ROYAL CANADIAN AIR FORCE

METAL PROCESSES

REVISION
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METAL PROCESSES

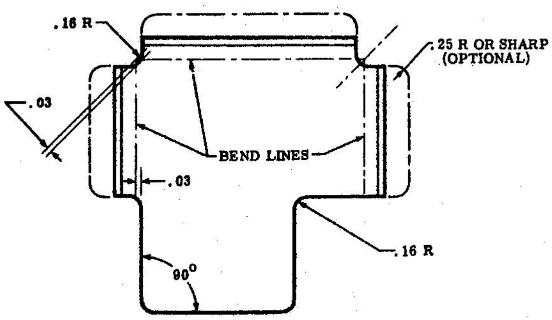
FABRICATION DETAILS

General

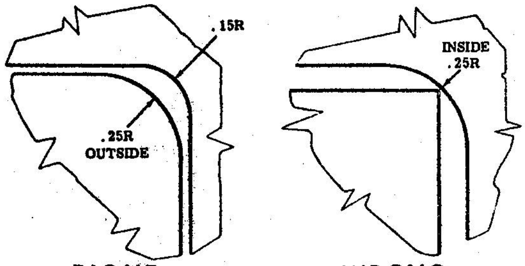
1 The following fabrication details are included for the guidance of personnel engaged in structural repairs. All dimensions shown are in inches. Tolerance on dimensions is ± .030 inch unless otherwise stated. These instructions do not supersede any official drawing or repair manual for the aircraft concerned.

Corner Radii

2 The following are the rules governing corner radii:



(a) Make the inside corner radii .160 inch. When used for bend relief, the .160 inch radius is located on the line bisecting the bend lines and cutting .030 inch into the flat portion of the web.



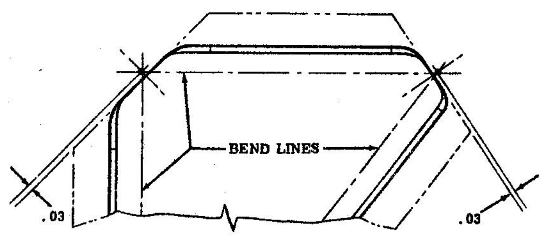
RIGHT WRONG

(b) Make outside corners, except butt-jointed exterior skins, (wing, fuselage, etc.), 90° in the flat pattern and .250 inch radius or sharp, (optional). Lap jointed exterior skins may be round cornered.

(c) Make the outside corners of butt-jointed exterior skins sharp unless otherwise dimensioned on drawing, or where mating inside and outside corner radii produce interference.

Diagonal Cuts

3 Diagonal cuts are to be made as follows:



(a) Where rivet or bolt spacing will permit, corner bend reliefs may be sheared in straight diagonal cut. Such cuts must be perpendicular to a line bisecting the bendlines and cut .030 inch into the flat portion of the web.

Stiffener and Stringer Cutoffs

4 For explanation of drawing callouts of stiffener and stringer cutoffs, see Figure 1.

Extrusion Profiles

5 Advisable tolerance for extrusions which are to have one leg cut away, provided that the resultant projection will not interfere with adjacent parts, is shown in Figure 2.

Bend Radii Minimum

6 Bend radii tables, (refer to EO 05-1-3/25 are charts of minimum allowable bend radii for simple bends in sheet and plate metal, These are not, in any case, to be construed as superseding the drawing. Bending must

