

RESPONSIBLE ENGINEER <i>A. Gruen</i>	NORTHROP Aircraft Division	IM-17	G
M&P ENGINEERING MANAGER <i>H. Miller</i>		DATE <u>7 June 1989</u>	
SPECIFICATION CONTROL <i>F. Kitchener</i>		RELEASE EO <u>F50936</u>	
	PROCESS SPECIFICATION	CODE IDENT. NO. 76823	REVISION

TITLE: CHEMICAL ENGRAVING OF ALUMINUM

(This revision, to incorporate EO F10959, supersedes Process Specification IM-17, Revision F, dated 5 December 1975. There are no technical changes in this revision.)

1. SCOPE

- 1.1 This specification establishes the materials and procedures for the fabrication of etched markings (nameplates) and etched stencils on aluminum and aluminum alloys using a caustic or acid etchant.
- 1.2 Procedures specified herein are applicable to prepared photosensitive materials, both fabricated by Aircraft Division and supplied by vendors.
- 1.3 Safety provisions for handling and use of hazardous materials listed herein are specified in HP-1.

2. APPLICABLE DOCUMENTS

2.1 The following specifications identify materials required by this specification. Use of these specifications is not required to perform the tasks described herein.

2.1.1 Government

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|---------|-----------|--|
| 2.1.1.1 | O-N-350 | Nitric Acid, Technical |
| 2.1.1.2 | O-S-598 | Sodium Hydroxide, Technical |
| 2.1.1.3 | O-T-634 | Trichloroethylene, Technical |
| 2.1.1.4 | TT-L-32 | Lacquer, Cellulose-Nitrate |
| 2.1.1.5 | TT-N-95 | Naphtha, Aliphatic |
| 2.1.1.6 | CCC-C-440 | Cloth, Cheesecloth, Cotton Bleached and Unbleached |

2.1.2 Industry

- | | | |
|---------|------------|-------------------------------|
| 2.1.2.1 | ASTM D1153 | Methyl Isobutyl Ketone (MIBK) |
| 2.1.2.2 | MD-10.16 | Marking Materials |
| 2.1.2.3 | MD-11 | Pressure Sensitive Tapes |

3. REQUIREMENTS

3.1 Materials and Equipment

3.1.1 Chemicals

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|---------|-------------------------|------------|------------------|
| 3.1.1.1 | Ferric Chloride | Commercial | (28-26-10-1320)§ |
| 3.1.1.2 | Acid, Nitric-42 Deg Be' | O-N-350 | (28-26-00-2050) |
| 3.1.1.3 | Sodium Hydroxide | O-S-598 | (29-26-32-4220) |

§ Aircraft Division Industrial Supplies and Equipment Code Number

IM-17G
 7 June 1989

3.1.2 Solvents and Thinners

3.1.2.1	Aliphatic Naphtha	TT-N-95	(27-26-34-1360)
3.1.2.2	Trichloroethylene, Type II	O-T-634	
3.1.2.3	Methyl Isobutyl Ketone (MIBK)	ASTM D1153	(27-26-34-1420)

 * **CAUTION:** To reduce fire hazards at the Aircraft Division, higher flash *
 * aliphatic naphtha shall be used and low flash point solvents *
 * shall be restricted to limited usage only. *

3.1.3 Wiping Cloths

3.1.3.1	Cheesecloth, Type 1, Class 2	CCC-C-440	(39-36-32-5000)
3.1.3.2	Tissue, Nu-Wipe	Nu-Wipe Inc.	
3.1.3.3	Rymplecloth 301	Commercial	(06-36-32-5200)

3.1.4 Kodak Photo Resist (KPR System)

3.1.4.1	Resist, Kodak Photo	Eastman Kodak Co.	
3.1.4.2	Thinner, KPR	Eastman Kodak Co.	
3.1.4.3	Developer, KPR	Eastman Kodak Co.	
3.1.4.4	Dye, KPR	Eastman Kodak Co.	

