

INCH-POUND

TT-C-490D  
March 31, 1993  
SUPERSEDING  
TT-C-490C  
March 19, 1985

## FEDERAL SPECIFICATION

CLEANING METHODS FOR FERROUS SURFACES  
AND PRETREATMENTS FOR ORGANIC COATINGS

This specification was approved by the Assistant Administrator Office of Federal Supply and Services, General Services Administration, for the use of all Federal Agencies.

## 1. SCOPE AND CLASSIFICATION

1.1 SCORE. This specification covers cleaning, surface conditioning, and preconditioning methods for improving the corrosion resistance of ferrous metals. The application of chemical conversion and pretreatment coatings provides uniformly textured substrates for receiving and retaining paint, lacquer, etc. In addition, this specification covers suitable cleaning processes for nonferrous surfaces (see 6.1, 6.1.2).

1.2 Classification. This specification covers the following cleaning methods and surface pretreatment processes:

1.2.1 Surface cleaning shall be by any of the following methods as specified (see 6.4):

- Method I - Mechanical or abrasive cleaning (for ferrous surfaces only).
- Method II - Solvent (immersion, spray or vapor).
- Method III - Hot alkaline (immersion, spray or electrolytic, for ferrous surfaces only).
- Method IV - Emulsion (with or without added water).
- Method V - Alkaline derusting (for ferrous surfaces only).
- Method VI - Phosphoric acid (alcoholic, detergent or solvent type with detergent).

1.2.2 Chemical conversion and pretreatment coatings shall be of the following types as specified (see 6.4).

- Type I - Zinc phosphate spray application (150 mg/sq ft min - 500 mg/sq ft max)

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Research Laboratory, Materials Directorate, Materials Standardization Office, ATTN: AMSRL-MA-S, Watertown, MA 02172-0001 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

AREA MFFP

DISTRIBUTION STATEMENT A. Approved for public release: distribution unlimited.

- Zinc phosphate immersion or dip application (300 mg/sq ft. min - 500 mg/sq ft max)

Type II - Aqueous iron phosphate (.35 mg/sq ft min)

Type III - Organic pretreatment coating (unless otherwise specified, MIL-C-8514 or DOD-P-15328)

Type IV - Non-aqueous iron phosphate (35 mg/sq ft min)

Type V - Zinc phosphate (500 mg/sq ft min - 1100 mg/sq ft max)

1.2.2.1 Method of application. New design documents, engineering drawings and ordering data shall indicate the type of coating required and method of application when applicable.

## 2. APPLICABLE DOCUMENTS

### 2.1 Government documents.

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

## SPECIFICATIONS

### FEDERAL

- A-A-884 - Tape, Pressure-Sensitive Adhesive, Box Closure
- A-A-1830 - Tape, Pressure-Sensitive Adhesive, Box Closure

### MILITARY

- MIL-C-8514 - Coating Compound, Metal Pretreatment, Resin-Acid
- MIL-C-53072 - Chemical Agent Resistant Coating (CARC) System  
Application Procedures and Quality Control Inspection
- DOD-P-15328 - Primer, Pretreatment (Formula 117 for Metals)

## STANDARDS

### MILITARY

- MIL-STD-171 - Finishing of Metal and Wood Surfaces

(Activities outside the Federal Government may obtain copies of Federal specifications, standards, and handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.)

Single copies of this specification and other product specifications required by activities outside the Federal Government for bidding purposes are available without charge from General Services Administration Business Office Centers in Boston; New York; Philadelphia; Washington, DC; Atlanta; Chicago; Kansas City, MO; Ft. Worth; Houston; Denver; San Francisco; Los Angeles; and Seattle, WA.

Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 (Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

#### AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A109 - Steel, Carbon, Cold-Rolled Strip  
ASTM A366 - Steel, Carbon, Cold-Rolled Sheet, Commercial Quality  
ASTM B117 - Salt Spray (Fog) Testing  
ASTM D610 - Evaluating Degree of Rusting on Painted Steel Surfaces  
ASTM D1654 - Special Scribing Tool for Use in Salt Spray Test

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also any be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 3. REQUIREMENTS

