NOT MEASUEMENT SENSITIVE

MIL-STD-865D (USAF)
01 March 2007
SUPERSEDING
MIL-STD-865C
1 November 1988

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

SELECTIVE, BRUSH PLATING, ELECTRO-DESPOSITION

This document is inactive for new design.

AMSC: N/A

AREA: MFFP

FOREWORD

1. This military standard is approved for use by 309MXSG/MXRL, Department of the Air Force, and is available for use by all departments and agencies of the Department of Defense.

2. This standard provides guidance on the process of electro-disposition (brush plating) for the Air Force repair, acquisition, and manufacture of parts and/or spare parts on the landing gear of all military aircraft.

3. Beneficial comments, recommendations, additions, deletions, and any pertinent data, which may be of use in improving this document, should be addressed to 309MXSG/MXRIL, Hill AFB, UT 84056-2609 or 309MXSG/MXRL@hill.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

CONTENTS

CONTENTS

1. SCOPE

1.1 Scope. This standard covers the process and materials for selective electro-desposition of various metals and alloys on ferrous alloys, aluminum alloys, copper alloys, nickel alloys and corrosion-resistant steel, etc.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in 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 Sections 3,4, and 5 of this standard, whether or not they are listed.

2.2 Government Documents.

2.2.1 Specifications, standards, handbooks, and commercial item descriptions. The following specifications, standards, handbooks and commercial item descriptions form a part of this document to the extent specific herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-5002 Surface Treatment and Inorganic Coating for Metal Surfaces of Weapon Systems (Inactive for New Design)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1504 Abrasive Blasting
(Inactive)

(Copies of these documents are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094 or http://assist.daps.dla.mil.online/start/)

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.

COMMERCIAL ITEM DESCRIPTIONS

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

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

2.3 Order of Precedence. In 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 laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 High Strength Steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 180,000 pounds per square inch (psi) and above.

4. GENERAL REQUIREMENTS

4.1 General. The selective plating process (sometimes called “brush” plating) is the method of depositing metal from concentrated electrolyte solutions or selected areas without immersion tanks. In this process, metal is deposited from an electrolyte held in an absorbent material attached to an inert anode. Plating contact is made by brushing or swabbing the part (cathode) to be plated with electrolyte-bearing anode.

4.1.1 Selective plating uses.

a. To prevent or minimize disassembly costs.

b. To minimize machining costs (plate to size).

c. To minimize masking costs.

d. To develop field reliability.

e. To plate small areas of extremely large parts.

f. To supplement conventional plating

g. To plate high strength steels.

h. To plate onto difficult to plate metals, i.e., Aluminum, Molybdenum, Titanium, etc, either as a bonding agent or for subsequent finishing.

i. To restore worn, corroded, or over-machined parts back to size.

4.1.2 Printed circuit repairs. Because of the growing demand and limited availability of electronic components, there has been a significant increase in the need for an approved repair process for salvage of damaged or defective printed circuit boards. Techniques have been developed utilizing selective plating for repair of these boards. These techniques are available through the manufacturer of the selective plating solutions. The specific types of repairs that can be accomplished are:

a. Repair of defective plating.

b. Repair of damaged contacts (fingers) due to peeling.

c. Repair of lifted, damaged, or missing pads and traces.

d. Adding new circuitry or re-routing traces on existing circuit boards.

e. Repair breaks in continuity.

f. Repairs o damaged plating in through holes.

4.1.3 Repair areas. The use of this process will be governed by the expediency and economics of the individual case. The areas to be repaired will normally be limited to reasonable small areas, but in some cases it will be practical to plate large areas.

4.1.4 Cleanliness. All solutions shall be clean and free from contamination. Extra care should be taken to insure that the solutions are not contaminated by used anodes, other plating solutions, and/or grease and oil from surrounding area.

4.1.5 Scale, oxide, and grease. Selective plating solutions are not designed to remove large amount of scale, oxide, oil or grease. Use mechanical or chemical methods to remove large amounts of scale or oxide. Use solvents to remove large amounts of oil or grease.

4.1.6 Selective plating characteristics. Selective plating solutions are 5 to 50 times as concentrated as tank solutions. The current densities used range from 500 to10,000 amps/FT^2. The voltage listed on the solution containers have been pre-calculated to give proper current densities. Too high a current density burns the plating and too low a current density produces stressed deposits and low efficiencies. Agitation is provided to anodes to cathode motion. Too slow a motion causes burning and too fast a motion results in burned plates, course grain structure and unsound deposits. The minimum operating temperature should be 70 degrees. Consult the technical data sheet or technical representative for maximum operating temperature of plating solutions.

