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MILITARY STANDARD

CLEANING AND TREATMENT OF ALUMINUM PARTS PRIOR TO PAINTING

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DEPARTMENT OF DEFENSE
Washington, DC 20301

Cleaning and Treatment of Aluminum Prior to Painting

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FOREWORD

Aluminum and aluminum wrought products during rolling, extrusion, drawing, forging, stamping and other processing accumulate oxides, mill scale, dirt and oils that must be removed to provide a sound base for paint. The purpose of this document is to furnish the requirements for cleaning and chemical treatment to provide this paint base.

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1. SCOPE

1.1 Scope. This document contains the requirements for nonelectrolytic chemical surface treatment of aluminum and aluminum alloys prior to painting.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specification. Unless otherwise specified, the following specification of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation forms, a part of this standard to the extend specified herein.

SPECIFICATION
MILITARY

MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.

2.2 Other publication. The following document forms a part of this standard to the extent specified herein. The issue of the document which is indicated as DOD adopted shall be the issue listed in the issue of the DODISS specified in the solicitation. The issue of the document which has not been adopted shall be that in effect on the date of the cited DODISS.

AMERICAN SOCIETY FOR METALS

Glossary of Metallurgical Terms and Definitions

(Application for copies should be addressed to American Society for Metals, Metals Park, Ohio 44073.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Source. The following definitions are derived from the American Society for Metals Glossary of Metallurgical Terms.

3.2 Alkaline cleaner. A material blended from alkali hydroxides and such alkaline salts as borates, carbonates, phosphates or silicates. The cleaning action may be enhanced by the addition of surface active agents and special solvents.

3.3 Caustic dip. A strong alkaline solution into which metal is immersed for etching, for neutralizing or for removing organic materials such as grease or paint.

3.4 Chromate treatment. A treatment of metal in a solution of a hexavalent chromium compound to produce a conversion coating of trivalent and hexavalent chromium compounds.

3.5 Conversion coating. A coating consisting of a compound of the surface metal produced by chemical or electrochemical treatments of the metal.

3.6 Deoxidizing. In metal finishing the removal of oxide films from metal surfaces by chemical or electrochemical reaction.

3.7 Etching. Chemically or electrochemically removing tenacious films from a metal surface to condition the surface for subsequent treatment such as painting.

3.8 Water break. The appearance of a discontinuous film of water on a surface signifying nonuniform wetting usually associated with a surface contamination.

3.9 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 3.10).

3.10 Solid waste. "Solid waste" means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (Source: Federal Acquisition Regulations, section 23.402).

4. GENERAL REQUIREMENTS

4.1 Aluminum surface treatment.

4.1.1 Cleaning and treatment sequence. Aluminum parts shall be surface treated to resist corrosion and provide a base for painting in the following sequence:

Step 1. Preclean (see 5.1.1).
2. Alkaline cleaning (see 5.2).
3. Post alkaline cleaner rinse (see 5.3).
4. Deoxidizer (see 5.4).
5. Post deoxidizer rinse (see 5.5).
6. Chromate chemical conversion coating (see 5.6).
7. Post conversion coating rinse (see 5.7).
8. Final acidulated rinse (see 5.8).
9. Drying (see 5.9).

4.2 Cleaning and treating requirements.

4.2.1 Processing of individual parts and welded assemblies.

4.2.1.1 Non-welded detail parts. Non-welded detail parts shall be cleaned and chromate conversion coated per section 5 before being assembled into the body.

4.2.1.2 Parts for resistance welded assemblies. Parts going into spot welded assemblies shall be cleaned and chromate conversion coated per section 5 before spot welding.

4.2.1.3 Parts for fusion welded assemblies. In general, fusion welded assemblies shall be cleaned and chromate conversion coated per section 5 after welding. Exceptions wherein the detail parts are chromate conversion coated and then welded are indicated by the drawings. An example exception is the welded folding windshield frame which is a fully enclosed framework.

4.2.1.4 Steel parts. Steel parts will not receive the treatments covered by this standard. Body applied steel parts shall be plated as indicated on the detail drawings.

4.2.2 Application of processes.

4.2.2.1 Processing. The cleaning and treating processes given in section 5 may be applied by spray or immersion. All processing shall be done continuously, i.e., there shall be no delay between the various cleaning, rinsing and treating processes.

