

METRIC

DOD-STD-2182 (SH)

29 January 1985

SUPERSEDING

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January 1967

MILITARY STANDARD

**ENGINEERING CHROMIUM PLATING (ELECTRODEPOSITED)
FOR REPAIR OF SHAFTING (METRIC)**



NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT

AREA MFFP

DOD-STD-2182(SH)
29 January 1985

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362

Engineering Chromium Plating (Electrodeposited) for Repair of Shafting
(METRIC)

DOD-STD-2182(SH)

1 This Military Standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2 Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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FOREWORD

1. This Military Standard provides instruction for the repair and refurbishment of shafting.

2 Industrial chromium or hard chromium is used for wear resistance, abrasion resistance and such incidental corrosion protection of parts as the specified thickness of the plating may afford.

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1. SCOPE

1.1 Scope This Military Standard establishes uniform standards for repair and refurbishment of shafting not subject to sea water service.

2 REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

- MIL-S-851 - Steel Grit, Shot and Cut Wire Shot, and Iron Grit and Shot - Blast Cleaning and Peening
- MIL-S-5002 - Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems.
- MIL-G-9954 - Glass Beads For Cleaning and Peening
- MIL-R-81841 - Rotary Flap Peening of Metal Parts
- MIL-P-81985 - Peening of Metals

STANDARDS

MILITARY

- MIL-STD-271 - Nondestructive Testing Requirements for Metals.

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer)

2.2 Other publications The following documents form a part of this standard to the extent specified herein Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply

ASTM

- B 487 - Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section (DoD adopted)
- B 499 - Measurement of Coating Thickness by the Magnetic Method Nonmagnetic Coating on Magnetic Basis Metals (DoD adopted)
- B 571 - Adhesion of Metallic Coatings
- B 578 - Microhardness of Electroplated Coatings.
- B 630 - Preparation of Chromium for Electroplating with Chromium.
- E 8 - Tension Testing of Metallic Materials (DoD adopted)

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(Application for copies should be addressed to ASTM, 1916 Race Street, Philadelphia, PA 19103)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. DEFINITIONS

Not applicable

4. GENERAL REQUIREMENTS

Not applicable

5. DETAILED REQUIREMENTS

5.1 Mechanical pretreatment Shafts for repair or refurbishment shall be prepared as specified in 5.1.1 through 5.1.5

5.1.1 Blemish removal and reduction of shaft diameter Slivers, burrs, grooves, pits, nicks and other surface blemishes in the area to be plated shall be completely removed. The removal of randomly located pits or grooves, which would result in excess reduction of the shaft dimension, may be repaired by brush-on application of nickel undercoat. Final removal of metal for diameter reduction shall be uniform in diameter for its entire length except at fillets, and shall be concentric with the shaft axis. The final surface shall be free of grinding or heat checks. Removal of metal in preparation for plating shall be made in a manner to assure compliance with the plating thickness limitation specified in 5.6.3

5.1.2 Length of reduced diameter section The length of reduced diameter section shall extend at least 3 millimeters (mm) (1/8 inch) beyond both ends of the bearing surface and where applicable, beyond the limits of carbon ring, labyrinth ring or packing gland in which the shaft will operate. The fillets at abrupt changes in shaft diameter or crank throws shall not be reduced or otherwise altered. Radius of curvature at ends of reduced diameter section, except at shaft shoulders shall be 0.5 mm (0.020 inch) minimum.

5.1.3 Crankshaft fillet The diameter of any crankshaft bearing surface shall not be reduced within 1.5 mm (1/16 inch) of fillet, (tangent point). Ends of reduced diameter sections of crankshafts shall be chamfered to approximately 45 degrees. Grinding wheels used for reducing diameter shall be dressed to corner radius of not less than 0.8 mm (1/32 inch).

