METRIC

MIL-STD-871C (USAF)
30 June 2015

SUPERSEDING
MIL-STD-871B
01 March 2007

DEPARTMENT OF DEFENSE STANDARD PRACTICE

ELECTRO-CHEMICAL STRIPPING OF INORGANIC FINISHES

Reactivated 30 June 2015 and may be used for new and existing design and acquisitions.

AMSC: N/A

AREA: MFFP

FOREWORD

1. This standard is approved for use by the AF-70 Hill AF Base, AFSC Hill 309 CMXG, Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

2. This standard provides guidance for the repair process, acquisition, and manufacture of parts and/or spare parts on the landing gear of all military aircraft.

3. Comments, suggestions, or questions on this document should be addressed to: AFSC Hill AF Base 309th CMXG Maintenance, Hill AFB, UT 84056-5228 or email to: 309.CMXG.Workflow@us.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

SUMMARY OF CHANGES

1. Changed the Uniform Resource Locator (URL) for the ASSIST data base throughout the document.

2. Changed MIL-STD header on each page to reflect document's change status

3. Formatted paragraphs, sentences, tables to a standard consistency

4. Front page:
   - Added new DoD seal
   - Deleted "Note" box
   - Added Distribution A statement

5. Page ii:
   - Changed POC program name
   - Changed verbiage IAW MIL-STD-962D

6. Page iii – iv: Added new page "SUMMARY OF CHANGES"

7. Page v – vi: "Contents" changed numerous page numbers to correspond with changes

8. Page 1:
   - Added A-A-59260, new CID document published 15-May-2014
   - Changed Mil-C-5541 to MIL-DTL-5541F as per current published document

9. Page 2:
   - Updated URL 29 CFR 1910 Subpart Z
   - Updated URL US Government Printing Office
   - Changed ASTM E1146 to ASTM E1146-08
   - Added Technical Grade Hydrochloric Acid
   - Changed ASTM D1732 to ASTM D1732-03
   - Added Practices
   - Changed Preparagraphtion to Preparation
   - Changed SAE-AMS-M-3171 to AMSM3171
   - Added On
   - Updated address to 1200 G St. NW, Suite 800, Washington DC 20005
   - Added URL for ACS

10. Page 3:
    - Changed Materials statement
    - Added Toxic chemical, hazardous substance and ozone-depleting chemical statement
    - Deleted all standard references

11. Page 4: Added degree symbol 190°and 375°

12. Page 8:
    - Changed g/l to g/L
    - Changed 120 g/L (60 oz/gal) to 120–140 g/L (16–32 oz/gal)
    - Changed 112–128 g/L (15–17 oz/gal) to 112–256 g/L (15–34 oz/gal)

13. Page 12: Changed (18–16 oz/gal) to (16–18 oz/gal)

14. Page 13: Deleted Change from previous issue

15. Page 14: Added CONCLUDING MATERIALS page

16. Page 15: Para 5.6.4 Changed Hydrochloric Acid, Initial Makeup from (30 oz/gal) to (34 oz/gal)

17. Page 16: Para 5.6.7 Changed Sulfuric Acid, Control from (144–155 oz/gal) to (147–154 oz/gal)

18. Page 17:
    Para 5.6.10 Changed Chromic Acid, Control from (22–28 oz/gal) to (23–28 oz/gal)
    Para 5.6.11 Changed Cyanide-Caustic, Control from (22–28 oz/gal) to (23–27 oz/gal)
    Para 5.6.12 Changed Phosphoric Acid, Initial Makeup from (5 oz/gal) to (6 oz/gal)
    Para 5.6.12 Changed Phosphoric Acid, Control from (4–8 oz/gal) to (5–8 oz/gal)
    Para 5.6.13 Changed Chromic-Sulfuric Acid, Temperature, Initial Makeup from (150°–170°F) to (154°–171°F)

19. Page 18:
    Para 5.6.14 Changed Multi-deposit Strip, Temperature, Initial Makeup from (55°–55°C) to (49°–55°C)
    Para 5.6.15 Changed Sulfuric Acid, Initial Makeup from (22 oz/gal) to (23 oz/gal)
    Para 5.6.15 Changed Sulfuric Acid, Control from 16–18 oz/gal) to (20–27 oz/gal)

20. Changed project number to correspond

CONTENTS

1. SCOPE

1.1 Scope. This standard covers the process and materials required for the stripping of inorganic finishes. Subsequent heat treating techniques needed to insure hydrogen embrittlement relief of the steel substrate are also described.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in Sections 4 and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Section 4 and 5 of this standard, whether or not they are listed.