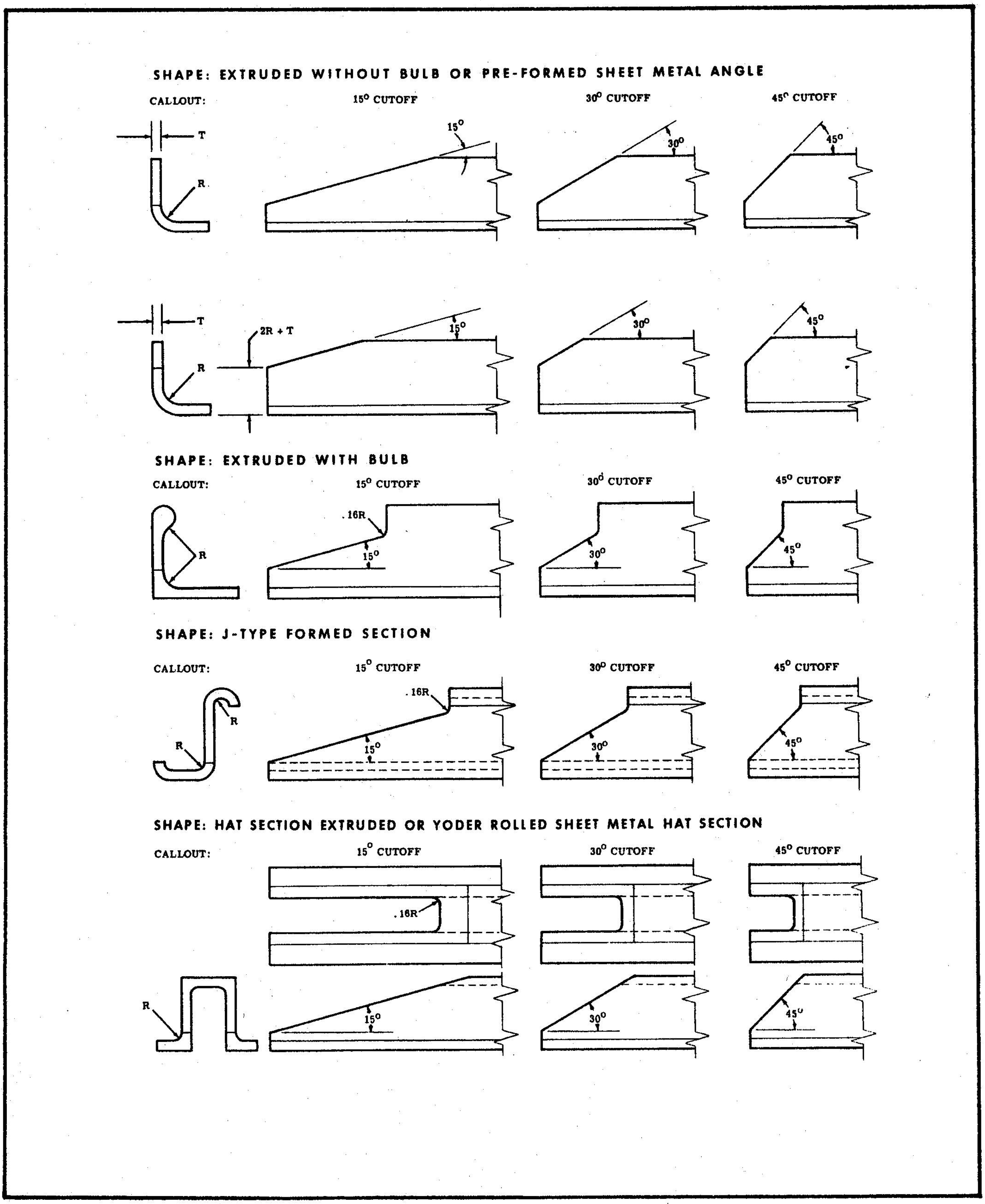


Figure 1 Typical Drawing Callouts

be done to conform with grain direction, (see Figure 4), and hot forming limitations.

Joggles

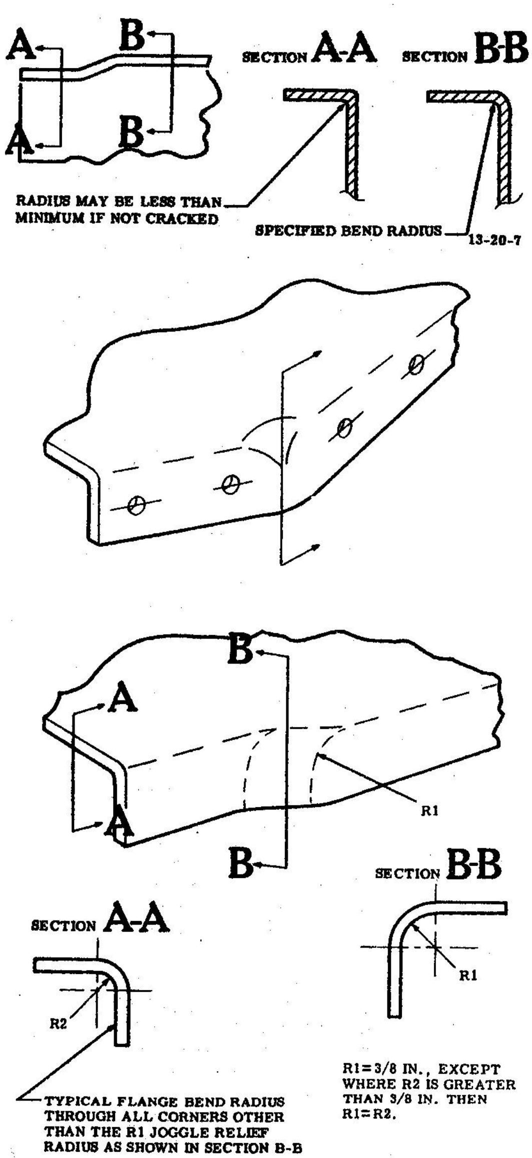
7 Provided no fracture of the metal occurs after joggling, sheet metal parts may have pinched bend radii less than the minimum specified. The bend radius of the flange adjacent to a joggle may be formed as shown to permit more complete forming. The radius must be R1 in the plane as shown. The bend radius at an abrupt change of contour may be similarly rounded off provided no interference with attachments or mating parts occurs at later assembly. Recommended joggle run outs are shown in Figure 3.