WARNING

Chemical breakdown of solutions may occur if advised maximum temperature is exceeded.

4.1.7 Activating. Materials that normally have passive surface (stainless steel, chromium, nickel, and aluminum) require an activating operation. The activating operation removes the passive surface.

4.1.8 Film removal. Etching operations sometimes results in the formations of an insoluble surface film, for example: carbon on carbon steel. These layers for interfere with adhesions; therefore, it is important that these films are removed in the preparation procedure prior to plating.

4.2 Solutions.

4.2.1 Types of solutions. The solutions used in selective plating include solutions for cleaning, etching and activating the surface to be plated, plating solutions for depositing pure or alloy metals, stripping solutions and special purpose solutions such as anodizing, chromate treatment, etc. Solutions of any manufacturers may be used provides they meet the applicable plating requirements and are qualified by procedure tests. However, plating and preparatory solutions of different manufacturers should not inter-mixed or substituted into a plating procedure.

4.2.2 Characteristics of selective plating solutions. The solution manufacturers have pre-cared and made available comprehensive literature on their solutions. This information should be reviewed when selecting a solution and the instructions followed when using the solution. The solution containers are labeled as to range of voltage for various anodes and solution factor. This information should be used during plating operations. The selective plating solution characteristics listed in the Appendix are presented as a guide for solution selection and use.

4.2.2.1 Solution usage.

a. Alkaline and neutral solutions are preferred on porous base metals, white metals, high strength steel and for improved throwing power.

b. Acid solutions are generally used for rapid build-up and as a laminating structure material in conjunction with alkaline type solutions.

4.2.2.2 Immersion deposits and pre-plates. Immersion deposits will formed by certain solutions on certain base materials when pre-wetting a surface with no current flowing. Immersion deposits have poor adhesion to the base materials. Pre-plates are often used to prevent immersion deposits from forming thereby improving adhesion. Common pre-plates are nickel, gold and palladium. When plating with solutions that form immersion deposits, care must be taken to avoid any solution contact with the part prior to plating. Solution literature generally is a good guideline on what solutions form immersion deposits.

4.2.2.3 Chrome plating solution. Chrome deposited from selective plating solutions is not recommended as a wear resistant coating. The hardness of selective brush plated chromium deposits is about 600 Brinell as compares to 1000 Brinell for hard chrome deposits from a tank. In addition the limited thickness and difficulty of producing sound deposits from selective chrome plating solutions result in the use of other metals such as nickel or cobalt in applications, which chromium would normally be used.

4.2.2.4 Build-up. Brush plating solutions are limited in the thickness that can be deposited since the deposit surface at some point becomes excessively rough. The thickness at which deposits become rough varies from 0.001 to .0030 inches but as a general rule the average is 0.005 inches. At this point for higher build-up, the deposit must be smoothed by machining, grinding, or sanding. The deposit must then be cleaned, etched and reactive before additional material can be applied. This can be easily and reliably done on more noble metals such as copper acid deposits, silver, gold, etc. The harder materials such as cobalt and nickel tend to form passive films and must be activated; an operation that requires speed and operator skill, this presents some element of risk. There several techniques to circumvent this element of risk, they are:

a. Select metals and/or specific solutions with less of a tendency to become rough with thickness. The manufacturers of selective plating solutions have developed several solutions specifically for heavy build-up. By supplying these solutions as a constant flow rate and the use of abrasive type covers such as “Scotch Brite” it is possible to deposit layers of metals such as nickel in excess of 0.030 inch without layering or sandwiching. The solution manufacturers list a normal maximum thickness build-up for each solution in their literature.

b. Use a lamination technique whereby layers of a harder more difficult to activate materials are laminated with a softer, more easily activated material. A typical example would be to plate 0.002 inch copper acid, polish and repeat until the desired thickness, is obtained. Copper acid deposits are easy to activate and, therefore, a simple reliable procedure is being used. Grain growth is in horizontal layers for soft metals and vertical layers in hard metals. Thus, alternating layers of hard and soft deposits dissipate or eliminate stress much the same as the theory behind plywood.

4.3 Anodes.

4.3.1 Anode materials and shapes. The removable anodes are available in a wide range of standard sized and three basic shapes. They are as follows:

a. Cylindrical – for plating inside diameters.

b. Concave – for outside diameters.

c. Flat or block shaped – for flat shapes

d. Bulk blocks of graphite material are available for manufacturing special shapes.