4.2.2.2 Coverage. All cleaning and treating will provide 100% coverage of open section parts. Closed section parts (i.e., welded "B" roll bar) will have 100% exterior coverage and as much interior coverage as possible with a spray system. Hidden internal mating surfaces of welded assemblies are not required to be cleaned and treated. Parts that are welded after cleaning and treating (i.e., folding windshield frame) will not be subjected to additional cleaning and treating after welding.

4.2.2.3 Welded assemblies. Welded assemblies or parts containing closed sections will require special care so that chemical constitutents from the individual processes are thoroughly applied and subsequently thoroughly rinsed to assure that no entrapment of unwanted acids, etc., remains in the final part.

4.2.2.4 Operation details. Additional cleaning and treating requirements include:

a. All processing equipment shall be suitable for use with the specified chemicals without causing contamination of the processing baths or the parts being treated. This applies to equipment adjacent to the process under consideration. For example, spray or carry-over from an acid bath may contaminate or damage equipment and parts that preceed or follow the acid bath.
b. The Alodine titrations shall be taken at the beginning of the shift and repeated every four (4) hours of production.
c. A line speed of 32 feet per minute shall be maintained.
d. Racking, transporting or handling of parts either between processes or after completion of the treating-process shall not contaminate or damage the parts or the treatments applied to the parts. Clean cotton gloves shall be worn by personnel handling such parts, except in the Strux nut and Body Shop areas where a 2-stage washer will cleanse the completed body assembly before painting.

4.2.3 Safety precautions.

a. Rubber gloves, aprons, boots and face shield shall be worn by operators carrying out all cleaning operations.
b. Special attention shall be taken when working with acid or caustic solutions to prevent contact with the bare skin. If this occurs, wash the affected area of the skin with copious quantities of clean water.
c. First Aid shall be contacted immediately if irritation of the skin occurs.
d. Baths, including water baths, shall not be used for heating or cooling food or drink.
e. Ingestion of any of the materials specified herein shall be avoided. Always wash hands before smoking or eating.
f. Where ingestion has occurred, medical attention shall be obtained immediately.
g. Safety glasses shall be worn under the face shield at all times when working with materials specified herein.
h. If eye contact occurs, the eyes shall be irrigated with water for a minimum of 15 minutes. Medical attention shall be obtained immediately.
i. Solvents shall be kept away from fire and other sources of ignition.
j. Sufficient ventilation shall be provided when using solvents and solutions in confined areas.

4.2.4 Recycled, virgin and reclaimed materials. There are no requirements for the exclusive use of virgin materials; however, all materials shall be new and unused. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this standard are met (see 3.9).

5. DETAILED REQUIREMENTS

5.1 Aluminum surface treatment. Aluminum and aluminum alloy parts shall be surface treated to provide increased corrosion protection and a sound paint base in the steps specified in 4.1.1.

5.1.1 Preclean.

5.1.1.1 Contamination. Gross organic contamination shall be removed by solvent degreasing or by the use of a pre-wipe cleaner such as Amchem P3-T 5156. This step shall be necessary only when heavy organic contamination is present. The exact nature of this operation shall be dictated by the amount and type of contamination.

5.1.1.2 Precleaning precaution. Abrasives containing iron such as steel wool, iron oxide, rouge or steel wire shall not be used for any cleaning operation. Particles from these products may become embedded in the aluminum and accelerate its corrosion.

5.2 Alkaline cleaning. Amchem Ridoline 357 (spray/powder) shall be used to remove surface contamination and produce a water break-free surface, Amchem Ridoline 357 is a silicated, inhibited, non-etching, non-smutting alkaline cleaner.

5.2.1 Ridoline bath make-up. To prepare this cleaner 12.5 pounds (lbs) of Ridoline 357 shall be dissolved in a separate container of water, mixed well and added to the bath per 100 gallons (gals) of final solution.

5.2.2 Application and control. Ridoline 357 shall be applied by spraying with the following controls

Temperature 140 to 160 degrees Fahrenheit (°F)
Spray time not less than 1 minute minimum
Nozzle pressure 15 to 20 pounds per square inch (psi)
Titration 9 to 15 milliliter (ml)

5.2.3 Alkaline cleaning bath maintenance. The Amchem Ridoline 357 bath shall be controlled in the plant by titration using Amchem Test Set No. 3634 or its equivalent.