2.2 Government Documents.

2.2.1 Specifications, standards, handbooks, and commercial item descriptions. The following specifications, standards, handbooks, and commercial item descriptions form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-55820	Orthophosphoric (Phosphoric) Acid, Technical
A-A-55827	Chromium Trioxide, Technical
A-A-55828	Sulfuric Acid, Technical
A-A-55829	Acetic Acid, Glacial, Technical
A-A-59105	Nitric Acid, Technical
A-A-59260	Sodium Hydroxide
A-A-59282	Chemicals, Analytical
A-A-59476	Ammonium Nitrate, Technical
A-A-59563	Sodium, Carbonate, Anhydrous, Technical

DEPARTMENT OF DEFENSE SPECIFICATIONS

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

(Copies of these documents are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094, or https://assist.dla.mil)

2.2.2 Other Government documents. The following Government document form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Subpart Z Toxic and Hazardous Substances

(Copies of this document are available online at US Government Printing Office or from the Superintendent of Documents, U.S. Printing Office, North Capitol & "H" Streets, N.W., Washington, D.C. 20402–0002)

2.3 Non-Government Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E1146 Standard Specification for Muriatic Acid (Technical Grade Hydrochloric Acid)

ASTM D1732 Standard Practices for Preparation of Magnesium Alloy Surfaces for Painting

(Copies of these documents are available from www.astm.org or ASTM International 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) INTERNATIONAL

AMS–M–3171Magnesium Alloy, Processes for Pre-treatment
And Prevention of Corrosion On

(Copies of these documents are available from www.sae.org or SAE World Headquarters, 1200 G St. NW, Suite 800, Washington DC 20005)

AMERICAN CHEMICAL SOCIETY (ACS) http://www.acs.org/content/acs/en.html

"Reagent Chemicals" (for replacement of Federal Specification O-G-491D)

(Copies of these documents are available from American Chemical Society, 1200 G St. NW, Suite 800, Washington DC 20005). Or https://global.oup.com/academic/product/reagent-chemicals-9780841239456?q=Reagent%20Chemicals&lang=en&cc=us#.

2.4 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. DEFINITIONS

3.1 High Strength Steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 1240 megapascals (MPa) (126 kilogram – force per millimeter square {Kgf/mm^2} 180,000 pound – force per square inch {PSI}) and above.

4. GENERAL REQUIREMENTS

4.1 Materials and Equipment. Materials and equipment used in electro/chemical stripping of inorganic finishes are as follows:

4.1.1 Materials. Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

4.1.2 Toxic chemicals, hazardous substances, and ozone-depleting chemicals. The use of toxic chemicals, hazardous substances, or ozone-depleting chemicals shall be avoided, if feasible. The desired performance requirements should be specified rather than the specific chemical or substance. If a toxic chemical, hazardous substance, or ozone-depleting chemical must be specified, it shall be listed as a key word in section 6 (see 5.12.9). The Environmental Protection Agency maintains an online list of toxic chemicals and hazardous substances at http://www.epa.gov/emergencies/tools.htm#lol that should be consulted.

(CAUTION: Some of these materials are classified as hazardous and toxic substances. Personnel exposure to such materials must be within the limits specified in OSHA Standard 1910-1000 Subpart Z. at https://www.osha.gov/law-regs.html)

4.1.3 Equipment.

4.1.3.1 Tanks should be resistant to the operating temperatures and the chemical environment.

4.1.3.2 Stripping tanks to be operated at temperatures other than room temperatures shall be equipped with automatic temperature indicating and regulating devices.

4.1.3.3 Either generated or rectified D.C. current may be used. An ammeter shall be placed in series with the tank anode. The ammeter shall have sufficient shunts and switches to provide a full-scale reading equal to the maximum capacity of the power source, and an accuracy of ± 10 percent of the current being measured.