The anodes shall be of high purity dense (minimum bulk density of 1.74 g/cc and a maximum grain size of 0.008 inches) graphite, platinum, platinum plated titanium, of 90 percent platinum and 10 percent iridium unless otherwise authorized by the responsible engineering organization. Separate anodes should be kept for use with each plating solution. Each anode should be dedicated to a solution and should be identified with solution code and polarity. Anodes that have been used for reverse current cleaning and etching operations should be marked as such and should not be used with forward current.

4.3.2 Anode selection.

4.3.2.1 Anode selection for preparatory steps. The cleaning, de-oxidizing, etching and activation steps usually require much less time than the plating steps. Therefore, close matching of the anode for preparatory steps is not as important as in the plating steps. To insure that thorough and uniform preparatory operations have been carried out, it is desirable to use adequate size tools for those operations, recommend that the preparatory tools cover a minimum of 10 percent of the area to be plated.

4.3.2.2 Anode selection for plating steps. Metal is deposited essentially only in the area of the tool to work contact. As a result, the following should be considered when selecting an anode:

a. The anode should have optimum contact area with the work place, approximately 1/3 to 1/2 the total area to be plated when used in manual operation. Power pack size and the configuration of the area to be plated are of primary importance in automated or mechanized flow plating.

b. The anode should be selected which most nearly conforms to the configuration of the parts: i.e. flat anodes for flat parts, cylindrical anodes for internal diameters and concave anodes for outside diameters, etc.

c. The anode should cover the full length of a diameter or a flat area.

d. When plating large areas, the maximum tool to work contact will depend on the plating solution and power pack used. The maximum contact area may be computed using the following formula:

$$\mathbf{C.A.} = \frac{\mathbf{A}}{\mathbf{C}}$$

In the above, C.A. = maximum contact area (In): A = amperage output of power pack; C = current density for the solution under optimum conditions.

e. After the anode has been selected, it shall be drilled as necessary for flow plating where required and wrapped with the appropriate material selected in conjunction with solution manufacturer's recommendations.

4.3.3 Tool coverings. The tool covering is used to hold and distribute the solution uniformity. Solution manufacturer's recommended tool coverings should be used as they are essential for successful plating. Some of the most commonly used covering are:

a. Scotch-Brite ™ or equivalent micro-fiber cover. This is the preferred cover for durability and versatility, as long as it is compatible with the solution being plated.

b. Dacron batting.

c. Pelon.

d. Scotch Brite.

e. Dacron felt.

Cotton, dacron or cotton dacron sleeving can be used to extend the tool covering life of the cotton or dacron batting.

4.4 Equipment. (Reference: A-A-59460)

4.4.1 Power unit. A suitable power source is required and shall operate on 110, 220, or 440 volts alternating current (AC), 60 Hertz single phase or three phase input. The unit shall be capable of producing direct current having smooth characteristics. The power unit must be able to output a minimum of 8 amperes at 10 volts. Minimum instrumentation shall include a volt meter, ammeter, ampere-hour meter, variable DC output and AC and DC circuit breakers.

4.4.1.1 Ammeter. The ammeter shall have sufficient capacity to provide a full-scale reading equal to the maximum capacity of the power source and an accuracy of ± five (5) percent of the current being measured.

4.4.1.2 Voltmeter. The voltmeter shall have sufficient capacity to provide a full-scale reading equal to the maximum capacity of the power source and an accuracy of ± 1.0 volt.

4.4.1.3 Ampere-hour meter. The ampere-hour meter shall be readable to a division compatible with power unit and application; i.e. 15 to 30 amperes 0.001 amp-hr, 60 to 200 amperes 0.01 amp-hr, over 200 amperes 0.1 amp-hr. Accuracy shall be ± 1 percent.

4.4.1.4 Micro-processor. Optionally replaces the signal digital ampere-hour meter, with five (5) programmable memories. The micro-processor will monitor up to a five (5) step procedure and notify the operator by audible alarm when required ampere-hours is reached in each step. It performs as a calculator, automatically inputs the results of the calculations into the power supply control mechanisms, and monitors selective plating operations as follows: performs surface area calculations and incorporates them with ampere-hour factor and thickness build-up requirements to determine pre-set ampere-hour values for the job. It then automatically programs the alarm system. The micro-processor is capable of monitoring coating thickness in inches or ampere-hours. In run mode, ampere-hour usage is monitored so that operator can record solution usage to avoid over depletion. Ampere-hour monitor retains data from repetitive operations in its cumulative memory.

4.4.2 Plating tool handles. The handles shall be designed to hold anodes of various sizes and configurations. The handles should be designed for rapid cooling. The handle shall be insulated for safety reasons.