5.2.3.1 Ridoline 357 titration.

Step 1: Pipette a 10 ml sample of the Ridoline 357 bath into a beaker.
Step 2: Add approximately 100 ml of water and 4 to 6 drops of Indicator Solution 2 (Brom Cresol Green). The solution will turn blue.
Step 3: Fill the automatic burette to the zero mark with Titrating Solution 20 (0.1 N hydrochloric acid).
Step 4: While stirring the sample, slowly run in Titrating Solution 20 from the automatic burette until the color changes from blue to yellow.
Step 5: The number of milliliters of Titrating Solution 20 used shall be recorded as the Ridoline Titration.

5.2.3.2 Ridoline 357 replenishment. To replenish the Ridoline 357 solution 1.25 lb of Ridoline 357 shall be added for each 100 gals. per milliliter (ml) lacking. The titration shall be kept within a range of 9.0 to 15.0 ml.

NOTE: Whenever a portion of the bath is discarded or lost by leakage, the volume shall be restored with the same proportion of chemical and water as used in the original bath (see 5.2.1).

5.2.4 Equipment. The equipment used for application of Ridoline 357 may be constructed of mild steel providing the requirements of 4.2.2.4a are met.

5.2.4.1 Bath maintenance requirements. Equipment shall include provisions for maintaining the bath at the specified temperature and provisions for agitation of the bath to keep the bath well mixed.

5.3 Post alkaline cleaner rinse. Following alkaline cleaning, the parts shall be rinsed with water to neutralize the cleaner action and prevent carry-over to other baths. The rinse should be continuously overflowed to prevent contamination.

5.4 Deoxidizer. Surface oxides shall be removed by treating with Amchem Deoxidizer No. 6-16 (sulfuric acid bath) in the following procedure.

5.4.1 Deoxidizer bath makeup. The following shall be added to produce a 100 gal. bath:

a. 75 gal of cold water.
b. 5 gal. of 66° Baume (Be') sulfuric acid. Note: It is imperative that acid shall be added slowly to water with stirring.
c. 5 gal Amchem Deoxidizer No 6.
d. Additional water shall be added to make the 100 gal. bath.

5.4.2 Deoxidizer application and control points.

a. Bath temperature 50° to 90°F.
b. Spray time - not less than 30 seconds.
c. Deoxidizer titration - 13.5 to 16.5 ml.
d. Sulfuric acid titration (5%) - 4.1 to 5.0.
e. Reaction products titration - 40.5 to 49.5 ml.

5.4.3 Amchem Deoxidizer No. 6-16 bath maintenance. The bath shall be controlled by an acid titration using Amchem Chemical Set No. 2016 or its equivalent and by a deoxidizer titration using Amchem Chemical Test Set No. 2981 or its equivalent. The acid need be checked only occasionally while the deoxidizer shall be checked more frequently, depending on bath usage. However, both shall be checked at least once a shift.

5.4.3.1 Acid titration. Acid titration shall be prepared in the following steps:

Step 1: Pipette a 10-ml. sample of the Amchem Deoxidizer No. 6-16 bath into a graduate and dilute to exactly 50 ml. with water.

Step 2: Pipette a 10-ml. sample of this dilute solution into a beaker and dilute to approximately 200 ml. with water. Obtain another sample by the same procedure. This second sample is used as a blank so that it shall be easier to distinguish the color change during titration of the dark-colored sample.

Step 3: Add 4 to 6 drops of Indicator Solution No. 2 (Brom Cresol Green) to each sample.

Step 4: Fill the automatic burette to the zero mark with Titrating Solution No. 22 (0.857 N sodium hydroxide).

Step 5: While stirring the test sample, slowly run in Titrating Solution No. 22 until a blue-green color appears. Place the blank sample near the test sample during titration so that the appearance of the blue-green color will be more apparent.

Step 6: Record the number of milliliters of Titrating Solution No. 22 used as the acid titration.

NOTE: In a heavily loaded bath where determination of the blue-green endpoint is difficult, a potentiometric titration is recommended using a pH of 3.7 as the equivalence point.

5.4.3.2 Sulfuric acid bath replenishment. To replenish the bath 1.1 gal. of 66° Be' sulfuric acid shall be added per 100 gals. of bath for each millimeter lacking from the specified operating titration for 5% by volume concentration (see 5.4.2).

5.4.3.3 Deoxidizer titration. Deoxidizer titration shall be performed in the following steps:

Step 1: Pipette a 5 mil sample of the Amchem Deoxidizer No. 6-16 bath into an iodimetric flask and dilute to approximately 100 ml.