4.1.3.4 An oven capable of baking parts at 190° ± 14°C (375° ± 25°F) shall be located near the stripping line. The size of the oven shall be adequate to enclose the parts to be stripped. The oven shall be equipped with temperature indicating, recording, and regulating devices.

4.2 Finish. The part, after stripping shall have a finish that is smooth and free from pits, nodules, and any other indications of harmful defects.

4.3 Racking. Sufficient contact area and pressure shall be provided to carry the current without overheating. Racking should be performed at the most convenient step prior to stripping.

4.4 Masking. Sections or areas of a part that are not to be stripped shall be masked

off. Plug and masking materials that do not contaminate the stripping solution shall be used. Masking shall be performed at the most convenient step prior to stripping.

4.5 Baking. All requirements for baking of the part shall be met.

4.5.1 Special baking requirement. Steel parts heat treated to 1240 MPa (180,000 psi) and above, shall be baked within four (4) hours of stripping for four (4) hours minimum at 190° ± 14°C (375° ± 25°F). Other process operations can be performed on the part provided they are accomplished within the time limit. No plating process may be used prior to baking. Steel parts stripped in solutions 1, 3, 5, 6, 11, and 14 will not require baking.

5 DETAILED REQUIREMENTS

5.1 Immersion of Parts. Parts shall be immersed in the process solution in a manner to prevent localized effects such as interface attack.

5.2 Dissimilar Metals. Dissimilar metal inserts shall be masked off or removed as necessary.

5.3 Immersion Processes. Immersion processes for stripping are preferred for parts having recessed areas, intricate shapes, or hollow areas.

5.4 Baking. Parts shall be baked for stress relief for four (4) hours minimum at 191° ± 14°C (376° ± 25°F) prior to stripping.

5.5 Procedure.

5.5.1 Step No 1: Degrease parts prior to further processing. Emulsion cleaning methods may be used if materials and equipment are available.

5.5.2 Step No. 2: Mask and rack parts as necessary.

5.5.3 Step No. 3. Strip inorganic coating in the appropriate solutions from Table I or II. Strip parts in the shortest time necessary to remove coating. Refer to Table III for information on solution makeup, control limits and process notes.

5.5.4 Step No. 4. Rinse part immediately in clean water.

5.5.5 Step No. 5. Rinse the part in hot water to facilitate drying.

5.5.6 Step No. 6. Bake steel parts heat treated above 1240 MPa (180,000 psi) in accordance with paragraph. 4.5.

5.5.7 Step No. 7. Inspect as necessary for the requirements of paragraphs 4 and 5.

TABLE I.

Stripping of Metal Coatings

Coating / Base Metal	Low Alloy Steel	Corrosion Resistant Steel	Aluminum Alloys	Aluminum Alloys
Brass Or Bronze	1 or 14	1, 2, 14	2 or 14 [1]	N/A
Cadmium Or Titanium cadmium	1 or 3	1, 2, 3	2	3 or 4
Chromium	5 or 6	5 or 6	7 or 15	4
Copper	1 or 14	1, 2, 14	2 or 14	N/A
Lead or Lead Solder	6, 8 [2], 14	2, 6, 8, 14	2 or 14	8 or 14
Gold	1	1	7	1 [1]
Nickel or Electroless Nickel	7 [2], 14	2, 7, 14	2, 14	7, 14
Silver	1	1 or 2	2	1 [1] or 9
Tin	1, 4 [2] 6, 14	1, 2, 4, 6, 14	2 or 14	4 or 14
Zinc	1 or 4 [2]	1, 2, 4	2	4

[1] CAUTION: This solution attacks the bare metal.s

[2] CAUTION: This solution cannot be used for steels heat treated to 1241 MPa (180 kip/in^2 {ksi}).

TABLE II.

Stripping of Conversion Coatings

BASE METAL	COATING	STRIPPING SOLUTION
Ferrous	Black Oxide	4
Ferrous	Manganese Phosphate	10 or 11
Ferrous	Zinc Phosphate	10 or 11
Ferrous	Ferrous Phosphate	10 or 11
Ferrous	Dry Film Lubricants	10
Magnesium	ASTM D1732	10
Magnesium	SAE-AMS-M-3171	10
Aluminum	Dry Film Lubricants	10
Aluminum	MIL-C-5541	12
Aluminum	Anodized Coatings	12 or 13
Zinc	Conversion Coatings	12
Cadmium	Conversion Coatings	12

TABLE III.

