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 SUPERSEDING
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MILITARY SPECIFICATION

CLEANING AND PREPARATION OF FERROUS AND ZINC COATED SURFACES FOR ORGANIC PROTECTIVE COATINGS

This specification has been approved by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. — This specification covers the cleaning and preparation of iron, steel and zinc-coated steel for the application of organic coatings (paint, varnish, lacquer, enamel, etc.). When specified or approved this specification may be used on fabricated items which possess some zinc and aluminum surfaces requiring treatment, in addition to the ferrous surfaces. (See 6.15).

1.2 Classification.—This specification covers the following grades and types of cleaning and surface preparation processes:

Grade I.—A crystalline phosphate base coating for use as preparation for painting iron, steel and zinc-coated steel; and, when specified, zinc alloys, or aluminum surfaces.

Grade II.—Cleaning treatments which leave the metal surface substantially bare.

Type 1—Mechanical (sand, shot, grit, or seed blasting preceded by degreasing if necessary to assure a grease-free surface and followed by cleaning to remove dust and metal particles) (for ferrous surfaces only).

Type 2—Hot alkaline cleaning (immersion, spray or electro-cleaning) (for ferrous surfaces only).

Type 3—Solvent cleaning (immersion, spray or vapor).

Type 4—Alcoholic phosphoric acid cleaning.

Type 5—Cleaning with hot phosphoric acid solution containing a detergent.

Type 6—Emulsion cleaning (cleaner applied with or without added water, and followed by a water rinse).

2. APPLICABLE SPECIFICATIONS

2. The following specifications, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS**FEDERAL**

QQ-M-151 —Metals; General Specification for Inspection of.

QQ-Z-325 —Zinc Plating (Electro-deposited).

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JAN-P-127 —Packaging and Packing for Overseas Shipment; Tape, Adhesive Pressure-Sensitive, Water Resistant.

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(Copies of specifications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer).

3. REQUIREMENTS

3.1 Material.—All material used shall be as specified herein, on the drawing, or of a quality consistent with good commercial practice.

3.2 Preproduction Approval (Grade I only).—Unless otherwise specified by the procuring agency, details of the proposed procedure, chemicals and the equipment to be used by the contractor shall be submitted through the contracting officer to the bureau or agency concerned in writing and written approval received, prior to the commencement of production. (See 6.6) The exact designation of any material proposed for use, together with the name of the manufacturer, should be stated. The proposed procedure should include a detailed method of control including limits for time, temperature, pH values, and all other pertinent details that will insure the requirements of this specification being complied with. No deviation from the approved process shall be permitted without prior written approval of the bureau or agency concerned through the contracting officer. Approval of process, materials and equipment implies no guarantee of acceptance of the results obtained in use. Regardless of any process or materials approved, items shall conform to all the applicable requirements of this specification.

3.3 Removal of soils and corrosion products.—Prior to the application of Grade I phosphate coatings or following the application of Grade II treatments, the surfaces of the parts shall be thoroughly free of oil, grease, dirt, scale, rust, and other foreign matter and shall show no visible signs of corrosion products.

3.4 Applicable methods.—If not specified, the method or combination of methods used shall be selected to suit the nature and the

degree of contamination present. Sulfuric or hydrochloric acid pickling shall not be used unless specifically approved or specifically authorized by the drawing or specification of the item being processed. Pickling chemicals shall be thoroughly rinsed from the surfaces before subsequent stages. Hydrochloric or sulfuric acid pickling will not be approved for use on assemblies, sub-assemblies or certain components which may entrap acid, or when for any other reason acid pickling is considered inadvisable. (See 6.6)

3.5 Rinsing.—Adequate rinsing shall be done to remove cleaning and preparation chemicals. The last rinse in water shall be with clean running water or in a constantly overflowing tank. The final rinse shall contain a small amount of chromic acid or mixture of phosphoric and chromic acids, sufficient to obtain a pH of 2.0 to 4.0. (See 6.7)

3.6 Drying.—The final stage of each process shall be thorough drying; care shall be exercised to assure that drying is complete especially in crevices, seams and other places which are generally the last to dry.

3.7 Application of organic coating.—After processing, the surfaces shall be given the organic protective coating directly before the surfaces can show evidence of rusting or other soiling. The temperature of the metal surface shall not be so high that blistering, poor adhesion or unsightly films result. (See 6.9).

