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Surface Preparation and Priming of Aluminum Alloy Parts for High Durability Structural Adhesive Bonding Hand Applied Phosphoric Acid Anodizing

RATIONALE

As part of the five year review process, this document was determined to be noncurrent.

NONCURRENT NOTICE

This document has been declared "NONCURRENT" by the Aerospace Materials Division, SAE, as of March 2007. It is recommended, therefore, that this specification not be specified for new designs.

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1. SCOPE:

1.1 This document describes a hand-applied, nontank, phosphoric acid anodizing process for surface preparation of aluminum alloys required to achieve optimum bondline durability for structural adhesive bonding.

1.2 This surface preparation system is designed to be used where a metal bond repair is required on a component or assembly that cannot be immersed in a tank.

1.3 This surface preparation system has been validated for use with 180°F (82°C) and 250°F (121°C) service, elastomer-modified, epoxy adhesive, and corrosion-inhibiting primer.

1.4 The process described herein is the result of extensive evaluation of structural and durability performance and detailed analysis of the individual bonding surfaces.

1.5 While the process described herein was originally developed for use in the adhesive-bonding of parts, components, or assemblies for aircraft, it is applicable to nonaircraft bonding operations as well. The procedure is normally used in repair operations.

1.6 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. DESCRIPTION OF THE PROCESS:

2.1 The surface preparation is the most critical step in the adhesive bonding process. The method and adequacy of the preparation of the adherend surfaces will determine the success or failure of the bond. In many cases, it will be necessary to use a nontank or hand procedure for repair on components that cannot be immersed in a tank or where surface preparation tanks are not available.

2.2 This document outlines the recommended procedures, including hand solvent cleaning, surface abrasion, nontank phosphoric acid anodizing, and application and cure of the corrosion-inhibiting adhesive primer. Application of the applicable adhesive and mating the component parts involves individual part geometry and complexity, and must be covered by a procedure prepared for each specific assembly or part.

2.3 To achieve the high reliability and durability required, special processing techniques must be followed as outlined in the primary steps shown below:

Solvent wipe of surfaces
Surface abrasion
Application of gelled phosphoric acid, gauze, and screen
Anodizing
Screen and gauze removal
Rinsing
Drying
Color check of surfaces
Primer application
Primer drying and curing
Adhesive application
Component parts assembly
Curing of structural assembly

3. HANDLING OF PARTS:

3.1 The utmost care shall be taken that the surfaces to be bonded are not touched at any time during the entire process. The surfaces and the phosphoric acid anodic coating are extremely susceptible to contamination and physical damage prior to the application and cure of the primer.

3.2 If the anodized surface becomes contaminated, or has areas that indicate no anodic film, corrective action shall be accomplished by reprocessing, beginning with surface abrasion.

3.3 Parts or surface areas of assemblies that have been anodized, primed, and cured should be adhesively bonded within 8 h of primer application (see 6.5.3). If this is not possible, parts may be stored in a protected, noncontaminating atmosphere for up to 96 h.

CAUTION: Do not touch the dried anodized surface. Do not apply tape to the surface

4. REPAIR ENVIRONMENT:

4.1 The work area where surface cleaning of parts is performed shall be isolated from operations that generate dust, oil vapors, or other contaminants. Similarly, smoking or eating in the controlled area shall be prohibited.

4.2 All personnel handling cleaned parts shall wear clean, white, lint-free gloves. Surfaces to be bonded shall not be touched by hands, gloves, or protective covering during handling.

4.3 Immediately after cleaning, parts shall be moved into a controlled atmosphere area for bond assembly.

4.4 If the cleaning and controlled bonding area are not in close proximity, the cleaned parts shall be sealed in a noncontaminating wrapping for transfer to the controlled atmosphere bonding area.

4.5 Where practical, it is recommended that individual parts be removed from the overall assembly aircraft for repair in the shop.

4.6 In cases where it becomes necessary to make in-site repairs on the aircraft, special care shall be taken to prevent the cleaning solutions from contacting surrounding surfaces or from entering crevices. Surfaces of high-strength steels and honeycomb core are of special concern in this regard.

4.7 Bonding of the part should be completed as soon as possible after cleaning, to minimize subsequent contamination.

5. SAFETY PRECAUTIONS:

5.1 The following safety precautions should be strictly observed while making repairs to or removing moisture from aircraft parts.

5.1.1 If the repair is to be made while the component is on the aircraft, the aircraft and repair cart, if used, shall be statically grounded. Only approved explosion-proof electrical equipment shall be used. Electrical equipment shall be grounded while in operation.

5.1.2 The fuel tank of the aircraft must be purged and checked continuously to prevent formation of a potentially explosive mixture. The repair area shall be kept well ventilated. Fire-fighting equipment shall be available during the repair operation.