Process Solutions

Stripping Solution	Section	Processing Solution	Immersion	Electrolytic
1	5.6.1	Cyanide – Caustic		X
2	5.6.2	Nitric Acid	X	
3	5.6.3	Ammonium Nitrate	X	
4	5.6.4	Hydrochloric Acid	X	
5	5.6.5	Hydroxide – Carbonate		X
6	5.6.6	Sodium Hydroxide		X
7	5.6.7	Sulfuric Acid		X
8	5.6.8	Acetic Acid-Hydrogen Peroxide	X	
9	5.6.9	Sulfuric – Nitric Acid	X	
10	5.6.10	Chromic Acid	X	
11	5.6.11	Caustic – Cyanide	X	
12	5.6.12	Chromic – Phosphoric Acid	X	
13	5.6.13	Chromic – Sulfuric	X	
14	5.6.14	Multi–deposit Strip	X	
15	5.6.15	Chrome Strip from Aluminum		X

The above stripping solutions are referenced in the Table I and II. Refer to the listed sections for information on solution make-up, control limits, and process notes.

Proprietary formulations are available for several of these processes. One example is a non-cyanide formulation to replace the cyanide based Multi-Deposit Strip, Solution 14. Proprietary formulations may be used provided the necessary precautions are taken to avoid substrate attack and hydrogen embrittlement. If a proprietary formulation is used, testing shall be accomplished to determine whether an embrittlement relief bake is required (Reference 4.5.1).

5.6. Stripping Solutions.

5.6.1 Solution 1: Cyanide – Caustic

	Initial Makeup	Control
Sodium Cyanide	90 g/L (12 oz/gal)	82 – 98 g/L (11 – 13 oz/gal)
Sodium Hydroxide	15 g/L (2 oz/gal)	8 – 22 g/L (1 – 3 oz/gal)
Temperature	Room to 71°C (Room to 160°F)	
Procedure	Make parts anodic at 2 volts maximum	

5.6.2 Solution 2: Nitric Acid

	Initial Makeup	Control
Nitric Acid	Concentrated	35° – 42° Baumė
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	Room	
Procedure	Immersion	

5.6.3 Solution 3: Ammonium Nitrate

	Initial Makeup	Control
Ammonium Nitrate	120 – 240 g/L (16 – 32 oz/gal)	112 – 256 g/l (15 – 34 oz/gal)
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	Room	
Procedure	Immersion	

5.6.4 Solution 4: Hydrochloric Acid

	Initial Makeup	Control
Hydrochloric Acid	255 g/L (34 oz/gal)	210 – 240 g/L (28 – 32 oz/gal)
Antimony Trioxide	15 g/L (2 oz/gal)	8 – 22 g/L (1 – 3 oz/gal)
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	Room	
Procedure	Immersion	

5.6.5 Solution 5: Hydroxide – Carbonate

	Initial Makeup	Control
Sodium Hydroxide	52 g/L (7 oz/gal)	45 – 60 g/L (6 – 8 oz/gal)
Sodium Carbonate	68 g/L (9 oz/gal)	60 – 75 g/L (8 – 10 oz/gal)
Temperature	Room	
Procedure	Make part anodic at 4 – 6 volts	

5.6.6 Solution 6: Sodium Hydroxide

	Initial Makeup	Control
Sodium Hydroxide	75 g/L (10 oz/gal)	68 – 82 g/L (9 – 11 oz/gal)
Temperature	Room	
Procedure	Make part anodic at 6 volts	

5.6.7 Solution 7: Sulfuric Acid

	Initial Makeup	Control
Sulfuric Acid	1125 g/L (150 oz/gal)	1100 – 1150 g/L (147 –154 oz/gal)
Glycerin	30 g/L (4 oz/gal)	22 – 38 g/L (3 – 5 oz/gal)
Dissolved Metal	30 g/L max (4 oz/gal max)	
Temperature	21° to 26.6° C (70° to 80° F)	
Procedure	Make part anodic at 2 volts	