3.1 Material. All material used shall be as specified herein, on the drawings, or in the contract.

3.2 Preproduction approval (type I and V). Unless otherwise specified by the procuring agency, details of the proposed procedure including chemicals, equipment, and control tests to be used by the contractor, shall be submitted in writing to the contracting office of the procuring agency concerned so that written approval can be granted prior to the commencement of production (see 6.5). The exact designation of any material proposed for use, together with the name of the manufacturer, shall be stated. The proposed procedure shall include a detailed method of control. including limits for time, temperature, concentration and all. other pertinent details. The contractor shall coat ten (4 X 6 X 1/32 inch) panels (see 4.2.2) by the proposed zinc

phosphate coating procedure outlined for use in the contract. The contractor shall test the coating weights of three of these panels and shall furnish the contracting officer a laboratory test report which confirms that the test panel coating weights are in conformance with the requirements of the contract. The contractor shall also coat five of the phosphatized test panels with the required paint film thickness and subject three of these five panels to a salt spray test for the number of hours indicated in table II of this specification or in the contract. The following panels shall be forwarded to the procuring activity along with the written procedure used to process the panels: three salt spray test panels, two untested phosphatized panels with the accompanying test report of the three which indicated conformance to the thickness requirements, and two painted panels. Deviation from the approved process shall not be permitted without written authorization of the contracting officer for the concerned procuring agency. Approval of the process, materials, and equipment does not guarantee acceptance of the results obtained in production (see 6.5.1.1). Any unapproved change to a government approved procedure will invalidate the procedure.

### 3.3 Cleaning methods.

3.3.1 Removal of soils corrosion and weld bi-products. As a result of cleaning, the parts shall be thoroughly free of oil, grease, wax, dirt, scale, rust, and other foreign matter and shall not show visible signs of corrosion products when tested as in 4.2.3. All weld slag/flux residue shall be removed. Weld spatter shall be removed from all surfaces exposed to normal view in the end item configuration. The method or combination of methods used shall be selected to suit the properties of the metal and the degree of contamination present. Method I must be preceded by degreasing with Method II or III to assure a grease-free surface. Method VI is prohibited for use on steels of Rockwell C40 or greater hardness, unless test data can substantiate that the combined phosphoric acid cleaning and phosphate coating treatment is not too severe for the steels being treated or should indicate that an adequate hydrogen embrittlement relief bake has been performed. Phosphoric, sulfuric or hydrochloric acid pickling shall not be used unless specifically approved or authorized by the drawing or specification for the item being processed.

Pickling may not be approved for use on assemblies which may entrap acid, or when for any other reason acid pickling is considered inadvisable. If pickling chemicals are specified, the parts shall be thoroughly rinsed to ensure that residual acids are removed from the surface before subsequent processing (see 6.5).

3.3.2 Rinsing. Adequate rinsing shall be performed to remove any alkali or acid remaining from the cleaning operation. Special care shall be exercised in rinsing complex shapes. The water rinse, after the cleaning operation, shall be checked for contamination as measured by total alkali or total acid. The rinse shall be regulated so that the total alkali contamination does not exceed 0.5 ml plus any total alkalinity correction factor in the water, or the total acid contamination does not exceed 0.5 ml (see 4.2.4). Conductivity devices could be used to automatically regulate the flow of rinse water according to rate of production.

3.3.3 Drying. Thorough drying shall be the final stage of each cleaning process, except where the cleaning treatment is to be followed immediately by

a type I, type II, or type V chemical conversion process or chromic acid rinse. Care shall be exercised to ensure complete drying in crevices, seams, or other difficult to dry places, especially prior to painting.

#### 3.4 Processing requirements (Types I, II, IV, and V).

##### 3.4.1 Cleaning. Cleaning shall be in accordance with 3.3.1.

3.4.2 Rinse after cleaning. Rinsing after cleaning shall be in accordance with 3.3.2.

3.4.2.1 Stress relief, Cold worked after heat treatment. Parts cold worked after heat treatment, having a hardness of Rockwell C40 or greater shall be stress relieved prior to phosphating.

##### 3.4.3 Chemical conversion coating.

3.4.3.1 Type I, and Type V. The properly cleaned articles shall be subjected to a balanced aqueous solution containing phosphoric acid, zinc, and accelerating agents until a uniform, insoluble, phosphate coating is produced. Dated records should be maintained for the chemical analyses and additions made to the solutions.

3.4.3.1.1 For type I only. Unless otherwise specified, type I zinc phosphate processes shall incorporate a crystal modifier or grain refining accelerator in the phosphating solution, a separate grain refiner as a pretreatment or a grain refiner addition to the cleaner.

3.4.3.2 Type II. The properly cleaned articles shall be subjected to a balanced aqueous solution containing phosphoric acid or acid phosphate salts with or without the addition of accelerating agents until a uniform insoluble phosphate coating is produced.

3.4.3.3 Type IV. The properly cleaned articles shall be subjected to a balanced nonaqueous solution containing an approved solvent and phosphoric acid and shall be treated until a uniform phosphate coating is formed.