3.1.5 Photosensitive Stock

3.1.5.1	Fotofoil	Miller Dial & Nameplate Co.	
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3.1.6 Clear Coating

3.1.6.1	Coating, Clear Gloss Acrylic	MD-10.16, Table 4	
3.1.6.2	Coating, Clear Luster Less 2626 High Solids	MD-10.16, Table 4	

3.1.7 Legend Filler

3.1.7.1	Enamel	Commercial	
3.1.7.2	Paste, Engravers White K-658 or Equivalent	George Gorton Machine Co.	
3.1.7.3	Lacquer Stik, Soft	Pannier Corp., TT-L-32	
3.1.7.4	Lacquer	TT-L-32	

3.1.8 Miscellaneous Materials

3.1.8.1	Cleanser, Dutch or equivalent	Commercial	(38-36-80-6300)
3.1.8.2	Lacquer, Black, Acid Resistant	Commercial	
3.1.8.3	Tape, Masking	MD-11, No. 1	(06-36-88-1920)
3.1.8.4	Brush, Bristle	Commercial	
3.1.8.5	Silk Screen	Commercial	
3.1.8.6	Scraper, Plastic	Commercial	

IM-17G
7 June 1989

- 3.1.8.7 Squeegee Commercial
- 3.1.9 Equipment
- 3.1.9.1 Plate Maker, Nu-Arc or equivalent Nu-Arc Company, Inc.
- 3.1.9.2 Gloves, White Cotton Commercial (02-36-44-3560)
- 3.1.9.3 Gloves, Rubber Commercial (02-36-44-3564)
- 3.1.9.4 Etcher, Splash Commercial
- 3.1.9.5 Spray Gun, No. 7, or equivalent The DeVilbiss Co.
- 3.2 Process Flowchart - Processing shall be in accordance with figures 1 and 2.
- 3.3 Supplier-Prepared Stock - Purchased prepared photosensitive stock may be substituted in lieu of Aircraft Division prepared stock or parts except as specifically noted. When purchased prepared stock is used, 3.4 is not applicable.
- 3.4 Preparation of Aluminum Stock
- 3.4.1 Cleaning
- 3.4.1.1 Surfaces shall be thoroughly cleaned prior to the application of photo resist.
- 3.4.1.2 Degrease, using a vapor degreaser, or solvent degrease using clean aliphatic naphtha, or MIBK, and a clean cloth (3.1.3).
- 3.4.1.3 Clean by vigorously scrubbing with a stiff bristle brush, cleanser (3.1.8.1), and hot water. Continue scrubbing until a no-water-break surface is obtained.
- 3.4.1.4 Immediately dry the parts by blowing with clean, dry, filtered air. Do not dry in static air.
- 3.4.1.5 Clean white cotton gloves shall be worn when handling cleaned parts.
- 3.4.2 Application of Resist
- 3.4.2.1 Method I - Application of acid-resistant lacquer by silk screening shall be performed as follows:
- Parts and the ambient air temperature shall be $75^{\circ} \pm 5^{\circ}\text{F}$. Temperatures outside this range will seriously affect the quality of the finished coating.
 - Mask the prepared metal by silk screening the design onto the metal surface with acid-resistant lacquer. Use 10xx to 17xx silk screen and a medium-hard squeegee. Clean screens with MIBK.
 - Allow the applied silk screen image to dry thoroughly.
- 3.4.2.2 Method II - Application of Kodak Photo Resist (KPR) by spraying shall be performed as follows:
- Parts and the ambient air temperature shall be $75^{\circ} \pm 5^{\circ}\text{F}$. Temperatures outside this range will seriously affect the quality of the finished coating.
 - Under darkroom red safelight conditions, position the parts horizontally and apply KPR, as received, by spraying. Slight thinning with KPR thinner may be used, as necessary, to produce a satisfactory coating.
 - Using a suction-cup spray gun and approximately 40 psi air pressure, apply 4 wet coats so that one coat is applied from each of 4 directions. Care shall be exercised to prevent runs and nonuniform coating thickness.

3.4.2.2 (Continued)

d. Dry in complete darkness for 24 hours.