3.8 Freedom from oils and greases.—Any cleaning and preparation method or methods used shall completely remove all traces of oils, waxes, greases and other soils when tested as specified in 4.2.2.

3.9 Freedom from alkalies and strong acids.—After the final rinse in the process, the surface of the item shall have a pH value of 2.0 to 6.0. (see 4.2.3)

3.10 Appearance (applicable to Grade I only).—Coating deposits shall be continuous

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and uniform in texture, evenly deposited and gray to black in color. They shall exhibit no mottled appearance, presence of white stains due to dried phosphating solution, corrosion products, finger-prints, and a minimum amount of contact marks. Parts exhibiting a nonuniformity of color due to heat treatment, composition of the basis metal, the degree of cold work performed on the basis metal, or presence of brown or orange stains from the chromic acid rinse shall not be cause for rejection.

3.11 Phosphate coating weight (applicable to grade I only) (not applicable to aluminum components).—The minimum coating weight shall be 150 mg/sq. ft. for spray processes and 300 mg/sq. ft. for dip processes when tested as specified in 4.2.5. Unless otherwise specified, the coating weight shall be tested at least every four hours. (see 4.3)

3.12 Paint adhesion and durability.

3.12.1 Paint thickness.—For all tests requiring painted panels, test specimens, or items, the paint thickness (dry film) on all surfaces shall be as specified for the end item. When the paint thickness is not covered in the end item specification, the drawing or paint specification requirement in the order cited shall be followed.

3.12.2 Paint adhesion. — Painted items, specimens, test panels shall show satisfactory paint adhesion when tested as prescribed in 4.2.4.2. Unsatisfactory adhesion shall be indicated by any of the following conditions of exposure of bare metal or underlying phosphate coating:

- (a) Any spot exceeding $\frac{1}{8}$ inch average diameter.
- (b) More than one spot $\frac{1}{8}$ inch or less average diameter and exceeding $\frac{1}{16}$ inch average diameter.
- (c) More than five specks $\frac{1}{16}$ inch or smaller average diameter.

3.12.3 Water resistance. — Cleaned, prepared and production painted items or specimens or panels shall show no objectionable blistering when tested as specified in 4.2.4.3. Objectionable blistering shall be indicated by any of the following conditions on a 4 by 12-inch test panel or equivalent area of test specimen or item. On items or specimens having an area less than 48 sq. in., a proportionately smaller number of failed areas will be permitted.

- (a) The appearance of a single blister more than $\frac{3}{16}$ inch long or more than one blister more than $\frac{1}{8}$ inch long.
- (b) The appearance of more than two lines or ringlets of blisters.
- (c) The appearance of ten or more blisters $\frac{1}{8}$ inch or less in length other than the lines or ringlets.

3.12.4 Salt Spray Resistance (grade I only). — The items, specimens, or panels, after application of the phosphate coating and paint, when subjected to the salt spray test required in 4.2.4.4 for the number of hours prescribed in the applicable paint specification, drawing, end item specification, or as otherwise specified, shall show no more than $\frac{1}{8}$ inch creepage, softening or blistering of the paint from the scribe mark. At all other points there shall be no more than a trace of film failure such as blistering or corrosion, and not more than 5 scattered blisters, none larger than 1mm. in diameter on a 4 by 12-inch test panel or equivalent area of test specimen or item. On items or specimens having an area less than 48 sq. in., a proportionately smaller number of failed areas will be permitted. (See 6.13)

4. SAMPLING, INSPECTION AND TEST PROCEDURES

4.1 Inspection. — Sampling and inspection shall be as specified and shall be made at the contractor's plant at any stage as may be required to determine compliance with requirements of this specification.

MIL-C-490A**4.2 Tests.**

4.2.1 Test specimens. — Test specimens shall be prepared from actual production items or parts thereof, or if size is prohibitive from scrap parts of the same kind and finish (from the same manufacturing lot if possible) which have been rejected for causes other than phosphating, material composition, and/or heat treatment. Standard panels may be used if the size of the item is prohibitive. Specimens need not be identical in shape or size but shall be stamped, etched, or otherwise indelibly marked for identification as a test specimen. Standard panels, when used, shall be not less than 3 by 6 inches in size. If standard panels are used in lieu of test specimens for ferrous surfaces, a cold rolled carbon steel strip in accordance with ASTM Specification A-109 having a Rockwell "B" hardness maximum of 65, and a velvet or satin finish equal to that commonly known to the trade as Carnegie Illinois Corporation No. 5 finish is considered acceptable; for aluminum surfaces, use of Al-17ST or 24ST aluminum panels is considered to be acceptable; for zinc coated surfaces, the panels shall conform to Class II, type I of Specification QQ-Z-325. All test specimens or standard panels shall be processed through all the cleaning, phosphating, painting and drying steps along with the items being processed.

