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DEPARTMENT OF DEFENSE STANDARD PRACTICE

BRUSH ELECTROPLATING ON MARINE MACHINERY

AMSC N/A AREA MFFP

FOREWORD

1. This 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. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.daps.dla.mil.

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1. SCOPE

1.1 Scope. This standard covers standard practice for brush electroplating on marine machinery.

1.2 Classification. Coating applications to be repaired by brush electroplating are of the following classes:

Class 1 - Corrosion-resistant coatings

Class 2 - Static contact coatings

Class 3 - Sliding contact surface coatings

Class 3A - Sliding contact surface coatings (requiring NAVSEA approval)

Class 4 - Nuclear power coatings

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard 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, 4, or 5 of this standard, 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59460 - Plating Unit, Selective (Brush), Portable

(Copies of this document are available online at https://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications 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.

CODE OF FEDERAL REGULATIONS (CFR)

Code of Federal Regulations, Title 29, Part 1910 - Occupational Safety and Health Standards

(Copies of this document are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20401 or online at www.gpoaccess.gov/index.html.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

T9074-AS-GIB-010/271 - Requirements for Nondestructive Testing Methods

(Copies of this document are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at https://nll1.ahf.nmci.navy.mil.)

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 these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM B374 - Standard Definitions of Terms Relating to Electroplating

ASTM E140 - Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

ASTM E384 - Standard Test Method for Knoop and Vickers Hardness of Materials

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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. DEFINITIONS

(Other definitions relating to this standard and electroplating in general should be in accordance with ASTM B374.)

3.1 Approved (approval). Approval refers to when the item under consideration has been accepted by NAVSEA or its authorized representatives.

3.2 Authorized representative. Authorized representative is any Government representative specifically authorized to approve equipment, material, or procedures within the scope of this document for NAVSEA. They are as follows:

a. For Government shipyards: The delegated representative of the shipyard commander.

b. For commercial shipyards: The delegated representative of the Supervisor of Shipbuilding, Conversion and Repair (SUPSHIP), or the American Bureau of Shipping (ABS) when specified in the ship's specifications for a particular ship. This includes all applicable areas in the shipyard and applicable items furnished to the shipyard by subcontractors.

c. When delegated by (a) or (b) above, the representative of Defense Contract Administration Services Management Area (DCASMA).

d. Technical representative specifically authorized by NAVSEA.

3.3 Plating activity. Plating activity is that organization responsible for and actually performing electroplating.

3.4 Postplating treatments. Any thermal or mechanical process done to the plated part. Postplating treatments include, but are not limited to, stress relief, peening, blasting, and machining.

3.5 Preplating treatments. Any thermal or mechanical process done to the unplated part. Preplating treatments include, but are not limited to, stress relief, peening, blasting, and machining.

4. GENERAL REQUIREMENTS

4.1 Equipment.

4.1.1 Power packs. Power packs shall be in accordance with A-A-59460.

4.1.2 Plating tool handles. Handles shall be insulated for safety reasons. Where corrosion is a problem, handles with stainless steel or aluminum cooling fins shall be used. Handles shall be covered with a corrosion-resistant material.

4.1.3 Automatic processing equipment. Commercially available automatic equipment listed below may be considered for process improvement:

a. Microprocessor for automatic coating thickness display and automatic calculation of ampere-hours (This unit may be attached to existing power packs or as an extra unit when new equipment is purchased.)

b. Microcomputer which prints out complete procedure for process control

c. Internal diameter plating devices

d. Plating solution tanks with built-in pumps, filters, heaters, and temperature control systems

4.2 Materials.

4.2.1 Solutions. The solutions used in brush electroplating are generally available only as proprietary products from brush electroplating supply manufacturers. Solutions from any manufacturer which meet all requirements of this standard may be used provided the user is qualified for brush electroplating with those solutions. Solutions from different manufacturers shall not be mixed and shall not be used with the same graphite anodes. A complete listing of solutions may be obtained from the solution manufacturers.

4.2.1.1 Solution acquisition. Acquisition of solutions shall be based on the following considerations:

a. The reliability of the products and service of the manufacturer based on past experience

b. Availability of qualified plating procedures and operators

c. Availability of training programs and technical documents

d. Availability of technical representatives for consultation and technical assistance for resolution of plating problems which may occur

4.2.2 Anodes. Anodes shall be made from graphite, 90-10 platinum-iridium or platinum, tantalum, columbium, or titanium clad. All anode materials except graphite may be used with different solutions provided they are thoroughly washed when changing to a new solution. Anodes used for reverse current shall be marked as such and shall not be used with forward current.