4.4.3 Dishes, beakers, and flasks. The dishes, beakers, and flasks required to hold the plating solutions and catch the run-off should be inert to the solutions and of the appropriate configuration.

4.4.4 Accessory equipment. Depending upon the type of work being done, other items may be required, such as:

4.4.4.1 Blasting equipment and abrasive. The size of the cabinet shall be adequate for the part to be plated. Air lines shall be suitably trapped and filtered to prevent in-process contamination of the parts to be cleaned. The blast material shall be aluminum oxide (AL_2O_3) or silica (SIO_2). The material shall be a particular size or grit that will not affect the micro finish or dimension of the part. (The blast material and blast procedure are subject to the approval of the responsible engineering organization.)

4.4.4.2 Motorized turning head. The motorized turning head is used for rotating components such as shafts, bearings, etc, to assure concentric and uniform plating. The motorized turning head shall have a speed control from 0 – 600 RPM with input of 110 volts, single phase, 600 hertz AC. The turning head shall also have an on – off reverse control in either direction of rotation.

4.4.4.3 Rotary power anode. Rotary power anodes are used to rotate the anode for the plating of internal diameters or to reduce operator fatigue on large areas. The rotary power anode shall have an input of 110 volts, single phase, AC. The rotary power anode shall have an input of 110 volts, single phase, AC. A stepless speed control from 0 – 900 RPM and a reversing switch are also required.

4.4.4.4 Additional equipment. Additional equipment, such as, transversing arms – mechanical arm for holding anode during plating, heater, pump, filter package – for solution maintenance and temperature control, solution coolers, etc, are available through the solution manufacturer.

4.4.4.5 Safety requirement. To provide safe working conditions, insure compliance with personal protective equipment standards (face shield, rubber gloves and apron) found in CFP, Title 29, Labor, Chapter XVII, Subpart I (OSHA Regulation).

5. DETAILED REQUIREMENTS

5.1 Calculation of required ampere – hours.

$$Amp - hr = FxAxT$$

Where "F" is the solution factor, "A" is the area to be plated, and "T" is the thickness to be plated.

a. Each selective plating solution has a solution factor, which is equal to the ampere – hours required to deposit 0.001 inch on one square inch of surface.

NOTE: This figure is 10^4 times the older factors used occasionally an older bottle might have a factor shown using an older method. If the US factor (not metric) is not between approximately 50 and 300 (i.e. you have a US factor of .03), mover the decimal 4 places to the right to give an updated factor (.03 would become 300).

b. Multiply this figure by the number of square inches involved. This gives 0.001 inch of deposit on the number of square inches involved or using the new "selectrons" figure the number of ampere – hours required to deposit one inch or deposit on the number of square inches involved.

c. Multiply the figure by the number of square inches involved "A." This gives the number of amp – hours required to deposit one inch of deposit on the number of square inches involved.

(OLD) $2in^2$ x 0.001 inch x 10^4 x 0.020 = .4 ampere – hours

(NEW) $2in^2$ x 0.001 inch x 200 = .4 ampere – hours

5.2 General plating procedure. This procedure is listed for general discussion. For specific applications see paragraph 5.3 and the solution manufacturer's instructions.

a. Prior preparation. Selective plating cleaning solutions are not designed to remove large amounts of grease, oil, oxide, and scale. Mechanical methods should be used to remove large amounts of scale or oxides. Approved solvents or cleaning solutions should be used to remove large amounts of grease or oil.

b. Electro-clean. Use electro-clean to remove residue amounts of grease, oil, and light oxide film. Forward current is normally used by reverse current can be used to prevent hydrogen embrittlement. Use electro-cleaning for areas larger than the area to be plated.

c. Rinse. The purpose of the rinse is to remove all of the previous solution, so that the following solution will not be contaminated. Rinsing is a very important step, and usually but not always follows each step. Rinse a larger area than the area to be plated. Use clear tap water; water clean enough to drink is suitable for brush plating methods. DO NOT USE DEIONIZED WATER.

d. Etch. Etch the surface as required. Small amounts of oxides may still remain on the surface of many materials after electro-cleaning. "Flowed" metal is often present on the surface from machining, grinding, and polishing operations or through usage of the part. The etching operation is used with reverse current and is continued until the oxide film, flowed metal and contaminated surface material have been removed and a uniform "grainy" surface appearance is obtained.