CAUTION: Nonaqueous solutions containing hazardous chemicals such as chlorinated hydrocarbons shall be avoided when possible due to their toxicity and are not advised for general use unless special equipment and trained operators are employed. If such chemicals are used, control exhaust and maintain adequate ventilation so that the concentration of chlorinated hydrocarbon in the air does not constitute a health hazard (see 6.3).

3.4.4 Rinse after phosphating (Types I, II, and V). Phosphating shall be followed by a clean water rinse, less than 100 deg. F or 38 deg. C, in order to remove residual salts and unreacted phosphating material.

##### 3.4.5 Final rinse.

3.4.5.1 Final rinse (type I, II, and V). The final rinse in types I, II and V processes shall be a chromic acid solution or mixture of phosphoric and chromic acids unless otherwise specified. Non-chromic acidified and non-

chromic alkaline rinses require the specific approval of the appropriate procuring agency. The material, temperature, concentration and other process controls including replenishment and discarding shall be stated in the procedure.

3.4.5.1.1 Non-chromic final rinses. Proprietary final acid/alkaline rinses which do not contain chromate are available and permissible for use over phosphate coatings provided they are specifically approved by the procuring agency. Phosphatized coatings must meet the requirements specified for paint adhesion and salt spray resistance or must meet those requirements specified for the designated coating system (see 6.9).

3.4.5.2 Type IV. The final rinse in a type IV process shall be that of the dip or spray condensate before the item leaves the vapor zone.

### 3.5 General requirements.

3.5.1 Appearance (Type I, II, IV, V). All coatings shall be continuous, uniform in texture, and evenly distributed.

3.5.1.1 Type I, zinc phosphate. Type I coating deposits shall be continuous, uniform in texture, evenly deposited, and gray to black in color. The coating shall not be mottled in appearance nor show any smut, powder, corrosion products, or white stains. Non-uniformity 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 inherent from the acidified final rinsing process shall not be cause for rejection.

3.5.2 Lighting conditions. A minimum light intensity of 50 lumens per square ft or 538 lux shall be provided at the working surface where manually controlled paint finish operations are performed. Minimum lighting applies to the manufacturing operations as well as in-process and final inspection areas (see 4.2.1.1).

3.5.3 Phosphate coating weight (Types I, II, IV and V). Coating weight shall be controlled or tested as in paragraph 4.2.6. Unless otherwise specified, the coating weight shall be tested at least every four hours of production (see 6.15). The following coating weights are applicable.

3.5.3.1 Type I zinc phosphate coatings. Type I covers zinc phosphate coatings. Type I coatings can be applied by spray, dip or immersion and permit a coating weight which ranges from a minimum of 150 mg/sq ft for spray applications and 300 mg/sq ft for immersion applications. A maximum coating weight of 500 mg/sq ft is specified for consistent, light coatings.

3.5.3.2 Type II aqueous iron phosphate coating. Type II has a minimum coating weight of 35 mg/sq ft.

3.5.3.3 Type IV nonaqueous iron phosphate coatings. Type IV non-aqueous iron phosphate requires a minimum coating weight of 35 mg/sq ft.

3.5.3.4 Type V zinc phosphate coatings. Type V zinc phosphate requires a coating weight between 500 - 1100 mg/sq ft inclusively.

3.5.4 Film thickness (type III only). The dry film thickness shall be 0.0003 to 0.0005 inch when tested as in 4.2.7.1.

3.5.5 Application of organic coating. The organic coating shall be applied to thoroughly dried surfaces within 24 hours after pretreatment. The dried surface shall not show any rusting or soiling prior to painting. The temperature of the metal surface shall be controlled to eliminate blistering, poor adhesion or unsightly film results.

3.5.6 Paint thickness. For all tests requiring painted test specimens, the paint dry film thickness (see 4.2.7) 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, the precedence shall be in the order cited.

3.5.7 Paint adhesion (all methods and types). The CARC or non-CARC (e.g., alkyd, enamels, lacquers, etc.) painted items or specimens shall show the following satisfactory paint adhesion when tested as in 4.2.7.2, and 4.2.7.3.

3.5.7.1 CARC painted items. Removal of two or more complete squares of top coat or top coat-primer-pretreatment coating from either test unit constitutes test failure.

3.5.7.2 Non-CARC painted items. Unsatisfactory adhesion shall be indicated by exposure of bare metal or underlying phosphate pretreatment by any of the following conditions:

- (a) Any area exceeding 1/8 inch average diameter.
- (b) More than one area exceeding 1/16 inch average diameter.
- (c) More than five areas less than 1/16 inch diameter.