4.2.2.1 Graphite anodes. For most applications, graphite anodes are most practical and least costly. They are available in a variety of shapes or in bulk blocks for machining special shapes. Graphite shall be acquired only from brush electroplating equipment manufacturers or their authorized agents because commercially available graphite may contain contaminants which are detrimental to electroplating. Graphite anodes shall be used with only one solution and shall be marked accordingly.

4.2.3 Tool coverings. The solution manufacturers' recommended tool coverings shall be used. If the solution manufacturers' recommended materials are not available, other coverings may be used provided the plating produced meets the solution manufacturers' requirements and the requirements stated herein and the coverings are approved by the plating activity's authorized representative. Some of the most commonly used coverings are:

a. Surgical grade United States Pure (U.S.P.) long fiber sterile cotton

b. Dacron batting

c. Pelon

d. Scotch-Brite™

e. Dacron felt

4.3 Plating procedures.

4.3.1 Requirements for plating procedures. Brush electroplating shall be performed to an approved written procedure. The procedure shall contain as a minimum the following:

a. Unique identifying number

b. Date of approval

c. Authorizing signature

d. Applicable plating thickness

e. Preplating treatments; if required

f. Required operator's qualification

g. Preliminary cleaning

h. Electrocleaning and etching

i. Rinsing

j. Activating

k. Plating solutions

l. Preplate (If no preplate is required, report that preplating is not required.)

m. Process controls (Report the process controls required to ensure the quality of the work. As a minimum, this shall include polarity, current density or voltage, anode to cathode speed, and temperature.)

n. Drying

o. Post plate treatments, such as blasting or grinding, if required

p. Records

q. Inspection requirements and acceptance criteria

4.3.2 Sources of information for procedures. In addition to this document, commercial manuals provided by brush electroplating solution and equipment contractors form the basis for information pertaining to brush electroplating. Current editions of commercial manuals should replace older ones. Activities performing plating shall contact their supplier to assure they are on the distribution list for new or revised manuals.

4.4 Qualification requirements.

4.4.1 Procedures. Procedures shall be qualified by performing plating in accordance with the procedure and inspecting for the attributes of 4.4.1.3 and any other requirements as necessary for the end use application of the plating. The qualification shall consist of using one specific plating solution on one base metal as designated in generic groups below.

a. Aluminum and its alloys

b. Chromium plated parts

c. Copper and its alloys except aluminum bronze

d. Low carbon steel

e. Medium carbon or high strength steels

f. Cast iron

g. Nickel and its alloys

h. Zinc

i. Aluminum bronze

j. Martensitic stainless steel

k. Austenitic stainless steel

Regardless of base metal used for qualification, it will qualify all base metals in that specific generic group for the type of plating applied. The test plates accomplished for procedure qualification may also be used to meet the practical examination in 4.4.2.2.2. Revisions to procedures other than editorial or administrative shall require requalification in accordance with this standard prior to use.

4.4.1.1 Specimens needed to qualify.

4.4.1.1.1 Manual application procedure. Specimens for qualification of procedures where the plated layer is applied manually shall be strips of metal approximately 5 inches long by 1 inch wide by 0.050 inch thick. When the procedure is used to fill defects, the strip shall contain a groove 0.0625 inch wide by 0.010 inch deep by 1 inch long. The length dimension of the groove shall coincide with the length direction of the strip and be centered on it.

4.4.1.1.2 Machine assisted application procedure. Specimen for qualification of procedures where the plated layer is applied with the assistance of a rotating head shall be a bar or pipe of sufficient wall thickness about 5 inches long by 0.75 inch Outside Diameter (OD) minimum. When the applicable procedure is used to fill pits or grooves, a groove 0.0625 inch wide by 0.010 inch deep by 1 inch long shall be cut into the specimen. The length dimension of the groove shall be parallel to the axis of the bar or pipe and at mid length.

4.4.1.2 Plating of qualification specimens. Defects shall be repaired by plating, if necessary. Plating shall be performed to a thickness equivalent to the maximum plating thickness to which the procedure is to be qualified on one side of strip or OD of bar or tube in accordance with the procedure.