5.1.4 Keyways and shaft shoulders If a part which has to be built up contains a keyway which is worn oversize, the keyway shall be reconditioned prior to surface preparation for the plating build-up. Sharp edges of keyways and shaft shoulders shall be removed by beveling with a hand stone or portable grinder. The fillet radius at the shoulder and reduced diameter section shall be not less than 0.8 mm (1/32 inch). The boundaries of areas to be plated and adjoining areas shall be blended by buffing or polishing.

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5 1.5 Previously plated shaft Unless otherwise specified in the contract or order (see 6 1), adherent deposit of chromium on shafts previously plated need not be removed

5.2 Stress relief treatment Steel shafts having an ultimate tensile strength of 1034 megapascals (MPa) (150,000 pounds per square inch (lb/in²) and above, which are machined or ground, shall be baked at 191 ± 14 degrees Celsius ($^{\circ}\text{C}$) (375 ± 25 degrees Fahrenheit ($^{\circ}\text{F}$)) for 3 hours or more prior to cleaning and plating for the relief of damaging residual tensile stresses For shafts which have been cold straightened, stress relief at a temperature 10 to 35°C (50 to 100°F) below the tempering temperature for at least 1 hour per mm (inch) of thickness, but not less than 1 hour, is required

5 3 Peening of shafts After machining and stress relieving (when required), and prior to plating, the area of the shaft to be plated shall be peened in accordance with MIL-P-81985 or MIL-R-81841 Unless otherwise specified in the contractor order (see 6 1), nitrided surface need not be peened However, where it is uncertain whether or not the nitride case has been cut or ground through, the area shall be peened

5.3.1 Peening intensity The peening intensity for steel, titanium and aluminum shafts shall be in accordance with MIL-P-81985 or MIL-R-81841 The peening intensity for nickel or copper alloy shafts shall be the same as for aluminum shaft

5 3 2 Peening material Peening material shall be metallic shot in accordance with MIL-S-851 as hardened cast steel (type I) for use on steel shafting. Glass bead in accordance with MIL-G-9954 shall be used for peening non-ferrous metal shafts

5.4 Certification of shot peeners

5.4.1 Operator certification. Prior to production peening, each peening operator shall be certified in accordance with MIL-P-81985 using the equipment, materials and tools required for peening parts in production as well as by various production processes.

5 4.2 Record of certification. The peening facility shall complete and retain a record of the peening operator's certification

5 5 Inspection prior to plating. Shafts to be plated shall be examined to assure freedom from injurious defects and damages which might adversely affect serviceability Measurements shall be made to assure that straightness, indexing, parallelism, roundness, centering and other requirements, as applicable, are within the specified tolerances The peened area, as well as fillets and other high stress areas, shall be liquid penetrant or magnetic particle inspected in accordance with MIL-STD-271 to assure that the shaft is free of cracks Magnetic particle inspection shall be performed by means of the yoke method of magnetization.

5.6 Plating requirements

5 6.1 Cleaning. After completion of all machining operations, heat treatment, peening and inspection, the shaft shall be cleaned in accordance

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with MIL-S-5002 For materials not included in accordance with MIL-S-5002, cleaning shall be performed by methods which will not adversely affect the adhesion of the deposit ASTM B 630 may be used for surface preparation of shafts which contain previously deposited chromium

5 6 2 Underplating The chromium shall be deposited directly on the surface of the shaft without application of a metallic undercoat, however, locally applied undercoat for repair of shallow pits or grooves is permitted (see 5 1 1)

5 6 3 Thickness Unless otherwise specified in the contract or order (see 6 1), after finish grinding, the plating thickness shall meet the specified thickness in accordance with the dimensional requirements, and in the case of salvage operations, to correct the deficiency Preparation of the shaft for plating shall be accomplished in a manner so that the final plating thickness (including previously deposited chromium not removed) will meet the following limits

<u>Type of shaft</u>	<u>Minimum thickness micrometer (inch)</u>	<u>Maximum thickness micrometer (inch)</u>
Straight	37 5 (0 0015)	625 (0 025)
Crankshaft	125 (0 005)	250 (0 010)