e. De-smutting. The etching operation on some materials results in the formation of a loose layer carbon. This layer causes poor adhesion to the base material. This layer can be removed by an appropriate de-smutting operation. The de-smutting is completed when the surface is uniform in appearance, and continued de-smutting does not result in the surface becoming lighter in color.

f. Activating. Activate the surface as required for plating on aluminum alloys, high alloy steel, stainless steel, chromium, nickel, or nickel alloys. The purpose of the activation step is to remove the characteristically passive surface of these metals.

g. Pre-plate. Pre-plating is required. In many cases to obtain maximum adhesion, pre-plates of a suitable metal are deposited prior to deposition of the metal desired. Follow solution manufacturer's recommendations for bonding and pre-plate thickness.

h. Electro-plate. The final preparatory operation should be followed as soon as possible by the plating operation. Electro-plate in accordance with the solution manufacturer's instructions.

i. Dry. Dry using a warm air blower, paper toweling, or clean dry rags.

5.3 Alternate activation method. An alternate method for activation of base metals is the abrasive blast method. There are distinct advantages to this type of activation procedure, such as, speed and consistency. Abrasive blast activation works well on all base metals and is especially useful in the activation of high strength steels, dissimilar metals and unknown metals. Reference MIL-STD-1504 and the solution manufacturer's recommendation for the use of this method.

5.4 Plating on dissimilar metals and changing base. As a general rule when you have two dissimilar metals to plate on, follow the plating procedure for the one with the most steps of activation. IF activation steps have to the mixed, use of reverse current activation steps. EXAMPLE: Fill pits in chrome plated aluminum.

a. Electro-clean using forward current until water does not break on surface.

b. Rinse thoroughly with clean tap water.

c. Activate the aluminum surfaces using reverse current and the appropriate solution until a uniform gray to black surface is obtained.

d. Rinse thoroughly.

e. Activate the chrome surface using forward current and the appropriate solution.

f. Do not rinse.

g. Immediately nickel-flash the surface to thickness of 0.001 inch. Nickel flash with one of the pre-plate nickels.

h. Rinse thoroughly.

i. Continue plating with the desired metal to the proper thickness.

j. Rinse and dry.

5.5 Surface preparation. The selective plating solution manufacturers have prepared and made available comprehensive literature on the use of their solutions. The literature should be reviewed when planning a selective plating repair. The following selective plating procedures for plating on some of the more common basis are presented as a guide.

5.5.1 Plating on aluminum and aluminum alloys.

a. Electro-clean with Cleaning and Deoxidizer 1010 or equivalent solution using forward current.

b. Rinse thoroughly with clean tap water.

c. Activate with reverse current until a uniform gray to black surface is obtained. "DO NOT" over activate.

d. Rinse thoroughly.

e. Immediately electro-plate to color with a pre-plate of nickel or copper.

f. Rinse thoroughly.

g. Continue plating with the desired metal to the proper thickness.

h. Rinse and dry.

NOTE: Certain aluminum alloys will exhibit improved adhesion if the following steps are inserted between steps “d” and “e”:

(1) Activate with forward current until a uniform, light surface is obtained.

(2) Rinse thoroughly.

5.5.2 Plating on copper and copper base alloys.

a. Electro-clean with Cleaning and Deoxidizer 1010 or equivalent solution using forward current until water does not break on the surface.

b. Rinse thoroughly in clean tap water.

c. Etch using a 1023, #3 etch, or equivalent with reverse current until a clean, copper colored surface is obtained.

d. Rinse thoroughly.

e. Electro-plate the part with any of the plating solutions except silver (see immersion deposit instructions).

NOTE: Alloys of Beryllium Copper may form a smut during etching operation. This can be avoided by substituting a nickel acid bonding layer for the etching operation.

5.5.3 Plating on 300 series and 400 series stainless steels, nickel base alloys, chromium base alloys, high nickel ferrous alloys, cobalt base alloys, nickel plate and chromium plate.

a. Electro-clean with Cleaning and Deoxidizer 1010 or equivalent solution using forward current until water does not break on the surface.

b. Rinse thoroughly in clean tap water.

c. Reverse current etch with the appropriate solution for the base material (as #4 or 1024 Etch and Activating solution) until a uniformly etched surface is obtained.

d. Rinse thoroughly in clean tap water.

e. Activate the surface using forward current and the appropriate solution for the base material (as #7 or 1027 activating solution).

f. **DO NOT RINSE.**

g. Immediately nickel-plate the surface to a thickness of 0.00005 to 0.0001. Nickel flash with one of the pre-plate nickels (as nickel 2080).

h. Rinse thoroughly.

i. Continue plating with the desired metal to the proper thickness.

j. Rinse and dry.