4.4.1.3 Inspection requirements. After plating, the specimens shall be inspected to the requirements of 4.8.1, 4.8.3, and 4.8.4 and tested for adhesion as follows. Specimens need not be inspected until after grinding, if it is specified.

4.4.1.3.1 Manual application procedure. The center of the strip shall be bent around a radius equal to four times the thickness of the test strip with the plating on the outside of the bend. The bent surface when examined at up to 5× magnification shall be acceptable if no separation or flaking occurs between the base metal and plating or the layers of plating, or if the plating cannot be peeled back with a sharp edged tool.

4.4.1.3.2 Machine assisted application procedure. The specimen shall be ground 0.003 inch off the diameter using standard grinding practice for the plating material. The plating shall be acceptable if no flashing or separation of plating occurs between the base metal and the plating or layers of plating.

4.4.1.4 Valve seat and disc repair procedures. To qualify procedures for repair of steam cuts and other damages in valve seats, discs, and stems, the following procedures are required (see 5.5.2):

a. Specimen: Mock-up to simulate production material, configuration, and restriction. The surface to be plated shall contain two grooves, 180 degrees apart, of about 0.125 inch wide by 0.010 inch deep.

b. Plating: Fill in grooves and provide a top coat of about 0.006 inch thick.

c. Grinding: Grind to remove about 0.002 inch of top coat plating.

d. Inspection: The ground surface shall meet the acceptance criteria as specified in 4.8.1.

e. Micrographic: The specimens shall be sectioned through and perpendicular to each examination grooved area. The polished and etched cross sections shall be examined at 50× magnification minimum. Linear or rounded defects shall not be acceptable. Evidence of porosity, lack of adhesion, or cohesion shall not be acceptable.

f. Hardness test: Micro-indentation hardness testing shall be accomplished three times on the top coat of each specimen. Micro-hardness measurements shall be taken per ASTM E384. Hardness conversions shall be per ASTM E140. The average hardness shall be not less than 380 Hardness Vickers (HV).

4.4.2 Qualification criteria. Prior to performing contact electroplating, prospective operators shall be qualified to perform this function by successful completion of training in the specified knowledge areas (see 4.4.2.1) and written and practical examination (see 4.4.2.2).

4.4.2.1 Training. The prospective operator shall demonstrate a working knowledge of the following:

a. The technical aspects of brush electroplating

b. Job safety for hazardous chemicals and electrical work

c. The calculation of plating amperage, plating time, quantity of solution required, and surface area and ampere-hours

d. The meaning of the following terms: current density, activation, anode, cathode, adhesion, burned deposits, modules, porosity stripping, etch, water-break, matte finish, and volts and amperes

e. Set up and operation of a power supply

f. Preparation of metal surface for brush electroplating

g. Selection, preparation of, and post use care of the plating tools (anodes) and covers

h. The attributes used to control plating thickness time and quality

i. Prevention of contamination of plating solutions

j. Proper masking technique

k. Proper plating technique

l. Proper surface finishing technique

m. Evaluation of deposit's adhesion, thickness, and visual appearance

n. Preparation of job records

4.4.2.2 Examinations.

4.4.2.2.1 Written examination. The prospective operator shall pass a written examination covering the subjects specified in 4.4.2.1.

4.4.2.2.2 Practical examination. The prospective operators shall demonstrate that they are capable of performing brush electroplating by successfully plating one of the test specimens (see 4.4.2.1) using an appropriate plating procedure. To be qualified to fill defects, the prospective operators shall be qualified using the grooved specimen in 4.4.1.1.1.

4.4.2.3 Qualification determination. An operator is qualified for Classes 1 and 2 (see 5.3) upon successful completion of training and testing as specified (see 4.4.2.1). An operator is qualified for Classes 3 and 3A (see 5.6 and 5.6.1) upon successful performance of plating a production piece or a mockup that simulates the production plating in shape, size, and position of the item being plated. If the operator is qualified to fill defects, the production piece or mockup shall contain the groove in 4.4.1.1.1. Successfully plating one mockup qualifies the operator for all similar work.

4.4.3 Requalification. Requalification shall be required when the operator has not performed any production work for which he/she is qualified for a period of 12 months or more, or when the there is reason to question the ability of the operator to produce quality plating.

4.4.4 On-the-job-training. Prospective operators may be employed for on-the-job training under the direct, on-site supervision of a qualified operator.

4.5 Restrictions and limitations.

4.5.1 Structural reinforcement. Brush electroplating shall not be used to restore strength to structural parts which have been unacceptably weakened by loss of metal.