Step 2: Add approximately 1 gram (1/2 teaspoonful) of Titrating Compound No. 2 (Potassium Iodide) and agitate the solution until the Titrating Compound No. 2 is dissolved.

Step 3: Add about 15 ml. of Acid Test Solution No. 2 (C.P. hydrochloric acid) in 5 ml. increments to the lip of the flask, raising the stopper slightly after each addition to allow the acid to run into the flask.

Step 4: Rinse the lip several times with water and replace the stopper.

Step 5: Fill the automatic burette to the zero mark with Titrating Solution No. 31 (0.1 N sodium thiosulfate).

Step 6: After approximately 1 minute, titrate with Titrating Solution No. 31 until a straw color appears.

Step 7: Add several milliliters of Indicator Solution No. 11 (Soluble Starch Solution) and continue the titration with Titrating Solution No. 31 (without returning the burette to zero) until the blue-black color disappears.

Step 8: Record the number of milliliters of Titrating Solution No. 31 used as the Deoxidizer Titration (DT).

5.4.3.4 Replenishment of deoxidizer. To replenish deoxidizer, 1/3 gal. of Amchem Deoxidizer Replenisher No. 16 shall be added per 100 gallons of bath for each milliliter lacking from the specified operating titration per Section 5.4.2.

5.4.3.5 Reaction product titration. As aluminum is processed in the Amchen Deoxidizer No. 6-16 bath, reaction products will gradually accumulate unless there is sufficient drag-out of the bath during processing. The following steps shall be followed:

Step 1: 5.ml. sample of the Amchem Deoxodizer No. 6-16 bath shall be pipetted into an iodimetric flask and diluted to approximately 100 ml.
Step 2: Approximately 1 gm. (1/2 teaspoonful) of Titrating Compound No. 7 (sodium peroxide) shall be added.
Step 3: Several glass beads shall be added to the flask and brought to a boil. (Note: The glass beads may be reused).
Step 4: Boil for approximately 20 minutes and then cool to room temperature.
Step 5: Add 15 ml. of Acid Test Solution No. 2 (C.P. hydrochloric acid) in three equal portions to the lip of the flask.
Step 6: Rinse the lip several times with water and replace the stopper.
Step 7: Add approximately two grams (one teaspoonful) of Titrating Compound No. 2 (potassium iodide) and agitate the solution until the Titrating Compound No. 2 is dissolved.
Step 8: Fill the automatic burette to the zero mark with Titrating Solution No. 31 (0.1 N sodium thiosulfate).
Step 9: After the sample has settled for approximately 1 minute, titrate it with Titrating Solution No. 31 until a straw color is obtained.
Step 10: Add several milliliters of Indicator Solution No. 11 (soluble starch solution) and continue the titration with Titrating Solution 31 (without returning the burette to zero) until the blue-black color disappears.
Step 11: Record the number of milliliters of Titrating Solution No. 31 used as the Reaction Product Titration (RT).

5.4.3.5.1 Control of reaction products. The number of days required for the Reaction Titration minus the Deoxidizer Titration (RT-DT) to reach a value of 30.0 shall be recorded.

5.4.3.5.2 Reaction products level. Divide the number of gallons in the bath by the number of days found above. This value is the number of gallons of bath which should be drawn off daily to deep the level of reaction products below 30.0 as follows:

Example: A 500-gallon bath requires 20 production days to reach an RT-DT value of 30.0. Therefore, 25 gallons per day should be withdrawn from the bath (500 divided by 20 = 25). This amount should be prorated per processing hour, i.e., for an 8 hour processing day, 3.1 gallons should be removed per hour (25 divided by 8 = 3.1 gallon per hour).

NOTE: Whenever a portion of the bath is discarded or lost by leakage, the volume should be restored with the same proportion of chemicals and water as used in the original bath. The Amchem technical representative should recommend suitable equipment for automatically controlling the bath concentration.

5.4.3.5.3 Operational notes. The degree of etching produced on aluminum is proportional to the immersion time. A slight etch is obtained in 1 minute. A deeper and more uniform etch is obtained in 5 to 10 minutes. For deoxidizing prior to spotwelding, 3 to 5 minutes is the recommended immersion time. If, after long usage, the Amchem Deoxidizer No. 6-16 bath etches too rapidly, the bath may occasionally be replenished with Amchem Deoxidizer Make-Up No. 6. The replenishment rate is the same as that with Amchem Deoxidizer Replenisher No. 16.