5.5.4 Plating on iron and carbon steels. (For steel heat treated above 180,000 psi, see paragraph 5.5.5.)

a. Electro-clean using forward current until water does not break on the surface.

b. Rinse thoroughly in clean tap water.

c. Reverse current de-smut with the appropriate etching solution, such as 1022 or #2 etch) to obtain a uniform light gray-to-black etched surface.

d. Rinse thoroughly.

e. Reverse current de-smut with the appropriate de-smutting solution, such as #3 or 1023 etch and de-smut, until smut is removed.

f. Rinse thoroughly.

g. Electro-plate the part with the desired metal. If cooper or silver is the desired metal, an undercoat is required.

h. Rinse and dry.

5.5.5 Plating on ultra high strength steels. (Steels heated treated to 180,000 psi and above.)

a. Electro-clean using reverse current until water does not break on the surface.

b. Rinse thoroughly in clean tap water.

c. Electro-plate the part with the desired metal. If cooper or silver is the desired metal, an undercoat is required. Plate initially at the highest voltage recommended for the solution so as to develop an initial barrier layer. Then reduce to the standard voltage.

d. Rinse and dry.

e. Bake the parts for four (4) hours at 375 ± 25 degrees “F” within four (4) hours of plating. Parts including carburized parts, which will decrease in hardness or be otherwise deleteriously affected by heating to 375˚ “F” (190˚ “C”) shall be heated to 275 ± 15 degrees “F” (135 ± 8 degrees “C”) and held at heat for not less than five (5) hours.

NOTES:

1. The activity with the engineering responsibility for the items to be plated should determine which selective plating solutions can be used on their high strength steel parts without a post plate bake.

2. Parts plated with Dalic Cadmium Code 2023, Liquid Development Company Cadmium LDC 4803, and Selectron Cadmium LHE (SPS 5070) have been tested in accordance with MIL-S-5002 (Inactive for New Design) and have satisfied the Air Force requirements for use without a post plate bake.

. 5.5.6 Inspection

a. Quality control responsibility. The responsible Quality Control Department shall enforce the requirements of this standard. Testing to meet the requirements shall be performed with such frequency as deemed necessary by the Quality Control Department to assure compliance with this standard.

b. Qualification of operators. Operators performing work under this standard shall be certified as qualified operators by the Quality Control Department or solution manufacturer’s certification. Certification shall be conferred on trained operators, who have successfully demonstrated knowledge of the process and their ability to produce satisfactory plating per this standard. Re-certification of operators is required at least annually.

c. Certification of equipment. All equipment shall satisfactorily demonstrate the ability to perform at a rated capacity and produce plating meeting the requirements of this standard every six (6) months. The Quality Control Department shall certify that the equipment conforms to this standard.

d. Inspection. The plating should be smooth, fine grained, adherent and free of visible blisters, pits, nodules, porosity, excessive edge build-up and other defects that would affect the functional use of the plated part.

e. Adhesion test. All contact plated surfaces shall be tested for adhesion of electro-deposits. The tape test is the generally accepted test in the selective plating industry. Shot peening or machining is the more severe test.

1. Tape test. Apply a one (1) inch wide strip of Minnesota Mining and Manufacturing Tape, Code # 250, or approved equivalent, with adhesive side

to the freshly plated surface. 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.

2. Shot peen test. Shot peen using Minnesota Mining and Manufacturing rotary peening tools. These tools consist of a rotary flap loaded with #330 Tungsten Carbide shot. The flap is used in a mandrel and rotated by an air or electric motor between 2000 and 3500 RPM. The intensities obtained by this method can be correlated to the Almen Standard.

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 provides the step by step process and procedures for selective, brush plating, electro-desposition to be used during repair process and acquisition of spares for the landing gear of all military aircraft. It is a process and procedure unique to the Air Force and is used primarily by the Air Force at Hill Air Force Base.

6.2 Subject term (key word) listing.

Acid
Alkaline
Chrome

6.3 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.

APPENDIX A

Plating Solutions

APPENDIX A

A.1 SCOPE: The following tables identify the plating solutions, along with the manufacturer's code and solution factor. These tables along with the engineering requirements identified in this standard, supports the repair process and the acquisition of spares for all military aircraft landing gear.