5.6.8 Solution 8: Acetic Acid – Hydrogen Peroxide

	Initial Makeup	Control
Acetic Acid	2 parts by volume	Make no Additions
Hydrogen Peroxide 30%	1 part by volume	Use to Depletion
Temperature	Room	
Procedure	Immersion	

5.6.9 Solution 9: Sulfuric Acid – Nitric Acid

	Initial Makeup	Control
Sulfuric Acid	66° Baumė	19 parts by volume
Nitric Acid	40° Baumė	1 part by volume
Temperature	Room	
Procedure	Immersion	

5.6.10 Solution 10: Chromic Acid

	Initial Makeup	Control
Chromic Acid	190 g/L (25 oz/gal)	175 – 210 g/L (23 – 28oz/gal)
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	Room	
Procedure	Immersion	

5.6.11 Solution 11: Cyanide - Caustic

	Initial Makeup	Control
Sodium Hydroxide	180 g/L (24 oz/gal)	175 – 200 g/L (23 – 27 oz/gal)
Sodium Cyanide	90g/L (12 oz/gal)	75 – 105 g/L max (10 – 14 oz/gal max)
Temperature	Room	
Procedure	Immersion	

5.6.12 Solution 12: Chromic – Phosphoric Acid

	Initial Makeup	Control
Chromic Acid	22 g/L (3 oz/gal)	15 – 30 g/L (2 – 4 oz/gal)
Phosphoric Acid	45 g/L (6 oz/gal)	39 – 60 g/L (5 – 8 oz/gal)
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	82° C to boiling (180° F to boiling)	
Procedure	Immersion	

5.6.13 Solution 13: Chromic – Sulfuric Acid

	Initial Makeup	Control
Chromic Acid	22 g/L (3 oz/gal)	15 – 30 g/L (2 – 4 oz/gal)
Sulfuric Acid	45 g/L (6 oz/gal)	30 – 60 g/L (4 – 8 oz/gal)
Dissolved Metal		15 g/L max (2 oz/gal max)
Temperature	68° – 77° C (154° – 171° F)	
Procedure	Immersion	

5.6.14 Solution 14: Multi-deposit Strip

	Initial Makeup	Control
Meta Nitro Benzene Sulfonate	60 g/L (8 oz/gal)	See paragraph 5.7
Sodium Hydroxide	15 g/L (2 oz/gal)	pH: 11 – 12
Sodium Cyanide	90 g/L (12 oz/gal)	75 – 105 g/L (10 – 14 oz/gal)
Temperature	49° – 55° C (120° – 130° F)	
Procedure	Immersion	

5.6.15 Solution 15: Chrome Strip from Aluminum

	Initial Makeup	Control
Sulfuric Acid	175 g/L (23 oz/gal)	150 – 200 g/L (20 – 27oz/gal)
Dissolved Metal		30 g/L max (4 oz/gal max)
Temperature	15.6° – 26.7° C (60° – 80° F)	
Procedure	Make anodic at 4 – 6 volts	

5.7 Solution Makeup: Unless otherwise specified, the following procedure shall be used in making up solutions:

5.7.1 Fill tank approximately 1/3 to 1/2 full with water.

5.7.2 Add chemicals slowly and stir until dissolved.

5.7.3 Add liquid acids slowly with mixing and allow solution to cool to normal temperature.

5.7.4 Add other liquid chemicals.

5.7.5 Fill tank to operating level with water and mix thoroughly.

5.7.6 Bring solution to operating temperature.

5.8 Analysis. A laboratory analysis of stripping solutions shall be performed as often as deemed necessary to insure that such solutions comply with this standard.

5.9 Rejection of parts. Parts that have been damaged by stripping shall be rejected. Examples of damage include: burning, warping, cracking, pitting, heavy etching, or distortion.

6. NOTES:

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

6.1 Intended use. This standard provides guidance on the process for electro/chemical stripping of inorganic coatings used in component repair processes. It is an Air Force unique repair/manufacturing standard.

6.2 Subject term (key word) listing.

Hazardous

Process

CONCLUDING MATERIALS

Custodian:
Air Force – 70

Preparing Activity:
Air Force – 70

Project MFFP-2015-007

NOTE: The activities listed above have an interest in this document as of the date of this document. Some organizations and responsibilities may change and verification of the currency of this information can be made by using ASSIST Online database or https://assist.dla.mil/.