, or four separate specimens shall be prepared in accordance with 4.3.2 to represent each inspection lot. If the number of items in an inspection lot is four or less, the number of items in the sample shall be determined by the procuring activity (see 6.2). Defects shall consist of deviations from the requirements specified in paragraphs 3.5 and 3.6.

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4.3.2 Separate specimens. When the plated articles are not readily adaptable to the test specified in 4.4.1 the test may be made by the use of separate specimens plated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented, and should be at least 6 square inches on a side and 1/16 inch thick. The specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to plating and shall not be separated therefrom until after completion of the processing.

4.4 Acceptance tests.

4.4.1 Corrosion resistance. The test for corrosion resistance shall be performed on the specimens selected in accordance with paragraph 4.3.1. The specimens shall be subjected to a continuous test of four hours in 5% salt spray fog in accordance with ASTM B117 (see 3.5.4). Any failure from a lot shall reject the lot.

4.4.2 Samples for corrosion resistance test. Samples used for test in 4.4.1 shall be discarded except as the procuring agency may permit replating and reinspection.

4.5 Hydrogen embrittlement relief treatment. All steel parts shall be baked at $375^{\circ}\text{F} \pm 25^{\circ}\text{F}$ ($191^{\circ}\text{C} \pm 14^{\circ}\text{C}$) for three hours or more after plating to provide hydrogen embrittlement relief. The baking shall begin within four hours after plating.

4.6 Hydrogen embrittlement relief test. Type 1a test specimens described in annex A1 of ASTM F519 (4340 steel at HRC 51-54) shall be plated and hydrogen embrittlement relief treated similar to the parts. Within one hour after baking, the specimens shall be loaded per ASTM F519. After testing, the specimens shall be examined for cracks. If failure occurs, the embrittlement relief time shall be extended until the specimens pass the test.

5. PACKAGING

5.1 Packaging. Packaging requirements are not applicable for 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 black chromium plate covered by this specification is military unique. Black chromium plate is hard, adherent, heat resistant, and free of light reflection. Black chromium plate is suitable for military applications such as rocket launcher rails, interior surfaces of optical parts, and small arms applications where a non-reflecting black coating is desirable. This coating provides limited corrosion protection, but added protection can be obtained by specifying a corrosion resistant underplate such as nickel.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- (c) Operations to be performed on the items after plating or further processed, if different (see 3.2.1).
- (d) Evidence of stress relief, if required (see 3.2.2).
- (e) When hydrogen embrittlement relief treatment is not required (see 3.4.2).
- (f) Sample of color to be duplicated, if required (see 3.5.3).

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- (g) Lot size, if different (see 4.2).
- (h) Number of samples to be inspected from the lot for nondestructive tests, and for destructive tests if the number of items in a lot is four or less (see 4.3.1).

6.3 Dimensional change. Black chromium deposits involve only a slight dimensional change of approximately 0.0002 inches. In the usual applications, however, the dimensional increase is of little or no importance. For that reason it has not been considered necessary to specify an exact thickness of coating which should be no more than necessary to meet the required performance.

6.4 Adaptability. Black chromium plate may be applied to metals the same as bright chromium plate. It may also be applied over bright chromium plate with an increase in plating time to obtain added corrosion protection.

6.5 Equipment and processing. Plating tanks of mild steel or polyvinyl chloride have been found entirely satisfactory. Lead or butyl rubber lined tanks are not suitable due to the high acetic acid content of the solution. Tanks need not be equipped with steam coils. An adequate exhaust system is required to remove the acetic acid fumes. Anodes of mild steel are preferred to carbon anodes due to the attrition of carbon anodes. Parts with deeply recessed areas may require auxiliary iron wire or platinum anodes as the throwing power of black chromium plating solution is not appreciably greater than that of ordinary chromium solutions. The processing operations require careful control and proper maintenance of the solution. Plating can be accomplished at normal room temperature or temperature as high as 110°F (44°C). The usual plating time is 30 to 45 minutes. Racks and hooks should be kept clean for good contact and have adequate current carrying capacity. A stable power supply of 6 to 12 volts at a current density of 40-90 amp. per sq. ft. is required. A solution that can be used for general application is as follows:

Chromium Trioxide, Technical - CrO ₃ Federal Specification 0-C-303	33-40 oz./gal.
Acetic Acid, Glacial, Technical-CH ₃ COOH Federal Specification 0-A-76	28.2 oz./gal. (by wt.)
Water - H ₂ O	Remainder
Barium Carbonate, Powder - BaCO ₃ or Barium Acetate, Crystal - Ba(CH ₃ COO) ₂	1 oz./gal.

Whenever an addition of CrO₃ is made to the solution, barium carbonate or barium acetate should also be added.

6.5.1 Solution maintenance. The bath may become sluggish and exhibit poor throwing power in use. The addition of one gallon of water per one hundred gallons of solution will generally improve the throwing power.

6.5.2 Solution analysis. The chromic acid and acetic acid content is determined by using an electrometric titrator with standard 0.1 Normal sodium hydroxide as the titrant. A curve is also made from a standard solution made up according to the formula in 6.5. The chromic acid is determined by comparing the volumes of standard sodium hydroxide for the unknown with the standard at pH 3.7.

6.5.3 Acetic acid. Acetic acid content is determined by a comparison of volumes at pH 5.7.

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6.5.4 Trivalent chromium. Trivalent chromium is determined by first oxidizing all the chromium to the hexavalent form and determining total chromium. Hexavalent chromium is determined by conventional methods. The difference is the trivalent chromium. A useful range is 8 to 12%.

6.5.5 Additional information. Further details on operation and solution analysis may be obtained by reference to Rock Island Arsenal Laboratory Report No. 55-2705 and Department of Commerce publication PB111830.

6.6 Color. The color is a dark gray approaching a dull black. It may be waxed or oiled to darken the surface.

6.7 Ozone depleting chemicals. Classes I and II ozone depleting chemicals should be avoided when cleaning the basis metal.

6.8 Hazardous materials. The DoD has put together a list of hazardous or environmentally damaging substances in a document called the SD-14. These chemicals should be avoided whenever another finish can be substituted for the finish specified herein.

6.9 Subject term (key word) listing.

Acetic acid
Barium
Basis metal
Butyl rubber
Chromic acid
Chromium
Hydrogen embrittlement
Lead
Stress relief

6.10 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:

Army - MR
Navy - SH
Air Force - 11

Preparing activity:

Army - MR

(Project MFFP-0665)

Review activities:

Army - AR, MI, PT
Navy - AS, EC, OS
Air Force - 13, 19
DLA - DH(DCMC-OF, DLSC-LEQ)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-DTL-14538D

2. DOCUMENT DATE (YYYYMMDD)
19990616

3. DOCUMENT TITLE **CHROMIUM PLATING, BLACK (ELECTRODEPOSITED)**

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

c. ADDRESS *(Include Zip Code)*

d. TELEPHONE *(Include Area Code)*
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYYYMMDD)

8. PREPARING ACTIVITY

a. NAME

U.S. ARMY RESEARCH LABORATORY

b. TELEPHONE *Include Area Code)*

(1) Commercial 410-306-0725
(2) AUTOVON 458-0725

c. ADDRESS *(Include Zip Code)*

WEAPONS & MATERIALS RESEARCH DIRECTORATE
ATTN: AMSRL-WM-M
ABERDEEN PROVING GROUND, MD 21005-5069

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Defense Standardization Program Office (DLSC-LM)
8725 John J. Kingman road, Suite 2533 Ft. Belvoir, VA 22060-2533
Telephone (703) 767-6888 AUTOVON 427-6888