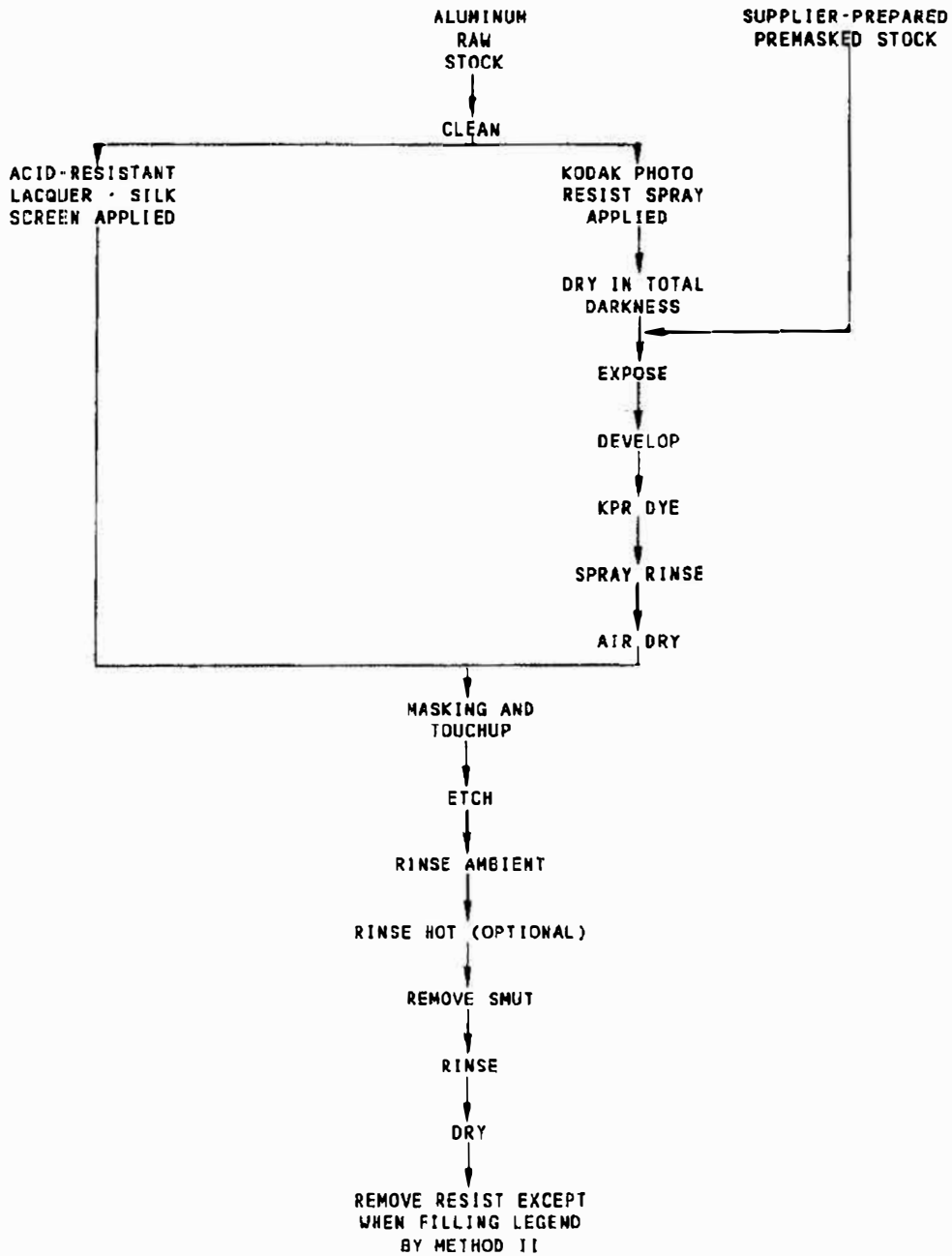


FIGURE 1. PROCESS FLOWCHART - PART PREPARATION AND ETCHING

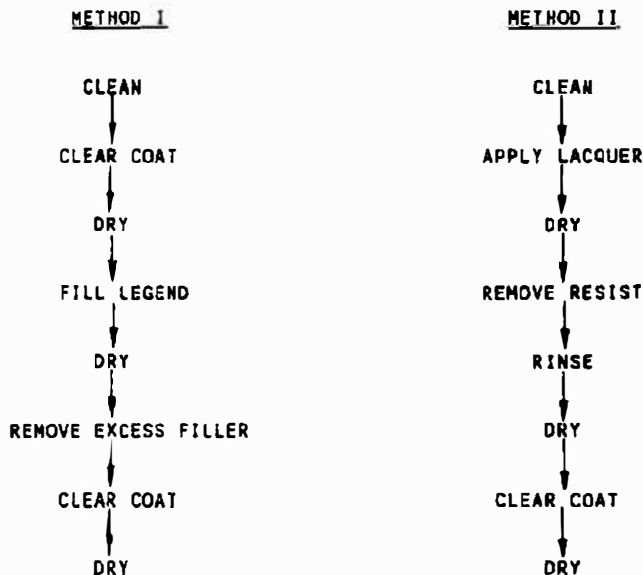


FIGURE 2. PROCESS FLOWCHART - FILLING LEGEND

3.5 Storage - Prepared photosensitive stock shall be stored so that the prepared surface is protected from scratches, abrasion, and exposure to natural or artificial light. Storage temperature shall be from 60° to 90°F. Aircraft Division prepared stock shall be used within 30 days. Supplier photosensitive stock has a storage life of 12 to 24 months.