4.2.2 Freedom from oils and greases.—The items, test specimens or panels, for test purposes after removal from the final rinse shall be rinsed in running water and the surfaces then examined for discontinuity of the water film (water break). If the water film is discontinuous, corrective action shall be taken. Inspection for acceptance shall be stopped until corrective action has been taken. After corrective action testing shall be continued at least once every hour until the water film maintains its continuity.

4.2.3 Freedom from alkalies and strong acids. — The surface of the items shall be tested with universal indicating papers or pH indicator solutions while still wet from the

final rinse or after wetting with a few drops of distilled water. Acceptable pH limits shall be between 2.0 and 6.0.

4.2.4 Paint adhesion and durability.

4.2.4.1 Paint thickness.—Paint thickness of the items, specimens, or standard panels shall be measured by a suitable instrument (see 6.11) which has been standardized on the same surface as that over which the organic finish has been applied.

4.2.4.2 Paint adhesion.—The test shall be performed on the painted item, specimens or standard panels of the same metal (see 4.2.1) after a maximum of 24 hours drying unless otherwise specified, (see 6.10). Water-resistant, pressure-sensitive adhesive tape ($\frac{3}{4}$ inch width) conforming to the requirements of Specification JAN-P-127, type II or III, grade A or B, shall be used. Press a 2-inch length of a somewhat longer piece firmly onto a flat or cylindrical surface of the item, rubbing out all air bubbles under the tape. Allow approximately 10 seconds for the test area to return to room temperature. Grasp a free end of the tape and at a rapid speed strip it from the specimen or item by pulling the tape back upon itself at 180° (in such a manner that the tape is folded back to back during the procedure). Observe for bared spots where the paint is removed. Disregard flecks of paint on tape if removal of paint has not been complete through to the metal or phosphate coating.

4.2.4.3 Water Resistance.—Unless otherwise specified a minimum of two items, sections thereof, or panels of the same metal (see 4.2.1), from each day's production shall be run through all steps of the regular production process, including painting. The specimens shall be air dried for a minimum of 96 hours or baked for the time and at the temperature specified in the applicable paint specification, followed by air drying for 24 hours. The specimens shall then be immersed in distilled water having a pH value of 5.0 to 7.0 at 73° F., plus or minus 2° F. for 24 hours.

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If the specimens show objectionable blistering as defined in 3.12.3, inspection for acceptance will be stopped until corrective action has been taken.

4.2.4.4 Salt spray resistance (applicable to grade I only).—Prior to initiation of production, or whenever a change in production or paint occurs, or when required by the inspecting officer, a minimum of three items, section thereof or standard panels of the same metal (see 4.2.1), shall be run through all steps of the regular production set-up, including painting. The specimen shall be air dried for a minimum of 96 hours or baked for the time and at the temperature specified in the applicable paint specification, followed by air drying for 24 hours. The painted specimens shall be scored through to the metal across the width of film, at least 2 inches long, using a sharp pointed knife. In instances where more than one metal is used, each metal shall be so scored. The specimens shall then be exposed to the salt spray specified in Specification QQ-M-151 for the number of hours as specified in the end item, drawing, or paint specification in the order cited. Production shall not be initiated until results of salt spray test are received, except at the contractor's risk. During production, one item, section thereof, or a panel of the same metal if the size of the item is prohibitive (see 4.2.1), from each day's production shall be subjected to the salt spray test as specified above, until five consecutive days' production have successfully passed the test. Sampling shall then be reduced to one sample twice per week. If, upon reduced sampling one failure occurs, corrective action shall be taken and sampling shall revert to one specimen from each day's production until five consecutive days' production have again successfully passed the test. If two consecutive failures occur after the contractor has been notified to take corrective action, in either the original sampling plan or the reduced sampling plan, inspection for acceptance will be stopped until necessary corrective action has been taken.