3.5.8 Salt spray resistance (all types). After pretreatment and painting, the specimens subjected to the salt spray test as in 4.2.8 for the number of hours prescribed in the applicable drawing, end item specification, paint specification, or one of the organic coatings listed in table 1, paragraph 6.9, shall show no more than 1/8 inch creepage, blistering, or loss of adhesion of the paint from the scribe mark. At all other points there shall not be more than a trace of film failure (rust grade no. 9, ASTM D610), and not more than 5 scattered blisters none larger than 1 mm (3/64 inch) in diameter on a 4 by 6 inch test panel or equivalent area of test specimen or item. For items or specimens having an area less than 24 sq inches, a proportionately smaller number of failed areas will be permitted.

3.5.9 Relief of hydrogen embrittlement. Parts having a hardness of Rockwell C40 or greater shall be heat treated after phosphating for 8 hours at 210-225 deg. F (99-107 deg. C) or must be held for 240 hours at room temperature to relieve any embrittlement due to hydrogen.

3.5.10 Hydrogen embrittlement relief test. Adequate verification tests must be performed on all parts having a hardness of Rockwell C40 or greater. Treated parts shall not reveal any developing cracks upon subsequent inspection.

#### 4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of section 3. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

#### 4.2 Test methods.

4.2.1 Tests. Tests shall be conducted as required in this specification. The right is reserved to make any additional tests deemed necessary to determine that the process meets the requirements of this specification.

4.2.1.1 Lighting adequacy. Should adequate lighting appear suspect at the work/inspection surface, a light intensity meter shall be used to assure that 50 lumens per square ft or 538 lux minimum is provided.

4.2.2 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, heat treatment or any combination thereof. Standard panels (e.g. SAE 1010) may be used when authorized by the contracting officer. 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 x 5 x 1/32 inch in size. If standard panels are used in lieu of test specimens for ferrous surfaces, the steel shall conform to Cold Rolled Carbon Steel Strip, ASTM A109 or commercial quality Cold Rolled Carbon Steel Sheets, ASTM A366 having a Rockwell B hardness of 55 to 75, and a surface roughness of 30 to 45 microinches (arithmetic average) as rolled; for zinc coated surfaces, the panels shall be made of the same coated material as specified in the contract. When coated steels are used, the standard test panels shall be made of the same material as that specified in the contract. All test specimens of standard panels shall be processed through all the cleaning, phosphating, painting, and drying steps along with the items being processed. Test specimens shall not be reused.



4.2.3 Removal of soils, Corrosion, and weld by-products. Following the rinse prior to phosphating, at least two test specimens shall be subjected to a water break test at the conclusion of a maximum of each 4 hours of production, dried and examined visually for rust, corrosion products, and soils. If the surface shows signs of soils or corrosion products, all items processed since last acceptance shall be rejected and corrective action taken. After corrective action, testing shall be continued at least once every hour until indications of soils or corrosion products are eliminated. Testing frequency shall then revert to two test specimens at the conclusion of a maximum of each 4 hours of production.

4.2.3.1 Water break test. The water break test shall be conducted in accordance with MIL-C-53072.

4.2.4 Rinsing. The water rinses after the cleaning and phosphate operation shall be tested for contamination every 4 hours of production (see 3.3.2).

4.2.4.1 Total alkali contamination test. Take a 10 ml sample of the rinse solution, dilute to 50 ml with distilled water and add 5 drops of Bromcresol Green Indicator. Slowly add testing solution (N/10 HCl) from a burette until the color of sample changes from blue-green to pale yellow. This is the endpoint and the number of ml of acid testing solution used is the total alkali contamination.

4.2.4.2 Total acid contamination test. Take a 10 ml sample of the rinse solution, dilute to 50 ml with distilled water and add 5 drops of phenolphthalein indicator. Slowly add alkaline testing solution (N/10 NaOH) from burette until the first permanent pink color is produced. This is the endpoint and the number of ml of alkaline testing solution used is the total acid contamination.

4.2.5 Final rinse. The final rinse shall be tested, replenished and discarded in accordance with procedures designated by the suppliers of the final rinse chemicals; these quality assurance provisions shall be documented in the approved procedure. Solution analysis shall be performed every four hours of production.

4.2.6 Phosphating process controls. All process control tests shall be conducted at a frequency of every four (4) hours of production.