3.6 Exposure

3.6.1 A film negative or positive may be used depending on the desired final results. The film may be made to meet the actual dimensions of the completed nameplate since all exposures are contact.

 * CAUTION: An over-mask, approximately equal to the depth of etch, may be *
 * required on small fine-line parts or on parts to be deep etched. *

3.6.2 Position the film against the sensitized surface of the part and place both in a vacuum printing frame with the sensitized surface toward the light source.

3.6.3 Expose the film and part to the light source for 45 seconds to 3 minutes using a Nu-Arc light source. Selection of the optimum exposure time for any particular design will be determined by normal photographic procedures. Test exposures and photographic step tables may be used as necessary.

3.7 Developing

3.7.1 The exposed image shall be developed by immersing the part in KPR developer for 3 to 3.5 minutes.

NOTE: Supplier prepared stock may be developed by immersion in liquid trichloroethylene for 30 to 45 seconds. This method is preferred.

3.7.2 Immediately (do not drain) immerse in KPR dye for 10 seconds to 1 minute.

3.7.3 Immediately (do not drain) spray rinse with clean hot water to remove all excess dye.

EM-17G
7 June 1989

- 3.7.4 Blow parts dry with clean, dry, filtered air. Allow to air dry an additional 10 minutes, minimum.
- 3.8 Masking and Touchup - Spray the back and edges of the parts with a continuous coat of acid-resistant lacquer to protect those areas during etching. Irregularities in the image may be touched up with the same lacquer. Allow the lacquer to air dry a minimum of 1 hour before etching. Paper masking tape may be applied to the edges if additional protection is required.
- 3.9 Etching - Wear rubber gloves when working with chemicals.
- 3.9.1 Ferric Chloride Method (Acid)
- 3.9.1.1 Etch the prepared parts in a splash etcher containing a 35- to 42-degree Baume ferric chloride solution at room temperature. Etching time will be dependent on the age and concentration of the etchant, the type of aluminum alloy being etched, and the depth of etch required.
- 3.9.1.2 Immediately rinse in clean cold water to remove all traces of etchant.
- 3.9.1.3 Rinse in clean hot water (optional).
- 3.9.1.4 Immerse in a 5- to 7-normal nitric acid solution at room temperature until all smut is removed.
- 3.9.1.5 Thoroughly rinse in clean water to remove all traces of nitric acid.
- 3.9.1.6 Dry by blowing with clean, dry, filtered air, or wipe dry with a clean cloth (2.3).
- 3.9.2 Sodium Hydroxide Method (Caustic)
- 3.9.2.1 Etch the prepared parts in a 9 to 14.5 percent by weight sodium hydroxide solution at room temperature. The parts shall be agitated while in the etchant solution and shall be removed and examined frequently to prevent excessive etching.
- 3.9.2.2 Rinse thoroughly with clean water to remove all excess etchant.
- 3.9.2.3 Parts requiring smut removal shall be immersed in a 5- to 7-normal nitric acid solution at room temperature until all smut is removed, and then rinsed with clean water until all acid is removed.
- 3.9.2.4 Dry by blowing with clean, dry, filtered air, or wipe dry with a clean cloth (3.1.3).
- 3.10 Removal of Resist and Lacquer - Remove all resist and acid-resistant lacquer from the etched parts by washing with one of the following:
- KPR thinner
 - Methyl isobutyl ketone (MIBK)
- 3.11 Filling of Legends
- 3.11.1 Method I - Application of a clear coating and legend filler shall be performed as follows:
- Clean foreign material from the surface of legend with a clean cloth (3.1.3).
 - Apply a thin clear coating (3.1.6) to legend and surface.
 - Allow to dry until tack free.
 - Apply filler material (3.1.7) to completely and uniformly fill the legend.
 - Wipe excess filler off the surface using a clean cloth (3.1.3).
 - Apply a thin clear coating (3.1.6) to the surface and allow to dry.