4.2.5 Phosphate coating weight (applicable to grade I only).—Three specimen items, sections thereof, or standard panels of the same metal (see 4.2.1), at the conclusion of a maximum of each 4 hours production shall be selected by the inspector for test. The clean, dry specimens to be tested shall be accurately weighed and the surface area of each shall be calculated.

4.2.5.1 Procedure for iron, steel, zinc and aluminum components.—The phosphate coatings shall be completely removed by immersion in a 5-percent chromic acid solution at 165° F. for 15 minutes, rinsed, dried and weighed. This process shall be continued until constant weight is attained. *The chromic acid shall be used one time only.* The coating weight shall be determined from the formula:

$$\text{Coating weight} = \frac{(\text{Initial weight in gms} - \text{final weight in gms})}{\text{Total area in square inches}} \times 144,000$$

4.3 Acceptance. — A maximum of each 4 hours production shall be considered acceptable provided that the representative specimens have a minimum coating of 150 or 300 mg/sq. ft. as required by the specific applicable type process. If the specimens fail to comply with the minimum coating weight for the specific applicable type process, further phosphating will be suspended until corrective action has been taken. Painting of the items up to any indication of failure of phosphate coating weight shall be continued during the performance of this test and painting shall only be stopped when corrective action is indicated.

4.3.1 After corrective action has been taken, new samples shall be selected and tested for coating weight. If 2 or all of the 3 specimens representative of this new production fail to comply with this requirement, further corrective action shall be taken for future production and all of the above production rejected. Such above action shall be taken until production is again acceptable.

MIL-C-490A**5. PREPARATION FOR DELIVERY**

5.1 Preparation for delivery is not applicable to this specification.

6. NOTES

6.1 The following paragraphs in this section of the specification (notes) are submitted for informative purposes and are not to be construed as mandatory requirements in the use of this specification.

6.2 Ordering data. — Procurement documents should contain the following information:

- (a) Title, number, and date of this specification.
- (b) Grade and type required. (See 1.2).
- (c) Approval (See 3.1).
- (d) Process (see 3.11).
- (e) Sampling and inspection (see 4.1).

6.3 Flash-zinc plated, phosphate coated sheets will be used when required by the drawing or specification for the component or when approval is obtained from the contracting officer. The flash plating of zinc prior to phosphate coating is not covered by this specification.

6.4 Grade I phosphate coating.—The properly cleaned articles or items should be subjected to a balanced aqueous solution containing phosphoric acid, phosphates, and accelerating agents until a uniform water insoluble crystalline phosphate coating gray to black in color is produced. The articles or items should be exposed to the phosphating solution for at least 3 minutes if the dip coating method is used or for at least 1 minute if the spray method is used. The article should then be rinsed in clean water, followed by a second rinse in a dilute chromic acid or combination of chromic and phosphoric acids solution, and dried.

6.5 Grade II, type 5.—The phosphoric acid cleaning material shall be maintained at a

free acid concentration, temperature range and duration of treatment sufficient to remove all visible corrosion products. The concentration of the acid should be measured and adjusted at least once each shift on the basis of a standard uncombined acid titration.

6.6 Preproduction Approval (Grade I only).—

6.6.1 *Army.* — Unless otherwise specified, for the Army, details of the proposed procedure, chemicals, and equipment to be used should be submitted through the contracting officer to the Paint and Chemical Laboratory, Aberdeen Proving Ground, Maryland. However, the procuring agency may authorize immediate production provided the contractor's process complies with the procedure in 6.6.3. (In those instances where approval is granted by the procuring agency confirmation shall be obtained by the procuring agency from the Paint and Chemical Laboratory, Aberdeen Proving Ground, Maryland.)

6.6.2 *Navy.*—Preproduction approval will not be required for proposed processes for applying crystalline phosphate base coatings under Grade I treatments on ferrous surfaces that correspond to the procedure outlined and described in 6.6.3. Unless otherwise specified, procedures, chemicals and equipment for Grade I treatments which do not correspond to the procedures in 6.6.3 will require preproduction approval of the procuring agency.

6.6.3 *Procedure (method of application of phosphate coating) (applicable to Grade I only).*—The phosphate coating should be applied in equipment consisting of a minimum of five stages. Additional stages may be added at the option of the contractor provided that the five basic stages are retained. The minimum requirements for either spray or dip application are as follows:

Stage 1, Cleaning.—The cleaning method used should be in accordance with Grade II, types 1, 2, 3, or 6 of this specification.