4.2.6.1 Phosphate coating weight (types I, II, IV, and V). Three test specimens (see 4.2.2), at the conclusion of a maximum of each 4 hours of phosphate processing shall be selected by the inspector for the test. The clean, dry specimens shall be accurately weighed and the surface area of each calculated. The phosphate coatings shall be completely removed by immersion in a 5 percent (by weight) chromic acid solution at 165 +/- 10 deg. F (740 +/- 5 deg. C) for 15 minutes, rinsed, dried and weighed. A new chromic acid solution shall be used for each repeat immersion. This process shall be continued until constant weight is attained. The coating weight shall be determined from the formula:

$$\text{Coating wt} = \frac{(\text{Initial wt in gms} - \text{Final wt in gms}) (144,000 \text{ inch}^2 \text{ mg/g ft}^2)}{(\text{mg/ft}^2) \quad \text{Total surface area in square inches}}$$

where the initial weight in grams represents the weight of the phosphate coated specimen  
and

where the final weight in grams is the weight of the stripped specimen

$$\text{Coating wt} = \frac{(\text{Initial weight in mgs} - \text{Final weight in mgs})}{(\text{mg/m}^2) \quad \text{Total surface area in square meters}}$$

Four hours production shall be considered acceptable provided that the average coating weight of the 3 specimens equals or exceeds the minimum coating weight required for the applicable type and not more than one sample falls below the minimum. The sample falling below the minimum shall be within 10 percent of the minimum requirement. The production lot represented by the failed test shall be reworked and corrective action taken until production is again acceptable. When determining the surface area of irregularly shaped objects, consideration and care should be taken to correctly determine the surface area of both the inner and outer surfaces of the test piece (see 6.15).

4.2.6.2 Phosphate coating weight for zinc and zinc alloy coated steels (type I and V). At the conclusion of a maximum of each four hours of phosphate processing, three specimens (see 4.2.2) shall be selected by the inspector for testing. The clean, dry specimens shall be weighed to the nearest milligram and the surface area of each calculated. The phosphate coating shall be completely removed by immersion in ammonium dichromate stripping solution for 5 minutes at approximately 70 deg. F (21 deg. C). The solution can be formulated by adding 40 gram of ammonium dichromate to 4 lbs (2.5 liter) of ammonium hydroxide. Adequate ventilation is required when using these chemicals. Upon removal from the stripping solution, use a white plastic policeman to gently scrape the surfaces to remove any residual coating and rinse the samples in water. Dry the test specimens and reweigh to the nearest milligram. Repeat this process until a constant weight is obtained. Coating weight shall be calculated from the formula in 4.2.6.1. Acceptance criteria are the same as those specified in 4.2.6.1.

4.2.6.3 Phosphate coating process controls. A free acid, total acid and accelerator titration as specified or recommended by the supplier's maintenance procedure for control.

4.2.7 Organic coating controls. Organic coatings must be applied in accordance with applicable coating application, system, or item specification.

4.2.7.1 Thickness of coatings. All applicable surfaces shall be coated and the basis for acceptance (the number of specimens tested) shall be as specified in the contract. All coatings, inorganic and organic shall be checked for dry film thickness, as required by the applicable specification or drawing. Film thickness gages shall be used for determining organic coating thickness (see 6.10) after the gage has been standardized on the same surface as that over which the organic finish has been applied.

4.2.7.2 Paint adhesion - CARC. After the complete paint finish has been applied and cured, two samples from each lot shall be selected for paint adhesion. Each sample shall be tested at two locations by scribing four one

inch lines completely through the paint finish to the substrate, one sixteenth to three thirty-second of an inch apart. Scribe four additional one inch lines, completely through the paint finish, one sixteenth to three thirty-second of an inch apart, rotated 90 degrees with respect to the first set of lines. The resulting pattern shall contain nine squares. Press a length of A-A-1830, A-A-884, or any commercially available tape with a minimum adhesion rating of 45 oz per inch of width firmly over the scribed pattern, rubbing out all air pockets. Wait ten seconds minimum and pull the tape from the paint surface. Nonconformance to 3.5.7.1 shall constitute failure of this test, and the production lot from which it comes is rejected.

4.2.7.3 Paint adhesion - non-CARC. Unless otherwise specified, a minimum of two test specimens (see 4.2.2) from each day's production shall be run through all steps of the regular production process including painting. Adhesion on the painted test specimens should generally be determined within 1 to 24 hours drying time for single coat applications. A two coat paint system should be tested after drying in accordance to the applicable paint specification. For example, a two coat alkyd system should not be tested until a minimum of 72 hours drying time while an epoxy-polyurethane system will require 168 hours before testing. Press a 2 inch length of a somewhat longer piece of pressure-sensitive adhesive tape (3/4 inch width) conforming to commercial item description A-A-1830, 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 item by pulling the tape back upon itself at 180 degrees (in such a manner that the tape is folded back to back during the procedure). Observe for bared areas where the paint is removed. Disregard flecks of paint on tape where the underlying metal or phosphate coating is not visibly exposed. Nonconformance to 3.5.7.2 shall constitute failure of this test, and all items processed since last acceptance shall be rejected and corrective action shall be taken.