5.4.3.6 Equipment. The tanks for the Amchem Deoxidizer No. 6-16 bath may be constructed of 300 Series stainless steel (preferably Type 316 for weldability) or lined with polyethylene or similar acid-resistant materials. The requirements of Section 4.2.2 must be met. Equipment shall include provisions for agitation of the bath to keep the bath well mixed.

5.5 Post deoxidizer rinse. The aluminum and aluminum parts shall be thoroughly rinsed with ambient water to neutralize acid of the deoxidizer and to prevent carry-over from the deoxidizer stage. Care shall be taken that there is no entrapment of deoxidizer inside the part or in crevices.

5.6 Chromate chemical conversion coating. To produce a corrosion resistant base for painting and bonding, the aluminum or aluminum parts shall be treated with Alodine 1200S. The coating weight shall not be less than 40 milligrams per square foot of surface.

5.6.1 Alodine 1200S bath make-up. For each 100 gallons of bath make-up 6.3 lb. of Alodine 1200S shall be added to the water while stirring. Alodine 1200S shall be first dissolved in a smaller container before adding to the bath.

5.6.2 Alodine 1200S spray application and control points.

a.	Temperature	70° to 100°F
b.	Immersion Time	- sufficient for minimum coating weight of 40 milligrams/sq.ft.
		(spray - approx. 15 to 30 sec. minimum)
c.	Titration	5.4-6.6 ml
d.	pH control	1.3 to 2.0

5.6.3 Maintenance of the chromate conversion bath. The Alodine 1200S coating chemical bath shall be controlled in the plant by a titration and pH check. The titration is accomplished by using Amchem Chemical Test Set or its equivalent. pH is best determined using an electrometric pH meter.

5.6.3.1 Alodine coating chemical titration. The chemical titration shall be performed in the following steps:

Step 1: Pipette a 5 ml sample of the Alodine 1200S coating chemical bath into an iodimetric flask and dilute to approximately 100 ml.

Step 2: Add approximately 1 g (1/2 teaspoonful) of Amchem Titrating Compound 2 (potassium iodide) and agitate until the Amchem Titrating Compound 2 is dissolved.

Step 3: Add about 10 ml of Amchem Acid Test Solution 2 (C.P. hydrochloric acid) in two equal portions to the lip of the flask, raising the stopper slightly after each addition to allow the acid to run into the flask.

Step 4: Rinse the lip several times with water and replace the stopper.

Step 5: Fill the automatic burette to the zero mark with Amchem Titrating Solution 31 (0.1 N sodium thiosulfate).

Step 6: After the sample has settled for approximately one minute, titrate it with Amchem Titrating Solution 31 until a straw color is obtained.

Step 7: Add several milliliters of Amchem Indicator Solution 11 (soluble starch solution) and continue the titration with Amchem Titrating Solution 31 (without returning the burette to zero) and the blue-black color disappears.

Step 8: Record the number of milliliters of Amchem Titration Solution 31 used as the Alodine Coating Chemical Titration.

5.6.4 Replenishment of the chromate conversion bath. Add 1 lb. of Alodine 1200S to 100 gallons of bath for each milliliter lacking. (This is equivalent to 1.2 kg per 1000 liters of bath for each milliliter lacking). The bath should be kept within 1 ml of the specified Alodine Coating Chemical Titration as defined in Section 5.6.2.

5.6.4.1 pH determination. A pH determination should be made after each replenishment of the Alodine 1200S coating chemical bath. The optimum pH for this bath is between 1.3 and 2.0.

NOTE: The pH of the Alodine 1200S coating chemical bath is controlled by the addition of 1/2 pint, or 0.24 liters, of concentrated nitric acid for every 2 to 4 pounds (1 to 2 kg) of Alodine 1200S used. It is recommended that no large bulk additions to nitric acid be made. The nitric acid additions should be made along with the required Alodine 1200S coating chemical additions. In certain instances, the pH of the bath will continue to decrease several hours after an addition of nitric acid (as the solution seeks equilibrium). Accordingly, small adjustments in pH should be made allowing 15 minutes to elapse before subsequent adjustment.