TABLE A-I Brooktron Plating Solutions

Brooktronic Engineering Corporation
28231 Avenue Crocker, Bldg 60 & 70
Valencia, CA 91355-1249
800-394-0922 or 6610294-1195
www.brooktronics.com

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Cadmium Acid	BEC 300	50
Cadmium Alkaline	BEC 301	40
Cadmium Special	BEC 302	46
Cadmium Low Hydrogen Embrittlement	BEC 305B	33
Chromium	BEC 310	300
Cobalt Acid	BEC 320	250
Cobalt High Speed	BEC 321	120
Copper Acid	BEC 330	120
Copper High Speed	BEC 333	87
Copper Alkaline HB	BEC 334	140
Copper Soft	BEC 335	120
Copper HS, NF	BEC 336	120
Iron	BEC 340	300
Lead	BEC 350	60
Nickel Acid	BEC 360	236
Nickel Neutral	BEC 362	100
Nickel M (Magnesium)	BEC 364	220
Nickel Black - High Steed	BEC 365	200
Nickel High Speed	BEC 367	96
Nickel Acid HB	BEC 368	186
Nickel Sulfamate	BEC 369S	140
Tin Acid	BEC 370	71
Tin Alkaline	BEC 371	70
Tin High Speed	BEC 373	68
Zinc Alkaline	BEC 381	89
Zinc High Speed	BEC 383	87
Cobalt – Nickel	BEC 420	200
Zinc – Nickel	BEC 430	140
Cobalt – Tungsten	BEC 460	250
Nickel – Tungsten	BEC 470	250
Tin – Lead	BEC 490	60

APPENDIX A
TABLE A-1 (continued)

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Gold Acid	BEC 20	65
Gold Alkaline	BEC 21	65
Gold Neutral	BEC 22	65
Gold Hard	BEC 23	70
Gold Ultra Pure	BEC 24	65
Indium	BEC 30	90
Palladium	BEC 50	220
Platinum	BEC 60	400
Rhodium A	BEC 70	145
Rhodium B	BEC 71	165
Silver	BEC 90	65
Silver Cyanide Free	BEC 95	90

APPENDIX A
TABLE A-II Brush Plating Services Solutions

Brush Plating Services
405 Main Street
Torrance, CA 90503-6865
(800) PLATE IT (800-752-8348) or 310-540-1550
www.brushplate.com

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Cadmium Special	BEST 1304	50
Copper Acid	BEST 1330	105
Copper Alkaline	BEST 1331	150
Copper High Speed	BEST 1333	105
Nickel, Black	BEST 1365	300
Nickel, "B" High Speed	BEST 1367	100
Nickel, "C" Acid	BEST 1368	200
Tin, Acid	BEST 1370	60
Tin, Alkaline	BEST 1371	50
Tin, Type "A" High Speed	BEST 1373	60
Zinc, Alkaline	BEST 1381	50
Zinc, High Speed	BEST 1383	85
Gold, Alkaline	BEST 1021	65
Gold, 23k	BEST 1023(Type II)	65
Gold, 24k	BEST 1024(Type I)	65
Platinum	BEST 1060	300
Palladium	BEST 1065	100
Silver, "Pure No Brightness"	BEST 1090	50

APPENDIX A

TABLE A-III Liquid Development Company Solutions

Liquid Development Company
3748 East 91st Street
Cleveland, OH 44105
800-321-9194 or 216-641-9366
http://www.1debrushplate.com

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Cadmium Alkaline	LDC 4802	70
Cadmium (No Bake)	LDC 4803	70
Chromium (HTC3)	LDC 2403	2000
Cobalt	LDC 2701	200
Cobalt M	LDC 2702	200
Copper Acid D	LDC 2901	130
Copper Alkaline	LDC 2902	130
Copper Acid Hi – Speed	LDC 2903	130
Copper Alkaline Hi – Speed	LDC 2904	130
Lead Alkaline	LDC 8202	50
Nickel	LDC 2801	300
Nickel Alkaline	LDC 2802	180
Nickel Hi - Speed	LDC 2803	150
Nickel Soft	LDC 2805	200
Nickel Sulfamate (Soft)	LDC 2820	200
Nickel Sulfamate (Medium)	LDC 2840	200
Nickel Sulfamate (Hard)	LDC 2854	200
Tin Alkaline	LDC 5001	50
Tin Acid	LDC 5003	30
Tin Zinc	LDC 5030	30
Zinc Alkaline	LDC 3001	110
Zinc Bright	LDC 3003	110
Zinc Nickel	LDC 3028	100
Gold 100	LDC 7900	60
Gold 50	LDC 7901	60
Gold 25	LDC 7905	60
Gold 10	LDC 7910	70
Indium	LDC 4901	90
Palladium	LDC 4601	170
Platinum	LDC 7801	1500
Rhodium	LDC 4501	800
Rhodium	LDC 4502	800
Silver	LDC 4701	50
Silver	LDC 4703	60
Silver	LDC 4704	50
Babbitt Navy Grade II	LDC 5029	60
Bronze	LDC 2950	130
Nickel – Cobalt	LDC 2827	300