IN-176
7 June 1989

3.11.2 Method II - Application of lacquer by spraying shall be performed as follows:

* **CAUTION:** Delete 3.10 when employing this method. *

- a. Clean foreign material from the surface of legend with a clean cloth (3.1.3).
- b. Spray entire legend and adjoining surfaces with lacquer.
- c. Allow to dry until tack free.
- d. Place in flat pan containing trichloroethylene.
- e. Employing a flat plastic scraper, immediately and gently scrape the surface to remove resist and lacquer from raised areas.
- f. Rinse thoroughly in warm water.
- g. Remove any remaining resist with trichloroethylene and a clean cloth (3.1.3).
- h. Dry by blowing with clean, dry, filtered air.

3.12 Finish Protection

3.12.1 All etched nameplates and labels shall receive one coat of clear coating over the face.

3.12.2 Etched nameplates of aluminum alloy that are not adhesive backed or not made of 1100 or 3003 alloy shall be coated on the back with one coat of zinc chromate or epoxy primer.

3.13 Fabrication of Stencils - Stencils may be made using the same procedures as specified above, except that only stencil letters shall be used for the legends, and that etching continues completely through the metal.

* **CAUTION:** Discontinue etching immediately after letters are completely *
* etched away. *

3.14 Safety

3.14.1 Chemicals - The chemicals specified in this document are strong acids and caustics. Care shall be exercised to prevent personal injury. When processing parts, making new solutions, or adjusting concentrations, the necessary safety precautions shall be observed as specified by the Safety Department and the responsible supervisor. Spent solutions shall be handled and disposed of in accordance with federal, state, and local health and safety regulations.

3.14.2 Solvents (Flammable) - The following protective measures shall be employed whenever flammable solvents are used.

3.14.2.1 Electrical Grounding - Electrically operated equipment shall be grounded prior to and during operation and shall be rated by the Underwriter's Laboratory as explosion proof if located within 25 feet of spraying or mixing operations. Major assemblies shall be electrically grounded prior to (and during) cleaning and coating with materials containing flammable solvents to prevent explosion or fire caused by static discharges.

3.14.2.2 Solvent Storage - Solvents shall be stored in approved metal containers with identifying labels permanently attached. Static bonding and grounding of containers used for storing flammable solvents shall conform to the California General Industry Safety Orders section on Flammable Liquids, or equivalent federal, state, and local safety regulations.

IM-17G
7 June 1989

- 3.14.2.3 Solvent Usage - Safety cans shall be used for handling and dispensing solvents and shall be properly labeled. Static bonding and grounding of containers for flammable solvents shall conform to the California General Industry Safety Orders section on Flammable Liquids, or equivalent federal, state, and local safety regulations.
- 3.14.3 Solvents (Nonflammable) - As protective measures, containers used for handling and dispensing nonflammable solvents shall be properly labeled.
- 3.14.4 Solvents (Flammable and Nonflammable) - The following precautions shall be observed whenever flammable and nonflammable solvents are used:
- a. Avoid the use of excessive amounts of solvents.
 - b. Use only in well-ventilated areas.
 - c. Avoid inhaling vapors. If toxic vapors are present, respiratory protection approved by the Safety Department shall be used.
 - d. Avoid contact with eyes and skin. Eye protection, protective gloves, and protective clothing approved by the Safety Department shall be used.
 - e. Store or dispose of solvent-saturated cloths in approved metal containers with self-closing lids.
 - f. No smoking or open flame within 25 feet of any area where solvents are used.
 - g. Disposal of waste solvents shall be in accordance with federal, state, and local health and safety regulations.

4. QUALITY ASSURANCE PROVISIONS

- 4.1 The finished marking shall be inspected for accuracy of legend and quality of workmanship. No visible flaw on the face of the marking is acceptable.
- 4.2 The finished stencil shall have clear-cut letters and numbers in the legend. Flaws on the face of the stencil, not detrimental to the legend, are acceptable.
- 4.3 Filled legends shall be completely and uniformly filled.

5. PREPARATION FOR DELIVERY

This section is not applicable to this specification.

6. NOTES

- 6.1 Information pertaining to this document may be obtained from Aircraft Division, Materials and Processes Engineering (3882/81).
- 6.2 Suppliers may obtain information pertaining to this document or additional copies from Northrop Corporation, Aircraft Division, Materiel (6424/32), One Northrop (3495/32), Aircraft Division.