4.2.8 Salt spray resistance. Prior to initiation of production, or whenever a change in production or paint occurs, or when required by the procuring activity, a minimum of three test specimens (see 4.2.2), shall be run through all steps of the regular production process including painting. The specimens shall be cured for the time and temperature used in production. The painted specimens shall be scored in accordance with ASTM D1654. In instances where more than one metal is used, each metal shall be scored. The specimens shall then be exposed to the 5 percent salt spray specified in ASTM B117 for the number of hours specified in the end item, drawing, or paint specification in the order cited.[1] For the purpose of this test the significant surface on cylindrical items shall be an area 600 on either side of a scribe mark. Production shall not be initiated until results of the salt spray test are received, except at the contractor's risk.

During production, one specimen (see 4.2.2) from each day's production shall be subjected to the salt spray test specified above, until five consecutive days' production have successfully passed the test. Sampling may then be reduced to one sample twice per week. If failure occurs, all items processed since last acceptance shall be rejected and corrective action taken. Sampling shall revert to one specimen from each day's production until five consecutive days' production have again successfully passed the test.

[1] Subject to approval of the procuring activity, an alternate method using one of the organic coatings listed in table II, paragraph 6.9 may be used.

4.2.9 Hydrogen embrittlement relief test. Unless otherwise specified, the test for the test for the effectiveness of the procedures used to control embrittlement lies in the subsequent service use of the material but is generally performed at a frequency of every 90 to 120 days.

## 5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery is not applicable to this specification.

## 6. NOTES

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

6.1 Cleaning methods. The cleaning methods and chemical conversion coatings covered in this specification are suitable for use as rust removers and preventatives for ferrous parts and as metal conditioners for ferrous metals prior to application of paints.

6.1.1 Ferrous surfaces. Cleaning methods are intended primarily for ferrous metal cleaning, rust removing, descaling, or surface etching purposes in conjunction with chemical pretreatment processes. Method I (abrasive blasting) is generally recommended to remove heavy rust and mill scale on metals with thicknesses greater than 1/8 inch and, when specified, may be coated without being given a conversion coating. Method VI (phosphoric acid) may be used to remove light to moderate rusting but is not considered an acceptable substitute for a chemical pretreatment process. The selection of the cleaning process is dependent on the type and amount of soil and corrosion products on the items.

6.1.2 Nonferrous surfaces. Certain cleaning processes in this specification may also be used on nonferrous surfaces, for example: mechanical cleaning, solvent cleaning, vapor degreasing, and emulsion cleaning. Care should be exercised to ensure that cleaning materials do not have detrimental affects on the items being claimed. In addition, this specification covers ferrous metal items containing small areas of zinc or aluminum surfaces or accessory fabricated parts of zinc or aluminum requiring treatment.

## 6.2 Chemical conversion and pretreatment coatings.

6.2.1 Type I. Type I process is intended primarily for use as a general all purpose pretreatment prior to painting on tanks, trucks, sedans, ammunition and other items, as specified and is generally recommended where extreme climatic exposure is anticipated. Type I is the preferred pretreatment for zinc plated (ferrous substrate) parts, prior to paint application.

6.2.2 Type II and IV. Types II and IV processes are intended primarily for use where metal parts are to be formed (assembled) after painting and for other end items as specified.

6.2.3 Type III. Type III is intended for use where size and shape preclude the use of types I, II, IV, or V, and where items containing mixed metal components are assembled prior to treatment.

6.2.4 Type V. Type V is typically used for non-painted applications.

6.3 Safety precautions. All safety requirements stated herein apply in addition to any applicable federal, state, and local rules or requirements. Chemical suppliers or manufacturers instructions and insurance underwriters instructions shall be followed to insure safe handling practices and appropriate regulations governing chemicals (see paragraph 3.4.3.3).

6.4 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

- (a) Specification identification includes: title, revision letter, and date of specification and existing amendment. Type of coating and applicable classification must also be specified.
- (b) Method and type required (see 1.2).
- (c) Approval (see 3.2).
- (d) Process (see 3.2).
- (e) Sampling and inspection (see 4.1).
- (f) Hydrogen embrittlement relief test (see 3.5.9, 4.2.9)

6.5 Preproduction approval (type I and V).

6.5.1 Army. Coatings prepared for subsequent paint application or other applications require detailed information of the proposed procedure, chemicals and equipment to be used as well as 10 preproduction phosphatized test panels (see 3.2). Preproduction submittal and approval shall be as specified by the contracting officer.