4.5.2 Cracks. Plating shall not be made over areas containing cracks. Cracks shall be completely removed by grinding or other mechanical means. Shallow grooves may be filled by copper plating and then the area plated with the specified material. Deep grooves shall be repaired by welding.

4.5.3 Hydrogen embrittlement. Steel and nickel alloys having a tensile strength of 150,000 pounds per square inch or greater, or a hardness equal to or greater than HRC 35 or Brinell (BHN) 327, shall be given a hydrogen baking treatment as follows:

a. Steels shall be baked at 375±25 °F (191±14 °C) for 3 hours or more within 2 hours after plating.

b. The nickel alloys, nickel-chromium alloy precipitation hardenable (UNS N07750), and nickel-copper alloy precipitation hardenable (UNS N05500) shall be baked at 600 to 650 °F and 500 to 550 °F respectively for 3 hours or more.

c. When baking in an oven is not feasible, thermostatically controlled induction or resistance heaters shall be used to accomplish the baking treatment.

d. Solutions and procedures specifically designed to deposit plating free of hydrogen shall be exempt from this requirement.

4.5.4 Case-hardened steel parts. Parts which have been nitrided, carburized, or otherwise hardened to HRC 45 (421) or greater shall not be restored to plan dimensions in the case-hardened area by brush electroplating.

4.5.5 Spray metallized parts. Previously spray metallized parts shall not be repaired by brush electroplating unless the metallized coating is completely removed.

4.5.6 Substitution of solutions. Substitution of solutions specified by the applicable procedure shall be prohibited. This prohibition shall apply to substitution of one proprietary solution for another even though both solutions have the same generic description. However, more than one proprietor's plating solutions (vice preparatory solutions) may be used in any one procedure provided the procedure is qualified separately in accordance with 4.4.1 for each combination of solutions.

4.5.7 Mixing of solutions. Mixing of solutions which do not have identical labels shall be prohibited unless specifically authorized by a manufacturer's procedure or other certified procedure.

4.5.8 Aged solutions. Solutions which have passed the manufacturer's expiration date or which have exhibited poor quality plating shall not be used on naval ship hardware.

4.5.9 Recovered solutions. Recovered solutions may be reused if they have not been chemically contaminated or mixed with other solutions. Recovered solutions may be stored if they have been filtered, are kept in separate non-contaminating containers from fresh solutions, and the remaining usable ampere-hours are indicated on the container. Expiration dates on stored recovered solutions shall not be exceeded. Solutions that have been pumped over dirty or oily surfaces of the workpiece shall not be reused.

4.5.10 Restrictions on electrodeposited metals.

4.5.10.1 Cadmium. Electroplating cadmium shall be prohibited.

4.5.10.2 Chromium. Brush electroplating of chromium shall be permitted only for decorative applications in thickness of 0.0001 inch and less. For applications where high hardness and wear resistance are required, nickel and its alloys with hardness in excess of HRC 35 and which produce dense adherent plates shall be used. For shafts with existing chromium plating, the chromium shall be completely stripped prior to applying other plating material. For areas requiring extensive build-up, soft nickel may be deposited to within about 0.004 inch of the final dimension followed by a deposit of an outer layer of nickel, or its alloys which are dense, adherent, and have hardnesses not less than HRC 35.

4.5.10.3 Lead and lead alloys. Brush electroplating of lead and lead alloys shall be restricted. It shall be used only on repair of plating on battery terminals and busing where its use has been previously authorized.

4.5.10.4 Cobalt and cobalt alloys. Cobalt and cobalt base alloy plating shall not be used on rotating shaft journals which are seated in babbitted bearings.

4.5.10.5 Tin, indium, and tin-indium alloys. Tin, indium, and tin-indium alloys provide excellent resistance to seawater and are ideal for repairing corrosion pits because of their fast deposition rate. However, because of the low melting points of these materials, their use shall be restricted to sea water and other ambient temperature applications.

4.6 Safety requirements. The general requirements for personal protective equipment shall be in accordance with the Code of Federal Regulations (CFR), Title 29, Chapter XVII, Subpart I. The following safety requirements apply.

4.6.1 Eye protection. Chemical goggles, face shields, or safety glasses with side shields shall be worn during brush electroplating operations. If overhead work is being performed, face shields shall be used.