APPENDIX A
TABLE A-III (continued)

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Tin – Indium	LDC 5049	70
Tin – Lead	LDC 5082	50
Tin – Cadmium	LDC 5048	50
Cobalt – Tungsten	LDC 2774	200
Nickel – Tungsten	LDC 2874	300

APPENDIX A
TABLE A-IV Dalic® Plating Solution (SIFCO)

SIFCO Selective Plating
5708 E. Schaaf Road
Cleveland, OH 44131-1308
800-765-4131 or 216-524-0099
http://www.brushplating.com

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in
AeroNik1® 250	7280	*
AeroNik1® 400	7281	*
AeroNik1® 575	7282	*
Cadmium (Acid)	2020	70
Cadmium No Bake®	2023	70
Chromium (Dense Trivalent)	2030	1370
Cobalt (Heavy Build)	2043	200
Copper (Acid, Heavy Build)	2050	130
Copper (Hi-Speed, Acid)	2055	130
Copper (Hi-Speed, Alkaline)	2056	150
Iron	2062	180
Nickel (Dense)	2080	210
Nickel (High Speed)	2085	150
Nickel (Ductile)	2086	250
Nickel (Ductile)	2088	210
Tin (Alkaline)	2090	70
Tin (Alkaline)	2092	70
Tin (High Speed)	2093	70
Zinc (Alkaline)	2100	110
Zinc (Heavy Build)	2103	110
Gold (Alkaline, 100 grams/liter)	3020	60
Gold (Neutral, 98 grams/liter)	3021	60
Gold (Acid, 90 grams/liter)	3022	60
Gold (Alkaline, 25 grams/liter)	3023	70
Gold (Alkaline, 50 grams/liter)	3024	60
Indium (60 grams/liter)	3030	90
Palladium	3040	170
Platinum	3052	1500
Silver (Hard, Heavy Build, 100 gr/liter)	3083	50
Silver (Non-Cyanide, 100 grams/liter)	3084	50
Babbitt – Navy 2	4011	60

* Factor varies depending on the solution freshness. See Technical Data Sheet.

APPENDIX A
TABLE A-V Selectron® Plating Solutions

SIFCO Selective Plating
5708 E. Schaaf Road
Cleveland, OH 44131-1308
800-765-4131 or 216-524-0099
http://www.brushplating.com

Plating Solution	MFRS Code	Solution Factor AMP Hrs/.001 in/1 in^2
Cadmium Acid	SPS 5050	70
Cadmium LHE	SPS 5070	70
Cobalt Machinable	SPS 5200	250
Cobalt (Semi Bright Heavy Build)	SPS 5204	160
Copper (Acid)	SPS 5250	130
Copper (High Speed Acid)	SPS 5260	130
Copper (Heavy Build Alkaline)	SPS 5280	240
Iron (Semi Bright, High Leveling)	SPS 5502	300
Nickel (Acid)	SPS 5600	250
Nickel (Special)	SPS 5630	380
Nickel (Acid, High Build)	SPS 5640	210
Nickel (Semi Bright, High Leveling)	SPS 5642	200
Nickel (High Speed)	SPS 5644	170
Nickel XHB	SPS 5646	170
Nickel (Neutral)	SPS 5650	250
Tin (Acid)	SPS 5900	30
Tin (Alkaline B)	SPS 5951	50
Zinc (Alkaline)	SPS 5980	110
Gold	SPS 5350	65
Gold (Non-Cyanide)	SPS 5355	260
Gold (Hard Alloy)	SPS 5370	65
Gold (Neutral)	SPS 5380	65
Gold (Acid)	SPS 5400	65
Palladium	SPS 5730	200
Platinum	SPS 5750	700
Rhodium	SPS 5800	800
Rhodium (Low Stress)	SPS 5810	600
Silver (Heavy Build)	SPS 5860	40
Silver (Non-Cyanide)	SPS 5870	40
Cobalt – Tungsten	SAS 5230	250
Nickel – Cobalt	SAS 5705	250
Nickel – Tungsten “D”	SAS 5710	340

CONCLUDING MATERIAL

Custodian:
Air Force – 70

Preparing Activity:
Air Force – 70

(Project MFFP-0723-000)

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 ASSIST Online database at http://assist.daps.dla.mil.