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Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting[1]

This standard is issued under the fixed designation D1730; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These practices cover four types of treatment for preparation of aluminum and aluminum-alloy surfaces for painting, as follows:

1.1.1 Type A—Solvent Cleaning.

1.1.2 Type B—Chemical Treatments.

1.1.3 Type C—Anodic Treatments.

1.1.4 Type D—Mechanical Treatments. These four types cover a number of procedures, as described herein.

1.2 Variations in surface treatment produce end conditions which differ, and which do not necessarily yield identical results when paints are applied. Service conditions will dictate the type of surface preparation that should be selected, although the quality produced by any individual method may vary with different alloys.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products

2.2 *Military Standards:*[3]

MIL-A-8625 Anodic Coatings for Aluminum and Aluminum Alloys

MIL-DTL-5541 Chemical Conversion Coatings on Aluminum and Aluminum Alloys

MIL-M-10578B Metal Conditioner and Rust Remover (Phosphoric Acid Type)

MIL-P-15328bB Coating Compound – Metal Pretreatment Resin Resistant

2.3 *Federal Specification:*[3]

TT-C-490 Chemical Conversion Coatings and Pretreatments for Ferrous Surfaces (Base for Organic Coatings)

3. Type A—Solvent Cleaning

3.1 Solvent cleaning does not disturb the natural oxide film on the metal and may prove adequate for some applications, such as ambient indoor or very mild service conditions. Three methods may be employed, as follows:

3.1.1 *Method 1, Manual Swabbing or Dip-Washing,* with a solvent such as mineral spirits or high-flask solvent naphtha. With this method it is extremely difficult to prevent accumulation of contaminants on the swab or in the solvent. This method is only recommended when other treatments are impractical.

3.1.2 *Method 2, Solvent Spray Cleaning* , in accordance with Method A, Procedure 1 of Practice D609.

3.1.3 *Method 3, Vapor Degreasing* , in special equipment employing trichloroethylene vapor, in accordance with Method A, Procedure 2 of Practice D609.

4. Type B—Chemical Treatments

NOTE 1—Materials and procedures employed in these methods of treatment are available from a number of sources as proprietary compounds or methods. Selection may be made from available sources. The hexavalent chromium methods given are not recommended as hexavalent chromium is a known carcinogen.

4.1 *Method 1, Alkaline Cleaners*—Alkaline solutions, such as caustic soda, etch the metal, thus destroying the natural oxide film. They are followed by an acid treatment, preferably nitric acid or phosphoric acid. They shall not be used on assembled structures. Inhibited alkaline cleaners are sometimes employed as a pretreatment to remove grease and oil prior to an acid treatment. Inhibited alkaline cleaners do not etch the

[1] These practices are under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of B08.07Conversion Coatings on Chromate Conversion Coatings.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098

surface. They are not generally recommended unless followed by a conversion treatment, such as described in Methods 4, 5, 6, or 7.

4.2 *Method 2, Sulfuric Acid, Chromium Trioxide Etch*—This treatment provides a clean and uniform surface without undue etching, and is effective for removing oil and water stains and any film formed during heat-treatment. The etching solution is prepared by adding 1 gal (3.78 L) of concentrated sulfuric acid and 45 oz (1.28 kg) of chromium trioxide to 9 gal (34 L) of water. It is used at a temperature of 160 to 180°F (71 to 82°C) (depending on the alloy and the amount of film) for about 5 min and is followed by a water rinse. This treatment produces a passive surface suitable for painting under mild to intermediate exposure conditions and where clear finishes are to be applied.

4.3 *Method 3, Alcoholic Phosphoric Acid Cleaner*—This treatment involves the use of an aqueous solution of phosphoric acid (10 to 15 volume %) with alcohol or other organic solvents, together with wetting agents, emulsifying agents, etc. The solution may be applied by swabbing or dipping at room temperature (70 to 90°F (21 to 32°C)), and should be allowed to remain on the surface for several minutes, followed by thorough rinsing with clean water. A very thin phosphate film is formed which tends to protect the metal and promote paint adhesion under mild to intermediate exposure conditions.

NOTE 2—U.S. Military Specification MIL-M-10578B describes a treatment of this type.

4.4 *Method 4, Crystalline Phosphate Treatment*—This surface-coating method consists in reacting the aluminum surface in a zinc-acid-phosphate solution containing oxidizing agents and other salts for accelerating the coating action. The aluminum surface is converted to a finely crystalline, phosphate coating of the proper texture adapted to inhibit corrosion and increase the adherence and durability of any applied paint film. It is recommended for product finishes. The phosphate coating process may be carried out by immersion or spray application. The aluminum surface is converted to the phosphate coating by immersion in the processing solution for 30 s to 4 min at 125 to 140°F (51 to 60°C), or by spraying the solution for 10 s to 2 min at 125 to 160°F (51 to 71°C).

NOTE 3—Before applying the treatments according to Methods 4, 5, 6, and 7 of Type B, the aluminum surfaces should be freed of grease, oil, or other foreign material by means of the procedure described in Method 3 of Type A, Method 1 of Type B, or any other suitable method.

NOTE 4—This treatment complies with the requirements of U.S. Federal Specification TT-C-490.