4.6.2 Respiratory protection. For shipboard operations, portable exhaust ducts with a capture velocity of 100 feet per minute shall be placed within 12 inches of the work surface or other equivalent ventilation provided. Shop work shall be in a well ventilated area. Plating with silver, gold, or other solutions containing cyanide shall be under conditions reviewed by safety engineers and meets the safety engineer's approval. Respirators are not required for use with other brush electroplating solutions.

4.6.3 Skin protection. Shoulder length solution-repellent sleeves or whole body solution-repellent garments shall be worn where required to prevent solutions from contacting the skin. An example is overhead plating. Acid and alkaline-resistant gloves shall be worn. Gloves shall be taped where they connect with other solution-repellent apparel to prevent leakage.

4.6.4 Recovery of solutions. Plastic troughs or catch basins shall be used to collect any plating solutions which may drip from the workpiece.

4.6.5 Mixing of solutions. Solutions containing cyanide shall be prevented from mixing with acid solutions. Cyanides and acid solutions react to make hydrogen cyanide gas, a deadly poison. This restriction includes control of waste solutions or solutions which have dripped off the workpiece.

4.6.6 Waste solution disposal. Waste solutions shall be disposed of in conformance with applicable local, state, and federal regulations.

4.7 Job planning requirements.

4.7.1 Selection of metals to be electroplated. The selection of a metal or metals for deposition in a repair job shall be based on the desired properties for the application. Among the factors to be considered include, but are not limited to, hardness, corrosion resistance, ease of electroplating, and wear. Section 5 and vendor's handbooks provide selection guidance.

4.7.2 Identification of base metal material. Base metal material shall be identified as to type (copper alloy, low carbon steel, nickel alloy, and so forth) and whether there is existing plating. When drawings are available, these may suffice to identify material. Some commercial brush electroplating procedures have sub-procedures included which provide a method for identification using conventional chemical spot tests.

4.7.3 Job records. A job record shall be kept for each plating job so that this information can be retrieved and re-used when appropriate. The job record generally will include most or all of the information provided in 4.7.3.1. Figure 1 (or a commercial procedure form) may be used to record the essential job data.

4.7.3.1 Essential job data. Essential job data shall include the following:

a. Unique identification of workpiece (name, drawing number, piece number, system and plating procedure used, and ship name or number)

b. Workpiece deficiency, or type and location of repair required (For example; pit filling in O-ring groove, build-up of shaft bearing seating area, build-up of motor bell housing outer fit area.) A sketch shall be made on the back side of the form to identify the location of the repair.

c. Workpiece material

d. Operating conditions including pressure, temperature range, corrosive environment, static or sliding contact and wear

e. Type of plating applied

f. Plating procedure number

g. Plating repair classification (see 5.3)

4.7.4 Design of anode. Requirements for conforming anode and size of anode shall be based on cost reduction by increasing plating contact area whenever advantageous. Flow-through pump-fed anodes shall be used whenever possible to reduce labor cost and to improve deposit quality.

4.7.5 Deposition time. On large or long jobs, deposition time shall be calculated using a standard commercial procedure and associated solution data. Very long jobs which are impractical may be identified in this way before the jobs are started.

4.7.6 Amount of solution required. The amount of solution required to accomplish the necessary build-up shall be calculated to ensure adequate stock of solutions is on hand.

4.8 Methods of inspection.

4.8.1 Visual inspection. Color matching shall not be required. The plating shall be smooth, fine-grained, adherent, and free of visible blisters, pits, nodules, porosity, and excessive edge build-up when examined with normal corrected vision without magnification. Burned deposits are not acceptable. Magnification may be used to determine the significance of a condition which has been found with the unaided eye. Stains on unplated areas from rinse water or solution run-off shall not be cause for rejection.

4.8.2 Adhesion tests. Contact plated surfaces shall be tested using an adhesion test. The tape test is an adhesion test and is the generally accepted test in the selective plating industry. The tape test shall consist of applying a 1-inch wide strip of Minnesota Mining and Manufacturing Tape code number 250, or equal, across the freshly plated but thoroughly dried surface and on a location where the plating meets the unplated surface, whenever feasible. Apply the tape with heavy hand pressure and remove the tape with one quick motion perpendicular to the plated surface. Any plating adhering to the tape shall be cause for rejection. Subsequent machining or grinding of Class 3 jobs is an adhesion test, since improperly bonded coatings fail during grinding. If the manufacturers of the plating solutions provide instructions on how to machine or grind electroplated parts, produced with their product, these machining and grinding instructions shall be followed when machining or grinding the electroplated parts.