5.6.5 Chromate conversion coating operational notes. The following operational reactions and occurrences shall be noted for successful chromate conversion coatings:

a. Each alloy reacts with the Alodine 1200S coating chemical bath to produce a coating that is characteristic of that alloy. For the treating time selected, the bath should produce a light irridescent golden to tan coating on aluminum. If the desired coatings are not obtained, add Alodine 1200S in 1/4 oz. increments (up to a maximum of 3.0 oz/gal.) (This is equivalent to adding 1.8 g increments up to a maximum of 22.5 g/L) until satisfactory coatings are produced. As the concentration of Alodine 1200S coating chemical is increased, the bath will have to be titrated to determine the operating titration. The desired coatings may also be obtained by adjusting the pH.

b. During normal operation, the bath pH will rise causing a reduction in color intensity of the coating. If during normal replenishment, the addition of the specified amount of acid does not maintain the desired color, the amount of acid per replenishment may be increased slowly to 1-1/2 pints (0.75 L) per 2 to 4 pounds (1 to 2 kg) of Alodine 1200S.

c. The initial charge and replenishment data contained herein are normal for most installations; however, the Amchem technical representative may suggest a deviation from this data if indicated by local conditions.

d. If the Alodine coating is powdery, the cause may be one or more of the following:

(1) The work has been improperely cleaned and/or rinsed.
(2) The concentration of the Alodine coating chemical(s) in the bath is too high.
(3) The Alodine coating coating chemical bath has become contaminated with phosphates, sulfates, chlorides, or some other contaminant (analysis required).
(4) The coating time is too long.
(5) The bath temperature is too high.
(6) The Free Acid of the DEOXYLYTE final rinse is too high (should not exceed 7.0).

e. If the Alodine coating is to light, the cause may be one or more of the following:

(1) The treating time is too short.
(2) The concentration of the Alodine coating chemical bath is too low.
(3) The temperature of the bath is outside the specified range.

5.6.5.1 Chromate conversion operation precautions. The following precautions shall be observed during the operation of the Alodine 1200S coating chemical process:

a. Adequate ventilation shall be provided for the Alodine processing area. Operators shall not breathe Alodine coating chemical vapors.
b. Operators shall be equipped with rubber gloves, aprons, and safety glasses. When handling Alodine 1200S coating chemicals, operators should use, in addition, respirators and face shields.
c. Any Alodine coating chemical bath or powder shall be immediately flushed from the skin with water.

5.6.5.2 Continuous high volume operation. For continuously high production lines, an Alodine 1200 toner or Alodine 45 coating chemical shall be added to the bath. The Amchem technical representative shall recommend the proper amount to be added.

5.6.5.3 Conversion coating equipment. The work is processed in conventional spray processing equipment. The equipment for the Alodine coating chemical and the deoxidizing stages shall be constructed of stainless steel (Type 316 preferred for weldability) or other suitable acid-resistant material, but not lead or glass. All other stages may be constructed of mild steel providing requirements of 4.2.2 are met, plus the following requirements:

a. All heated tanks shall be equipped with steam plate coils and side heating (preferred for a more even temperature distribution) or other heat sources capable of heating the bath to the specified temperature.
b. Acid-resistant crates, baskets, tumbling barrels, or conveyors, etc., should be provided to carry the work through the various stages.
c. Equipment shall include provisions for agitation of the bath to keep the bath well mixed.

5.7 Post conversion coating rinse. Parts shall be rinsed with ambient temperature water to remove residual chromate compounds.

5.8 Final acidulated rinse. Parts shall be rinsed with Amchem Deoxylyte 41 final rinse to neutralize the alkalinity carried over from the previous rinse. This is a dilute chromic acid rinse to improve adhesive and paint adhesion.

5.8.1 Deoxylyte rinse make-up. For each 100 gals. of rinse, add 0.4 to 0.8 pints of Deoxylyte 41 to water while stirring.

5.8.2 Deoxylyte application and control.

Temperature	Ambient to 140°F
Rinse Time	30 seconds minimum (spray)
Nozzle Pressure	6 to 15 psi
Hexavalent Chromium Titration	1.3 to 2.6 ml
pH Control	4.0 to 5.5

5.8.3 Maintenance of deoxylyte bath. The Deoxylyte 41 final rinse bath is manually controlled in the plant by a pH control (Alkalinity Titration) and by a Hexavalent Chromium Titration using Amchem Chemical Test Set 3594 or is equivalent; this chemical test set is also used to monitor the bath concentration/condition when LINEGUARD electronic control equipment is used.

5.8.3.1 pH adjustment of unusually hard or alkaline water. Hard water which may cause excessive precipitation or alkalinity of the Deoxylyte 41 final rinse bath shall be corrected with Deoxylyte 41A toner. The amount to be added to the make-up of the bath is determined by the Alkalinity Titration.