4.5 *Method 5, Amorphous Phosphate Treatment*—This process comprises treatment of clean aluminum surfaces in a warm (95 to 130°F (35 to 54°C)) aqueous solution comprising phosphoric, and hydrofluoric acids, chromium trioxide or a solution thereof. The aluminum surface is converted to a thin, adherent, amorphous coating, iridescent green to gray-green in color, depending upon the aluminum alloy treated, which inhibits corrosion and increases the adherence and durability of applied paint films. This method is recommended for use under the more severe conditions of service, and for product finishes. The coating process may be carried out by immersion or spray application. The time of treatment will vary from 15 to 45 s for the spray process, and from 30 s to 3 min for the immersion application (see Note 3 and Note 5).

NOTE 5—Most of the treatments conforming to Methods 5, 6, and 7 of Type B comply with the requirements of U. S. Military Specification MIL-DTL-5541.

4.6 *Method 6, Carbonate Chromate Treatment*—This process comprises treatment in a hot (180 to 190°F (82 to 88°C)) dilute solution of sodium carbonate and potassium chromate for periods from 2 to 20 min, followed by a water rinse. The surface is then given a final treatment in hot 5% potassium dichromate solution, followed by a final rinse. The treatment produces a thin, adherent, conversion coating on the surface, increasing the corrosion resistance of the metal and promoting paint adhesion. This method is recommended for use under the more severe conditions of service and for product finishes (see Note 3 and Note 5).

4.7 *Method 7, Amorphous Chromate Treatment*—This process comprises treatment of clean aluminum surfaces in aqueous chromium trioxide solutions containing suitable accelerating agents such as fluoride-containing materials. The aluminum surface is converted to an adherent, amorphous, mixed metallic oxide coating, irridescent golden to light-brown in color, which increases the corrosion-resistance and the adherence and durability of any applied paint film. This method is recommended for use under the more severe conditions of service and for product finishes. The coating process may be carried out by immersion, spray, or brush application, at room temperature (70 to 90°F (21 to 32°C)), in from 15 s to 5 min contact time (see Note 3 and Note 5).

4.8 *Method 8, Acid-Bound Resinous Treatment* (see Note 6)—This surface treatment involves the use of a suitably applied acid-bound resinous film of approximately 0.3 to 0.5 mils (7.6 to 12.7 µm) thickness. The treatment is based on three primary components: a hydroxyl-containing resin; a pigment capable of reacting with the resin and an acid; and an acid capable of insolubilizing the resin by reacting with the resin, the pigment, and the metal substrate. The aluminum surface should be prepared by Methods 1, 2, or 3 of Type A (see Section 3) or chemical treatments, Type B, 4.1 or 4.2 prior to the application of this treatment. The film may be applied by brush, spray, or dip. Under normal conditions it should dry sufficiently for recoating within 30 min; and within 8 h it should not be softened by organic solvents commonly used in paint coatings. The film has good adhesion to the metal substrate and promotes good adhesion of most subsequent organic coatings to itself. This method is recommended for severe service conditions, particularly on fabricated structures, either in the shop or in the field.

NOTE 6—Materials meeting the requirements of U.S. Military Specification MIL-P-15328b may be used to apply Method 8 of Type B.

5. Type C—Anodic Treatments (see Note 7)

5.1 Anodic treatment in either sulfuric acid or chromium trioxide electrolyte will provide a protective and inert oxide coating which increases the corrosion-resistance of the metal and promotes paint adhesion. It is recommended where maximum corrosion-resistance by the treatment itself is desired.

Anodic treatments should not be used on assemblies of dissimilar metals. The two procedures are as follows:

NOTE 7—Treatments conforming to Methods 1 and 2 of Type C comply with the requirements of U.S. Military Specification MIL-A-8625.

5.2 *Method 1, Sulfuric Acid Anodic*— This treatment consists in making the part the anode in a 15% sulfuric acid electrolyte (by weight) and applying current at a potential of about 16 to 18 V and a current density of 12 A/ft^2 until desired thickness of coating is obtained. After rinsing in cold water, the coating is sealed for 10 min by treatment in a boiling solution of 5% potassium dichromate. This method is not recommended where danger of acid entrapment is encountered.

5.3 *Method 2, Chromium Trioxide Anodic*— This treatment consists in making the part the anode in a 10 weight % chromium trioxide electrolyte at a temperature of 100°F (38°C) and applying a potential of 40 V for a period of 30 to 60 min. After first rinsing in cold water, the coating is finally rinsed in water at 150°F (66°C) minimum, and dried; an optional final sealing treatment to obtain maximum protection is obtained by immersion in a solution containing 0.01 g chromium trioxide per litre of water (0.0013 or 1 gal) at a temperature of 208 to 212°F (98 to 100°C) for 5 min.

6. Type D—Mechanical Treatments

6.1 *Method 1, Hand or Power Wire-Brushing* , or other abrasive treatment. Wire-brushing, either by hand or power, roughens the surface of the metal and mechanically improves the anchorage for superimposed paint films. The disadvantages are that the natural oxide film on the metal is disrupted and oil or grease films and other foreign matter are not completely removed.

6.2 *Method 2, Sandblasting,* where employed on aluminum or its alloys, must be carried out at relatively low pressures and with a fine silica sand. It roughens the surface and mechanically improves the anchorage for paint films, but destroys the natural oxide film on the metal. Where used, it should be followed by an inhibitive chemical treatment.

7. Keywords

7.1 aluminum; pretreatment for painting; surface treatment