4.8.3 Thickness of deposit. Deposit thickness on the workpiece shall be determined by the before and after dimensional measurements whenever possible. When measurement cannot be made, the thickness shall be estimated from area and ampere-hour data.

4.8.4 Dye penetrant inspection. Dye penetrant inspection of Classes 3 and 3A applications shall be in accordance with NAVSEA T9074-AS-GIB-010/271. Use a visible dye penetrant (Type II). Use a post emulsifiable, lipophilic removal method (Method C). Use a nonaquious development form (Form D). Any defect greater than 0.0625 inch in length shall be cause for rejection.

5 DETAILED REQUIREMENTS

5.1 Types of damage which can be repaired. Brush electroplating may be used to repair any type of damage which does not result in structural weakening. Cracks and substantial loss of material, particle pull-out from gears, very deep or very large pits which compromise pressure boundary integrity, and damage to case hardened surfaces with hardness greater than HRC 45 cause structural weakening and may not be repaired. Wear, scoring, corrosion and mismatchining do not cause structural weakening and may be repaired. Examples of damage which cannot be repaired are.

5.2 Repair of pits and scores. Pits and scores shall be filed, honed, ground, or electrochemically machined dish shaped to remove steep walls and sharp corners. On shafting with scored or smeared metal at the journal, all smeared metal shall be removed so that brush electroplating is on undisturbed base metal.

5.3 Classification of repairs. Applications shall be classified as follows (see 5.4 to 5.7).

5.4 Class 1 (corrosion-resistant) coatings. Allowable thickness shall be governed by practical and economical use of the metal or metals deposited and shall be restricted to the qualification limit of the procedure. Three types of corrosion-resistant coatings may be repaired by brush electroplating: sacrificial coatings (zinc or aluminum), noble or semi-noble metal coatings (gold, silver, chromium, or nickel), and anodized coatings. Sacrificial coatings may be repaired with electroplated zinc. Noble or semi-noble metal coatings may be repaired by applying the same metal as was present before being damaged. An exception is chromium which shall be repaired with nickel or cobalt patches; when appearances are all-important, a thin coating of chromium may be used. Anodized aluminum may be repaired using an anodizing solution (refer to contractor's instruction manual).

5.5 Class 2 (static contact) coatings. Allowable thickness shall be not greater than 0.030 inch exclusive of filling pits, scores, dents, and other imperfections, when the total surface area of the defects comprises not greater than 10 percent of the area to be plated. The maximum allowable plating thickness shall not exceed the qualification limit of the procedure. Class 2 coatings are generally for surface restorations for purposes of sealing or fit, or to electrical conductors. The following paragraphs show the type or types of repairs and repair procedures to which this class is applicable.

5.5.1 Seawater static sealing surfaces. The application for seawater static sealing surfaces shall be as follows:

a. Type of damage: corrosion pits, scratches, gouges, and mismachining

b. Typical work-pieces: flanges, valve and pump mating surfaces, all types of static sealing surfaces including, but not limited to, O-ring grooves and submarine main shaft seal static sealing surfaces

c. Typical base metals: nickel-copper, copper-nickel, bronzes, stainless steels, or chrome plated steel

d. Allowed build-up thicknesses: not greater than 0.030 inch over wide surfaces, no limit on thickness filling pits, provided pits do not compromise pressure boundary strength (Thickness limitations imposed by the qualified procedure shall be observed.)

e. Soft metals: Tin, indium, and copper

f. Top coat: Not required (If a nickel top coat is applied, an alkaline or neutral pH solution shall be used when plating over tin filler (to prevent dissolution of the tin) and an acidic pH solution shall be used when plating nickel or nickel-tungsten over copper.)

g. Authorization: all applications authorized

5.5.2 Steam static sealing surfaces. The application for steam sealing surfaces shall be as follows:

a. Type of damage: scratches, corrosion, steam cuts, and mismachining

b. Typical work-pieces: flanges and valve turbine mating surfaces

c. Typical base: carbon steel, alloy steel, and chromium stainless metals steel

d. Allowed build-up thickness: not greater than 0.050 inch over wide surface (No limit on filling pits, provided that pits do not compromise pressure boundary strength. Thickness limitation imposed by the qualified procedure shall be observed.)