5.8.3.2 Alkalinity titration. Alkalinity titration shall be determined as follows:

a. To 100 ml of water, add 3 to 5 drops of Amchem Indicator Solution 2 (Brom Cresol Green). Titrate to a green endpoint with Amchem Solution 20 (0.1 hydrochloric acid). For each 1.0 ml of Amchem Titrating Solution 20 required to reach the endpoint, add 1.3 fl. oz. of Deoxylyte 41A Toner to every 100 gallons of bath. (This is equivalent to 100 ml of Deoxylyte 41A Toner for every 100 liters of bath).

CAUTION: Deoxylyte 41A Toner shall be added to the water before Deoxylyte 41 final rinse is added. The concentrated solutions shall never be mixed together.

b. Since the hardness of local water may occasionally vary, a quick check of the continued efficiency and adjustment can be readily made with pH paper (pH range 3.0 to 5.5). A pH between 4.0 and 5.0 is desirable in Deoxylyte 41 final rinse baths.
c. If the pH of a new bath is outside the desirable range by as much as 0.5 of a pH unit, an alkalinity titration of the water shall be made and the Deoxylyte 41A Toner addition readjusted for subsequent baths.

NOTE: If the ph of a new bath is greatly outside the optimum range of 4.0 to 5.5, a major change of the nature of the water supply may have occurred. In this case, discard the bath and reestablish the necessary amount of Deoxylyte 41A Toner to be added.

5.8.3.3 Hexavalent chromimum titration 1/. This determination shall be performed in the following steps:

Step 1: Measure a 25 ml sample of the Deoxylyte 41 final rinse bath into a 250 ml flask and dilute with water to approximately 50 ml.
Step 2: Add 50 ml of Amchem Auxiliary Test Solution 16 (46% sulfuric acid, 7% phosphoric acid and 0.3% sulfamic acid) and stir vigorously until the bubbling ceases.
Step 3: Add 5 drops of Amchem Indicator Solution 15 (Ferroin). Shake well. The sample should turn bluish-green.
Step 4: Fill the automatic burette to the zero mark with Amchem Titrating Solution 35 (0.1 N ferrous ammonium sulfate).
Step 5: Slowly run in Amchem Titrating Solution 35 from the automatic burette until a reddish-brown color is obtained.
Step 6: Record the number of milliliters of Amchem Titrating Solution 35 used as Titration A.

1/ NOTE: Since the reactivy of Amchem Titrating Solution 35 changes slightly with time, Titration A shall be multiplied by a correction factor to obtain the Hexavalent Chromium Titration.

5.8.3.4 Correction factor. The correction factor for hexavalent chromium titration shall be determined once a week as follows:

Step 1: Pipette a 10 ml sample of Amchem Auxiliary Test Solution 18 (0.1 N Potassium Dichromate) into a flask and dilute with water to approximately 50 ml.
Step 2: Complete Steps 2, 3, 4 & 5 above, using this sample.
Step 3: Record the number of milliliters of Amchem Titrating Solution 35 used as Titration B.
Step 4: Calculate the correction factor using the following formula:

$$\text{Correction Factor} = \frac{10}{\text{Titration B}}$$

5.8.3.5 Calculation of hexavalent chromium titration. Using the following formula, determine the hexavalent chromium titration:

Titration A x Correction Factor = hexavalent chromium titration

The Deoxylyte 41 final rinse bath should be kept within the specified hexavalent chromium titration range (see Sect. 5.8.2). For every 1.0 ml of hexavalent chromium titration lacking, add 0.30 pints of Deoxylyte 41 per 100 gallons of bath (this is equivalent to 0.38 liters of Deoxylyte 41 per 1000 liters of bath).

NOTE: Whenever a portion of the bath is discarded or lost by leakage, the volume should be restored with the same proportion of chemicals and water as used in the original bath (see Sect. 5.8.2).

5.8.3.6 Deoxylyte 41 operational recommendations and precautions. The Deoxylyte 41 final rinse bath shall be drained and remade daily for best results with the following precautions:

a. The initial charge and replenishment data contained herein are normal for most installations; however, an Amchem technical representative may suggest a deviation from this data if indicated by local conditions.

b. For optimum quality, it is essential to maintain the final rinse as free as possible from contaminants. While no definite safe limits can be set for every system, experience has shown that water is potentially injurious to quality if it exceeds any of the following:

(1) 70 ppm total chlorides and sulfates (calculated as Cl and SO_4).