5 6 4 Depositional increment Unless otherwise specified in the contract or order (see 6 1) maximum increment of deposition shall not exceed 300 micrometers (μm) (0 012 inch) radial thickness Finish radial thicknesses in excess of 250 μm (0 010 inch) shall be applied in approximately equal increments and each increment ground to remove from 12 5 to 50 μm (0 0005 to 0 002 inch) radial thickness of chromium

5 6 5 Single shaft processing Unless the shaft being plated is connected either to a separate rheostat and metering system or is one of a production run under plating control equivalent to single piece operation, it shall be the only in-tank work during the time of electrodeposition

5 6 6 Coverage The plating shall cover all surfaces where build-up or salvage repair is required including keyways, shaft shoulders and shaft diameters

5 6 7 Masking Areas to be immersed in the plating solution which are not to be plated shall be properly masked

5 6 8 Embrittlement relief Coated steel shafts having a hardness of Rockwell C 35 and higher shall be baked at $191 \pm 14^\circ\text{C}$ ($375 \pm 25^\circ\text{F}$) for a minimum of 4 hours, within 4 hours after plating to provide hydrogen embrittlement relief When specified (see 6 1), shafts having a tensile strength level of 1655 MPa (240,000 lb/in²) or above shall have notched specimens concurrently plated and baked The specimens, prepared and tested in accordance with 5 9 2 2 and 5 9 7 respectively, shall not crack or fracture

5 6 9 Surface finish of bearing and sealing surfaces When specified (see 6 1), bearing and sealing surfaces of shafts shall be finished by grinding and lapping, or honing to meet the specified surface finish Chromium deposition

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shall be sufficient to permit grinding of the deposit so as to produce a smooth, nonabrasive surface. Bearing and sealing surfaces shall not be used in the as-plated condition.

5 6 10 Plating quality The plating shall be fully bright, smooth, fine grained, adherent, uniform in appearance free from blisters, pits, nodules, frosty areas, excessive edge build-up and other defects. The plating shall show no indications of contamination or improper operation of equipment used to produce the deposit, such as excessively powdered or darkened plating, or other defects. The size and number of contact marks shall be at a minimum consistent with good shop practice. Superficial staining which has been demonstrated as resulting from rinsing or slight discoloration resulting from baking operations to relieve embrittlement shall not be cause for rejection.

5 6 11 Adhesion The adhesion of the plating shall be such that, when examined at a magnification of approximately 10 diameters, the chromium plating shall not show separation from the base metal when subjected to test methods in accordance with 5 9 5. The formation of hairline cracks caused by post-plate grinding which does not result in flaking, peeling or blistering of the plate shall not be cause for rejection.

5 6 12 Hardness The hardness of the chromium plating, when tested in accordance with 5 9 6 shall have a minimum average Knoop hardness from six readings of 750 HK₁₀₀.

5 7 Certification test requirements Certification control shall consist of the following.

- (a) A production plating procedure which shall be used for production plating. The procedure shall include the requirements of this document as well as criteria necessary to produce consistent results.
- (b) Plating of two test specimens in accordance with 5.9.2 and 5.9 2 1. The specimen shall be of sufficient size for test and evaluation of plate thickness, quality and adhesion (see 5 6.3, 5 6 10, and 5 6 11). When specified in the contract, (see 6 1) two hardness and two embrittlement specimens in accordance with 5 9 2 1 and 5 9 2.2 are required, and shall be tested and evaluated in accordance with 5 8 4 4 and 5 8.4 5. All test results shall be recorded.

5 8 Production quality assurance Production quality shall be assured by certification and the maintenance of production records. Production process shall be subjected to modification by the contracting activity as stated in the contract (see 6 1).