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Stage 2, Rinse. — A clean water rinse with a constant overflow maintained by the continuous addition of fresh water.

Note. This stage is not necessary when grade II, types 1 or 3 are used.

Stage 3, Phosphating. — The phosphate coating may be applied by either the dip coating method of at least 3 minutes in duration, or by the spray method of at least 1 minute duration.

The equipment used should be constructed of materials resistant to the action of the phosphating solution and should not contain copper alloy fitting or brazing where they may come in contact with the solution.

The phosphating bath should be operated at temperatures and concentration designated by the suppliers. Dated records should be maintained noting the periodic analyses and additions to the solutions. Fog sprays should be provided on both dip tanks and spray equipment to prevent the solution from drying on the work surface prior to the subsequent water rinse.

Stage 4, Water Rinse. — A clean water rinse with a constant overflow maintained by the continuous addition of fresh water.

Stage 5, Chromic Acid Rinse. — A final hot rinse (140° to 210° F.) maintained at a pH of 2 to 4 through the addition of flake chromic acid or mixtures of chromic and phosphoric acids. This final rinse should be checked by a standard free and total acid titration at least once every 3 hours and the bath discarded when the total acid reading rises to more than seven times the free acid reading.

All rinses should be discarded at least every 24 hours. The work should remain in each rinse for a minimum of 1 minute, except in spray processes where the time may be reduced to 30 seconds.

6.7 Failure to remove water soluble chemical residue by rinsing, while its harmful effect on the paint coating is not immediately apparent, will result in early failure of the

paint by blistering, flaking and rapid spread of corrosion products from a scratch.

6.8 The procedure for grade II, types 2, 3, and 6 cleaning should, in general, follow the methods outlined in Specification MIL-P-116.

6.9 In general, it is advisable to avoid metal temperatures above 130° F. for cellulose lacquers or 160° F. for enamels unless coating-material has been specially formulated for the purpose.

6.10 When applied over a grade I phosphate coating, paints conforming to the requirements of Specifications MIL-E-10687, MIL-L-11195, and MIL-P-11414 should pass the paint adhesion test in less than 2 hours drying time. MIL-P-11414 primer applied over a grade II treatment should pass the paint adhesion test in less than 4 hours. Under adverse drying conditions such as high humidity and/or low temperatures, longer drying schedules may be necessary. In no case should the time needed to pass the paint adhesion test with these paints exceed 24 hours.

6.11 The following instruments for measuring paint thickness have been found to be satisfactory:

Aminco—Brenner Magnegages—
American Instrument Company, Silver Spring, Md.

Elcometer—Distributed by—
Henry H. Gardner Laboratory, Inc.,
4723 Elm St., Bethesda 14, Md.

"G.E." gage, General Electric Company,
Schenectady, N. Y.

Lea gage—Lea Manufacturing Company, Waterbury, Conn.

6.12 After application of phosphate coating or cleaning treatment, changes in appearance are to be expected and may be desirable for improving paint adhesion. Grade I phosphate coating leaves a chemical deposit.

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Grade II, type I (mechanical cleaner) roughens the surface. Grade II, type 4 (alcoholic phosphoric acid cleaner) discolors the surface. Grade II, type 5 (hot phosphoric acid cleaner) etches the surface.

6.13 It is intended that the maximum amount of corrosion in the salt spray test (3.12.4) be comparable to photograph 9-1 in ASTM Standard Method of Evaluating Degree of Resistance to Rusting Obtained with Paint on Iron or Steel Surfaces, D610-43. This standard may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.

6.14 This specification is intended to supersede Picatinny Arsenal Purchase Description PA-PD-191 (Revision 1), 7 August 1952.

6.15 When aluminum, zinc or other nonferrous metals are processed separately, the cor-

responding applicable finish should be specified; i.e., for aluminum, use MIL-C-5541; for zinc plating use QQ-Z-325, for zinc surfaces, use MIL-T-12879 (QMC), etc.

Notice.—When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may be in any way related thereto.

Custodians:

Army—Ordnance Corps
Navy—Bureau of Ships
Air Force

Other interest:

Army—EQSigT
Navy—MCOY.