(2) 200 ppm alkalinity (calculated as $CaCO_3$).

(3) 225 ppm of the above two limits (1 & 2) combined (conductivity of approximately 800 micro-omhos at 130°F (54°C).

(4) A plug of the Deoxylyte 41 final rinse drums should be loosened to relieve any possible gas pressure.

c. In hard water areas, the use of deionized water is recommended for maximum quality and economy.

d. Processing solutions which are dragged into the Deoxylyte 41 final rinse bath from previous stages are another major source of contaminants. To detect the influx of contaminants, it is recommended that a titration for total acidity using Amchem Chemical Test Set 3594 shall be made at least once daily or whenever an abnormal condition is suspected.
The total acid titration is performed as follows:

(1) Pipette a 25 ml sample of the Deoxylyte 41 final rinse bath into a flask.

(2) Add 6 or 7 drops of Amchem Indicator Solution 3 (phenolphthalein).

(3) Slowly run in Amchem Titrating Solution 11 (0.1 sodium hydroxide) from the automatic burette until a purple color is obtained.

(4) Record the total number of milliliters of Amchem Titrating Solution 11 used as the total acid titration.

e. If the Total Acid Titration exceeds that of the fresh, unused Deoxylyte 41 final rinse bath by more than 1 ml, it is advisable to discard all or part of the bath and restore the new bath with the same proportion of chemicals and water as used in the original bath (see 5.8.1).

f. If the Total Acidity rises unusually, or if LINEGUARD conductivity control equipment is used and the conductivity increases by more than approximately 30%, all or part of the bath shall be discarded and replenished with new Deoxylyte 41 final rinse bath makeup.
g. If Total Acidity or LINEGUARD conductivity has increased abnormally, check the condition of the water used or the operation and condition of the rinse water in the stage preceding the Deoxylyte final rinse state. Maintain an adequate overflow of clean water in the rinse preceding the Deoxylyte 41 final rinse stage.
h. The Deoxylyte 41 final rinse shall be operated at as low a temperature as possible without impeding subsequent drying.
i. The quality of the coating produced in power spray processing equipment is generally improved by the installation of an Auxiliary Spray Riser (see TSDS No. DY-O-AUX).
j. Light-brown stains may appear on the work if concentration of Deoxylyte 41 final rinse bath is too high or if the bath is too hot (preventing adequate run-off). If the staining is objectionable, it can usually be corrected by overflowing the Deoxylyte 41 final rinse bath or by lowering its temperature.
k. The normal protective precautions employed for handling strong acids such as the use of rubber gloves, aprons, boots, safety glasses, face shields, etc. shall be observed when handling Deoxylyte 41 final rinse or Deoxylyte 41A Toner.
l. Organic materials shall never be exposed to Deoxylyte 41 final rinse chemicals or its residues since rapid oxidation and subsequent fire hazards may occur.

5.8.3.7 Final acidulated rinse equipment. The tanks for the Deoxylyte 41 final rinse may be constructed of mild steel. The requirements of 4.2.2 must be met.

5.9 Final acidulated rinse drying. Parts coming from the final acidulated rinse shall be dried as soon as possible in an indirectly fired oven or by other means which will not contaminate the metal with fumes, oil, or partially burnt gases under the following conditions:

a. The metal temperature shall range from ambient and range to, but not exceed 150°F, to maintain best corrosion resistance.
b. Cavities or pockets which trap moisture should be blown dry with clean compressed air. Moisture splatters should be dried with clean cloths.
c. If handling of the dried, unpainted work is necessary, operators shall wear clean cotton gloves in the unracking area and the alodine small parts painting area.

5.10 Quality assurance provisions. The quality of aluminum pre-treatment shall be maintained by applying the quality assurance provisions of 4.0 of MIL-C-5541.

6. NOTES

6.1 Intended use. The cleaning procedure covered by this standard are intended for use in providing paint adherence and corrosion protection on aluminum and aluminum alloys.

6.2 Subject term (key word) listing.

Alkaline etching of aluminum
Aluminum treatment for painting
Chromate conversion coating
Cleaning and treating aluminum prior to painting
Conversion coating of aluminum
Corrosion protection of aluminum

6.3 Supersession data. This standard supersedes AM General Corporation, AMG 154, Cleaning and Treatment of Aluminum Parts Prior to Painting, dated August 24, 1983.

Custodian:
Army - AT

Preparing activity:
Army - AT

(Project MFFP-A383)