5 8 1 Certification of quality compliance A certificate of quality compliance shall be prepared for each lot of material offered for acceptance (see appendix). The certificate shall include actual data of specified tests (see 5 8 2). Qualitative results of nondestructive tests and other inspections or tests shall be recorded on the certificate. The certificate shall state that each lot has been sampled, tested and inspected in accordance with this standard and meets all requirements specified in this standard. The certificate shall be signed by a responsible representative of the contractor.

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5 8 2 Production and test records When specified (see 6 1), production records as listed below shall be developed for each lot

- (a) Certification control data (see 5 7)
- (b) Peening operator qualification record (see 5 4)
- (c) Test results of the peening intensity, thickness, surface finish, quality and adhesion (see 5 3 1, 5 6.3, 5 6 9, 5 6 10, and 5 6 11), and when required, the hardness and embrittlement test (see 5 6 12, and 5.6.8)
- (d) Confirmation of pre-plating stress relief, inter-increment grinding and post plating baking, as applicable (see 5 2, 5.6 4, and 5 6 8)

5 8 3 Lot A lot shall consist of plated articles of the same base metal composition, class, surface condition and finish, plated simultaneously on separate rheostat and metering system or is one item of a production run under plating control equivalent to a single piece operation, treated under the same conditions and approximately the same size and shape and prepared for inspection at one time.

5 8 4 Sampling for production assurance Sampling and acceptance for production assurance shall be performed in accordance with the requirements specified in 5 8 4 1 through 5 8 4 5

5 8 4 1 Visual examination Each item in the lot shall be subjected to the visual examination of 5 9 3.

5 8 4 2 Thickness of plating (or final dimension) The lot shall be measured for plate thickness to meet the specified dimensions (see 5 6 3) For locations where direct measurement is not feasible, separate specimens (see 5 9 2 1) may be used.

5 8 4 3 Adhesion test Two specimens per lot, prepared in accordance with 5 9 2, and 5 9 2 1, shall be tested and evaluated in accordance with 5 9 5

5 8 4 4 Hardness test Two specimens per lot shall be tested in accordance with ASTM B 578 to determine conformance to 5 6 12 Three readings shall be made on each specimen

5 8 4 5 Embrittlement test Two specimens per lot shall be tested in accordance with 5 6 8 for hydrogen embrittlement relief of heat treated steel parts to determine compliance for those parts, comprising a lot, having a tensile strength level of 1655 MPa (240,000 lb/in²) or above Specimens prepared in accordance with 5 9 2 and 5 9 2 2, and plated concurrently with the lot, shall be used to represent the lot When tested as specified in 5 9 7, cracks or failure by fracture shall be cause for rejection Failure of one or more of the test pieces shall constitute failure of the lot

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5 9 Certification test procedures

5 9 1 Test specimens as production specimens When the test specimens are plated and tested just prior to production plating, and all test results are satisfactory, these results shall be considered production results required by 5 8 4 if the general plating conditions have not changed

5 9 2 Preparation of the test specimens Plated shafts are of such form, shape, size and value as to prohibit use thereof, and are not readily adaptable to test specified herein. When specified (see 6 1 1), destructive tests shall be made by the use of separate specimens plated concurrently with the articles they represent. The separate specimens shall be of a base metal equivalent to that of the article. "Equivalent" base metal includes chemical composition, grade, condition and finish of surface prior to plating. For example, a cold-rolled steel surface should not be used to represent a hot-rolled steel surface. Due to the impracticality of forging or casting separate test specimens, hot-rolled specimens may be used to represent forged and cast steel articles. The separate specimens shall be introduced into a lot at the beginning of the production shaft preparation, and shall not be separated therefrom until after completion of the plating. Conditions affecting the plating of specimens, including the spacing, plating media, bath agitation and temperature, in respect to other objects being plated shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurements, unless the necessity for their use has been demonstrated.

5 9.2 1 Specimens for thickness, adhesion and hardness tests. If separate specimens for thickness, adhesion, and hardness tests are specified (see 6 1 1), they shall be strips approximately 25 mm (1 inch) wide, 150 mm (6 inches) long and 1.5 mm (1/16 inch) thick. The specimen for thickness determination shall be used for adhesion and hardness test.