e. Typical filler metals: silver, copper

f. Typical top coat metals: none required

g. Authorization: all applications authorized

5.5.3 Machinery static mating surfaces. The procedure for machinery static mating surfaces shall be as follows:

a. Type of damage: fretting, mismachining, misalignment, and corrosion

b. Typical work-pieces: motor or generator bell housings, motor or generator shafts at rolling element bearing fit area, keyways, and cylinder heads

c. Typical base metals: steels, bronze, copper-nickel, and nickel-copper

d. Allowed build-up thickness: not greater than 0.030 inch

e. Not greater than 0.030 inch: nickel, copper, and silver

f. Typical top coat: none required (When damage is caused by fretting, 0.0003 to 0.0005 inch of tin or tin-indium may be applied over the hard top coat to prevent further fretting.)

g. Authorization: all applications authorized

5.5.4 Printed circuit repairs. Printed circuit repairs are authorized using approved procedures.

5.6 Class 3 (sliding contact surface) coatings. Allowable thicknesses shall be limited to not more than 0.025 inch exclusive of filling pits, scores, and other imperfections, when the total surface area of the defects comprises not more than 10 percent of the area to be plated. The maximum allowable plating thickness shall not exceed the qualification limit of the procedure. Class 3 brush plated surfaces are generally for wear resistance. Shaft journals, hydraulic cylinders, pistons, rams, valve stems, electrical contacts, and commutators are examples of equipment that is plated for wear resistance. The following is a typical application of this class:

a. Type of damage: wear, scoring, corrosion, or mismachining

b. Typical work-pieces: straight shafts and crankshafts and valve stems in packing area

c. Typical base: steels, stainless steels, bronze, metals nickel copper, and chromium

d. Allowed build-up: not greater than 0.025 inch, except thickness filling pits and scoring is limited to a depth of 0.020 inch

e. Typical hard: nickel, or nickel-tungsten alloy, not less than 0.002 inch over top coat copper filled pits

f. Authorization: sliding surfaces except Classes 3A and 4 shafts which require NAVSEA approval

5.6.1 Class 3A (sliding contact surfaces requiring NAVSEA approval) coatings. Class 3A coatings are the same as Class 3 coatings except they are applied in areas where the applications require that NAVSEA approval be obtained before applying them. Surfaces which are in this class are in turbines, reduction gears, electric power generating equipment, main propulsion shaft seals, steam valve seats, discs and stems, steering gear rams, and other sliding contact areas when specified.

5.7 Class 4 (nuclear power) coatings. Plating on parts under the cognizance of the Nuclear Propulsion Directorate shall be performed only upon their approval. Approval of procedures by NAVSEA or the prime contractor is required.

6. NOTES

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

6.1 Intended use. This standard is intended for use by activities in developing a contact plating capability.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this standard.

6.3 Documentation. Documentation should be required for Classes 2, 3, and 3A plating jobs. Sample job record form as shown on figure 1 should be used. NAVSEA approval should be required for Class 3A application.

6.4 Subject term (key word) listing.

Anodes

Contact plating

Electrodeposition of metals

Hydrogen embrittlement

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

BRUSH PLATING JOB RECORD Date:	
Part/component: Ship/project: Base metal: Location: ☐ Shop ☐ Ship Application Class:	Job order: Plating procedure: Operator: NAVSEA approval: ☐ Yes ☐ Not req. NAVSEA ltr no:
Reason for plating [1/]	
Action required (itemize) [2/]	
QA check list: ☐ Pre-plating inspection ☐ Operator certification ☐ Plate thickness/dimension ☐ Yes ☐ Not req. Hydrogen bake Inspector name and signature	☐ Visual inspection ☐ PT inspection ☐ Tape test ☐ ☐ Date:

FIGURE 1. Sample job record.

Step Number	Operation [3/]	Solution Number	Voltage	Anode plus or minus	Ampere hours required	Ampere hours drawn	Remarks
Remarks:							

FIGURE 1. Sample Job Record – Continued.

NOTES:

[1/] Provide a brief description of the type, location, and extent of damage. Use "remark" section for sketch, if feasible.

[2/] Provide sequential instruction (Example: (1) Remove corroded area to sound metal; (2) Inspect ground area for defects; (3) Nickel plate to plan dimension plus 0.010 inch; (4) Machine to plan dimension (5) Inspect plated and adjacent surface).

[3/] Record actual operational data.

Preparing activity:
Navy – SH
(Project MFFP-2010-003)

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.daps.dla.mil.