6.5.1.1 Army preproduction procedure approval for type I or V coatings. Coating procedures used in the application of type I or V zinc phosphate coatings must be approved prior to commencement of production. Prospective contractors are requested to furnish detailed coating procedures along with the preproduction test panels processed therewith (see 3.2).

6.5.2 Activities other than Army. Preproduction approval will not be required for proposed processes for applying crystalline phosphate base coatings under type I treatments on ferrous surfaces that correspond to the procedure outlined and described in 6.5.3. Unless otherwise specified, procedures, chemicals and equipment for type I treatments which do not correspond to the procedures in 6.5.3 will require preproduction approval of the procuring agency.

6.5.3 Procedure (method of application of phosphate coating, applicable to type I and type V). The phosphate coating shall be applied in 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 one of the methods of 1.2.1 or a combination thereof.

Stage 2, rinse. A clean hot water rinse 125 deg. - 180 deg. F (52 deg. C 82 deg. C) with a constant overflow maintained by the continuous addition of fresh water entering from the bottom and/or by spraying fresh water on the parts leaving the rinse.

NOTE. This stage is not necessary when cleaning method I (abrasive blasting) and/or II (solvent) is used.

Stage 3, phosphating. The properly cleaned articles or items should be subjected to the phosphating solution (see 3.4.3.1) for at least the time required to secure the designated coating weight suggested for type I spray or dip processes in accordance with the supplier's recommendation.

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

The phosphating bath should be operated at temperatures and concentrations 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 is maintained by the continuous addition of fresh water entering from the bottom.

Stage 5, acidified rinse. A final chromic, chromic-phosphoric or other acidified rinse should be prepared and maintained in accordance with the suppliers' recommendations (see 3.4.5.1). Such treatment is beneficial to the removal of unreacted chemical residues and provides a protective coating or seal which improves corrosion resistance. Care should be taken to maintain rinse strengths which will not stain or hinder the coating.

Follow manufacturer's suggestions for acidified rinse. Experiment with conditions (time, temperature, and agitation) required for optimum seal.

Non-chromic final rinses may not perform satisfactorily and may require testing data to show that adequate performance requirements can be met.

Improper rinsing techniques have a detrimental affect on items requiring subsequent paint. Although the harmful effect an the paint coating may not be apparent immediately, it can result in early failure of the paint by blistering or flaking from a scratch and the rapid spread of corrosion products.

After treatment, the phosphated parts shall not be handled with bare hands, oily or contaminated gloves.

Organic-finishing of prepared surfaces should not be delayed as contamination from ambient sources may occur causing a reduction in adhesion of the organic coating. Specification requires application of coating within 24 hours of pretreatment.

6.6 Type II. The properly cleaned articles or items should be treated (see 3.4.3.2) until a phosphate coating is produced which is insoluble in water and has a color varying from golden yellow to purple. The article or

items should be exposed to the phosphating solution in a spray process for at least one minute or 3 minutes in an immersion process.

6.7 Type III. Correct film thickness is important for MIL-C-8514, and DOD-P-15328 pretreatment coatings. Small steel panels prepared with films, too thick, too thin, and correct, may serve as visual color guides for wash primer pretreatment.

6.8 Type IV. The properly cleaned articles should be treated (3.4.3.3) in a nonaqueous bath containing phosphoric acid by immersion or spray method of application for at least one minute. The articles shall be distillate rinsed while still resident in the vapor zone and will be dry and ready to paint on cooling.

#### 6.9 Primer information.

6.9.1 Non-CARC primers. For illustrative purposes only, table I contains examples of test requirements for specific paints, when applied over pretreatment coatings.

TABLE I. Paint information for non-CARC coatings.

Test	TT-E-516	TT-P-664
Dry film thickness, mils	0.9 - 1.1	0.9 - 1.1
Salt spray - dry at 12 deg. F (49 deg. C)	24 Hours	24 hours
Exposure time, hours	48	192
Adhesion - air drying time hours	1	1

6.9.2 Inspection and acceptance of paint. Inspection and acceptance criteria are as indicated in MIL-C-53072.

TABLE II. Paint information for CARC coatings.