5.1.3 CAUTION:

When preparing processing chemical solutions, always add acid to water. Never add water to acid. Whenever acid is being added to water, the solution should be continuously agitated or stirred. The solution must not come in contact with skin or clothing. In case of contact with skin or clothing, immediately wash the affected area with generous amounts of cold water. Always wear eye protection and rubber gloves when using these solutions.

6. SURFACE PREPARATION PROCEDURE:

6.1 All fabrication processes, inspection, prefits, and adjustments for individually identified assemblies should be completed before the start of the surface preparation cycle.

6.2 The preparation procedure shown in synopsis in 2.3 should be performed in a continuous operation as detailed in the following paragraphs:

NOTE: Prior to the start of processing, be sure undamaged areas, crevices, and fasteners are protected from acid contamination by masking off these areas with suitable tape and plastic film. Protect working bench tops and surrounding areas by placing plastic film (e.g., PETP) between the part and the bench top.

6.2.1 Precleaning:

6.2.1.1 Solvent wipe the surfaces surrounding the repair area to remove soil, such as oil, dirt, and grease.

6.2.1.2 Remove organic finish from affected surfaces with solvents, mechanical abrasion, or approved stripper. Prevent strippers from entering existing bondlines, as strippers may have deleterious effects on the bond. If tightly adhered old adhesive is exposed on an inner surface, it can be allowed to remain by smoothing to remove rough spots (do not expose bare metal) and used as a base for new adhesive bond.

6.2.2 Phosphoric Acid Nontank Application:

6.2.2.1 Solvent wipe the surfaces to be anodized using methyl ethyl ketone (MEK), 1,1,1 trichloroethane (MIL-T-81533), or equivalent.

CAUTION: Methyl ethyl ketone is flammable. Do not use near an open flame.

6.2.2.2 Abrade the surface with nonwoven abrasive, such as nylon abrasive pads or equivalent.

6.2.2.3 Dry wipe with clean gauze to remove dust and debris.

6.2.2.4 Apply a uniform coat of the gelled phosphoric acid to the aluminum surface using a glue brush.

NOTE: Proprietary gelled phosphoric acid electrolytes are commercially available. Alternatively, a satisfactory gelled phosphoric acid electrolyte can be prepared by thickening a 10 to 12% by weight solution of phosphoric acid with colloidal silica, to form a paste. Details for preparing the 10 to 12% by weight phosphoric acid solution are given in 8.1. Details for thickening the 10 to 12% phosphoric acid solution to a gelled paste are given in 8.2.

6.2.2.5 Place 2 or 3 layers of gauze or cheesecloth over the top of the gelled acid electrolyte; apply another coat of gelled phosphoric acid to completely saturate the gauze.

6.2.2.6 Place a piece of stainless steel screen over the phosphoric acid gel and gauze layer. The gauze and screen should be approximately the same size as the area to be anodized.

6.2.2.7 Apply another coating of the gelled phosphoric acid over the stainless steel screen.

CAUTION: Be sure the stainless screen does not contact any part of the aluminum surface.

6.2.2.8 Connect the screen as the cathode (-) and the aluminum to be anodized as the anode (+). (See Figure 1.)

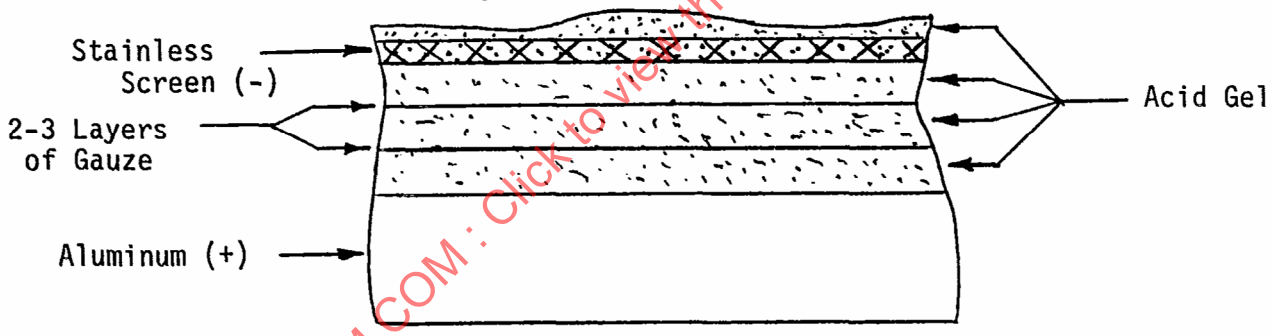

FIGURE 1 - Anodizing in Process

6.2.2.9 Apply a DC potential of 4 to 6 V for 10 to 12 min.

NOTE: A rectifier may be used to supply the voltage and current during anodizing. Current density should be in the range of 1 to 7 A/ft^2 (10.8 to 75 A/m^2). When a DC power supply is not available, a fresh or fully charged dry or wet cell battery may be used to anodize small areas.