5 9.2.2 Specimens for embrittlement relief Separate specimens for embrittlement relief test shall be round notched specimens with the axis of the specimen (load direction) parallel to the direction of rolling. The configuration shall be in accordance with ASTM E 8 for standard size round specimens. Specimens shall have a 60 degree V-notch located approximately at the center of the gage length. The cross section area at the root of the vee shall be approximately equal to half the area of the original cross section. The vee shall have 0.254 ± 0.0127 mm (0.010 ± 0.005 inch) radius of curvature at the base of the notch (see 6 1 1).

5 9.3 Visual examination Plated shafts shall be visually examined for compliance with 5 6.6, 5 6 7, 5 6 9, and 5 6.10 after plating. There shall be no non-conformance articles or separate specimens as specified in 5 9 2 and 5.9.2 1.

5 9 4 Thickness test Micrometer shall be used for measurement of plating thickness wherever feasible. When direct measurement is not feasible, the magnetic test method in accordance with ASTM B 499 or the microscopic measurement method performed on separate specimen in accordance with ASTM B 478 is acceptable.

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5 9 5 Adhesion test Adhesion may be determined by subjecting the concurrently plated specimen to a bend-to-rupture test or grind test in accordance with ASTM B 571, and shall meet the requirement of 5.6 11.

5 9 6 Hardness test The hardness of the plating shall be determined in accordance with ASTM B 578 and shall meet the requirement of 5 6 (see 6 1 1)

5 9 7 Embrittlement relief test The notched samples prepared in accordance with 5 9 2 2 and plated concurrently with the lot, shall be subjected to a sustained tensile load equal to 75 percent of the ultimate notch tensile strength of the material. The specimens shall be held under load for at least 200 hours and then examined for cracks or fracture to meet the requirement of 5 6 8 (see 6 1).

6. NOTES

6 1 Ordering data Acquisition documents should specify the applicable requirements contained herein and include the following information

- (a) Whether previously plated chromium is to be removed (see 5 1 5)
- (b) Whether nitrided surfaces need to be peened (see 5 3).
- (c) Final plating thickness or shaft diameter required (see 5 6 3)
- (d) Maximum increment of deposition permitted (see 5 6 4)
- (e) If embrittlement test is required (see 5 6 8)
- (f) Surface finish required on bearing and sealing surfaces (see 5 6 9)
- (g) Whether two hardness and two embrittlement specimens are required (see 5 7)
- (h) Whether production records are required to be maintained and any modification to production records (see 5 8)
- (i) Whether production records should be supplied (see 5 8 2)

6 1 1 The contractor of the base metal parts should provide the plating facility with the following data or specimens

- (a) The material type, tensile strength and hardness of steel parts and location to be plated (see 5 9 2, 5 9 2 1 and 5 9 6)
- (b) Heat treatment for stress relief, whether has been performed or is required (see 5 2)
- (c) When embrittlement test required by 6 1, the contractor of the base metal parts should provide the plating facility with notched specimens (see 5 9 2 2)

Preparing activity:
Navy - SH
(Project MFFP-N274)

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APPENDIX

DATA REQUIREMENTS

10. DATA

10.1 Data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL incorporated into the contract. When the provisions of FAR 52.227-7031 are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this standard is cited in the following paragraphs.

<u>Paragraph no</u>	<u>Data requirement item</u>	<u>Applicable DID no</u>	<u>Option</u>
5.8.1	Certification data/report	UDI-A-23264	---

(Data item descriptions related to this standard, and identified in this appendix will be approved and listed as such in DoD 5000.19L, Vol II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

10.2 The data requirements of 10.1 and any task in sections 4 or 5 of this standard required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this standard. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

INSTRUCTIONS. In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (*DO NOT STAPLE*), and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE. This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification 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.

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