Test	MIL-P-53022	MIL-P-53030	MIL-P-53084
Dry film thickness, mils	I: 0.9 - 1.1 II: 1.0 - 1.5	1.0 - 1.5	0.9 - 1.1
Cure (Dry) conditions (Recommended)	air dry: 4 hr Type I 6 hr Type II	air dry for 168 hr	20 min @ metal temp of 350 deg. F (177 deg. C), air cool to rm temp of 66-79 deg. F (19-26 deg. C)
Salt Spray Exposure, hours	336	336	1000

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

Elcometer - Distributed by - Gardner Laboratory, Inc., Bethesda, Maryland

Erichsen Paint Inspection Gage - Erichsen Instruments, Inc., Akron, Ohio

"G.E." gage - General Electric Company, Schenectady, New York

Lea gage - Lea Manufacturing Company, Waterbury, Connecticut

Positector 2000 - KTA-TATOR, Inc., Pittsburgh, Pennsylvania

6.11 Appearance. After application of chemical conversion coating or use of one of the cleaning methods, changes in appearance are to be expected. Types I, II, IV, and V phosphate coatings leave a chemical deposit. Cleaning methods leave the metal surface substantially bare. Alcoholic phosphoric acid and phosphoric acid containing a solvent and detergent (method VI) discolor the surface. Hot phosphoric acid with a detergent (method VI) etches the surface.

Table III lists examples of specification materials which may be used for cleaning purposes.

TABLE III. Specification material applicable to each method.

Cleaning method	Specification
Method I	---
Method II	0-T-236
	0-T-634
	P-D-680
	TT-T-291
	MIL-C-15074
	MIL-D-26847
	MIL-T-81533
Method III	P-C-436
	P-C-437
	P-C-535
Method IV	MIL-C-11090
	MIL-C-43616
Method V	MIL-C-14460
Method VI	MIL-C-10578

6.12 Temperature of basis metal. In general, metal temperatures should be lower than 130 deg. F (54 deg. C) for cellulose lacquers and 160 deg. F (71 deg. C) for enamels unless the coating material has been specially formulated for the purpose. Temperatures from 60 deg. F - 120 deg. F (16 - 49 deg. C) are the most satisfactory (see 3.5.5). The temperature of the surface must not exceed 225 deg. F (107 deg. C) prior to painting, because heating above this temperature tends to dehydrate the phosphate crystal and deteriorates the basis coating.



6.13 Pretreatment. Application of organic coatings over bare untreated ferrous surfaces is not a recommended practice. Organic coating should be applied to surfaces prepared with a conversion coating or pretreatment.

6.14 Phosphate coating weights. The Environmental Protection Agency (EPA) regulations are imposed by both Federal and State agencies which place a financial burden on the contractor. Therefore, accurate alternative stripping methods may be substituted for the chromic acid stripping solution described in paragraph 4.2.6.1 provided the same accuracy can be maintained.

6.14.1 Scanning electronic microscope. The scanning electronic microscope (SEM) is often used to study the morphology of zinc phosphate crystals. It can be used to assure proper coverage on production parts and is useful for preproduction approval.

6.14.2 Coating weight conversions. Coating weights are given in mg/sq ft throughout this specification. However, because there may be a need to express the coating weight in mg/sq m, the following conversion factor is noted for informational purposes:

$$\text{mg/m}^2 = (\text{mg/ft}^2) (10.764 \text{ ft}^2/\text{m}^2)$$

6.15 Coating weight test results. Quality assurance inspection tests performed in accordance with paragraphs 4.2.6.1 and 4.2.6.2 are mandated to ensure timeliness and availability of the coating weights obtained. Coating weight verification tests must be performed within one hour of sample preparation to assure that process controls are effective and that out-of-tolerance conditions are rapidly corrected. Records must be maintained at the phosphate application site and upon request of the acquisition activity, such records including reports of the test results must be made available (see 3.5.3 and 4.2.6.1).

6.16 Problem alloys. Alloys such as AISI 4340 or SAE 4340 may be difficult to process. It is important that the contractor consult with the supplier of the processing chemicals used in production and work out a procedure which will achieve the desired phosphatized coating with respect to coverage and coating weight.

6.16.1 Type I, spray systems. Stopping of the conveyor line while parts are being processed is unacceptable. Parts must be reworked should they fail to meet visual acceptance criteria.

Custodians:

Army - MR  
Navy - YD  
Air Force - 11

Preparing activity:

Army - MR

Civil Agency Interest:

GSA

Review activities:

Army - MI, ER, AV, EA, AR, AL, AT, ME, SM  
Navy - AS  
Air Force - 80

Project No. MFFP-0471

User activities:

Navy - MC, OS, SH  
Air Force - 80

Civil agency coordinating activity:

GSA-FSS

(WP# ID-2839A/DISC-0094A. FOR ARL/MD USE ONLY)