6.2.2.10 At the end of the anodizing process, open the circuit and carefully remove the screen and gauze.

6.2.2.11 Moisten a piece of clean gauze with distilled or deionized water and lightly wipe off the gelled acid with the moistened gauze as quickly as possible. Do not rub the anodized surface. Immersion or spray rinse should be used if possible.

6.2.2.12 Air dry for not less than 30 min at room temperature or oven dry at 140 to 160°F (60 to 70°C) in a circulating air oven. A hot air gun may be useful in drying, provided the air temperature does not exceed 160°F (70°C).

6.2.2.13 Examine the treated surface for uniformity of coating (see 7.7). A properly anodized surface will show an interference color (original color changes to a complementary color) when viewed through a polarizing filter rotating 90° and examined at a low angle of incidence to fluorescent light or daylight.

6.2.2.14 If no color and color change is observed in step 6.2.2.13, repeat steps 6.2.2.2 through 6.2.2.13.

NOTE: Sometimes machined or abraded surfaces are difficult to inspect for color. Rotation of the polarizing filter is required because some pale shades of yellow or green are so close to white that without a color-change inspection, they may be considered "colorless," which would falsely indicate lack of anodic coating.

6.3 Anodizing Both Sides Simultaneously:

6.3.1 In the case of patch doublers or skin details in which both surfaces are to be anodized, a setup as shown in Figure 2 may be used.

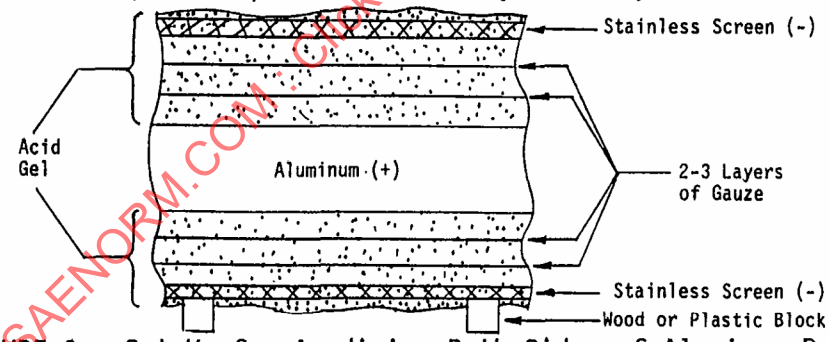

FIGURE 2 - Set Up for Anodizing Both Sides of Aluminum Detail

6.3.2 In this procedure, both surfaces of the aluminum are coated with the gelled phosphoric acid, covered with acid-coated gauze (2 layers) and then covered with the stainless steel screen as the cathode.

6.3.3 Elevate the part slightly to allow gases formed during anodizing to escape from the bottom surface. Trapped gases will result in smut deposits on the surface and a poor anodic coating.

6.4 Anodizing of Inverted (Overhead) Surfaces: This type of surface is very difficult to repair as gravity presents a problem. A plastic container should be placed under the area to catch the gelled electrolyte that will be lost during processing. Overhead surfaces not exceeding 4 in^2 (26 cm^2) should not be anodized. If possible, invert the component to allow working on an upright surface.

6.4.1 Prepare the overhead surface as described in 6.2.2.1 through 6.2.2.3.

6.4.2 On a bench top, or equivalent, secure a piece of stainless steel screen to the surface of a clear acrylic sheet, approximately 0.06 in (1.5 mm) thick, using vinyl-type electroplate tape. The screen should be slightly larger than the area to be anodized and the acrylic sheet should be slightly larger than the screen.

6.4.3 Attach a stainless steel wire to the screen to be connected as the cathode (-).

6.4.4 Apply a uniform coat of the gelled phosphoric acid to the screen.

6.4.5 Place 2 or 3 layers of gauze over the gelled acid coated screen; apply another coat of the gelled acid to completely saturate the gauze.

6.4.6 Wet the surface to be anodized with the gelled acid and immediately secure the screen and gauze to the area by taping it to the surface using the acrylic sheet to hold the gauze and screen securely on the surface.

CAUTION: Be sure the stainless steel screen does not contact any part of the aluminum surface and that no voids occur in the acid gel between the gauze, the screen, and the surface being anodized.

6.4.7 Connect the screen as the cathode (-) and the aluminum surface as the anode (+) and anodize as described in 6.2.2.9 through 6.2.2.14.

6.5 Application of Primer and Adhesive:

6.5.1 The adhesive primer should be applied immediately after drying the anodized surface.

CAUTION: Do not touch the dried anodized surface. Do not apply tape to the surface to be bonded.

6.5.2 Mix, apply, and dry or cure the adhesive primer in accordance with the manufacturer's instructions.

6.5.3 After beginning adhesive primer application, it is recommended that the adhesive application, part mating and curing of the assembly be completed within 8 h, with approximately the first 1.5 h being used for adhesive primer application and cure.