Grain Direction

8 For definition of grain direction for bending and forming operations, see Figure 4.

Section Forming (Degreeing)

9 Angular change of flanges of straight aluminum alloy extrusions may be made up to a maximum of 15° open or closed. The angular change may occur away from existing fillets or other non-uniform sections. Where the angle is opened, a concave surface results on the outside of the angle, which should be filed or



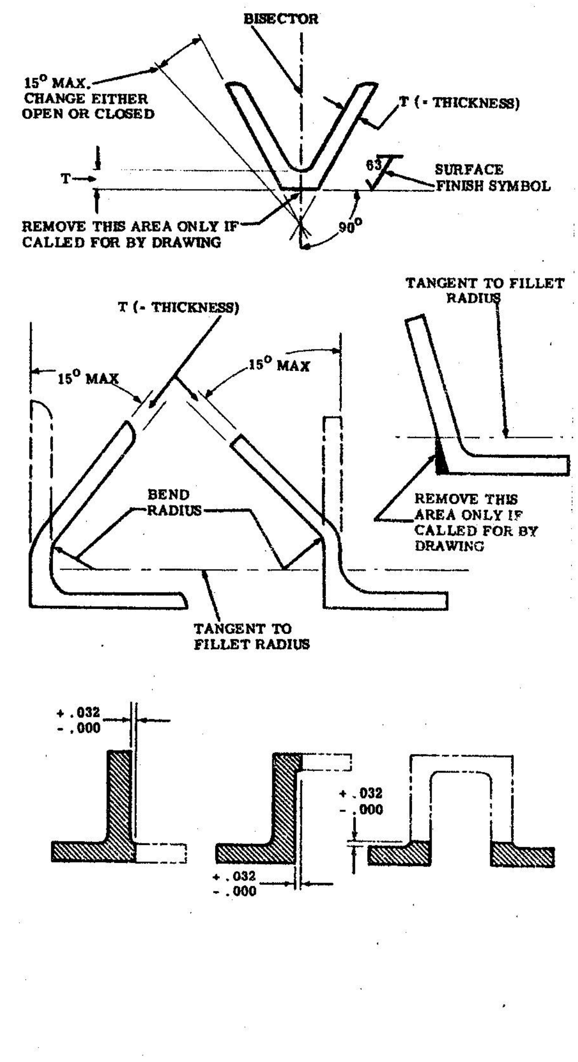
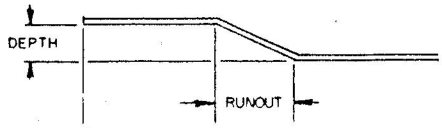


Figure 2 Extrusion Profiles



A - Joggle depth which determines applicability or either "B" or "C" factors. (Equivalent to minimum height allowing reverse curve for a given material thickness at minimum bend radii and for given value of "B")

B - Factor for material formability.

C - Four times recommended minimum bend radius plus twice the material thickness.

If joggle depth is greater than "A"

$$\text{Runout} = B \times \text{Depth}$$

If joggle depth is less than "A"

$$\text{Runout} = \sqrt{\text{Depth}\ (C - \text{Depth})}$$

JOGGLE RUNOUT FACTORS FOR ALUMINUM ALLOYS

THICK-NESS	24S-0 B=3		24S-T3 B=4		57S-0 65S-0 B=3		65S-T4 B=4		65S-T6 B=4		75S-0 B=4		75S-T6 B=8	
	A	C	A	C	A	C	A	C	A	C	A	C	A	C
.012	.015	.149	.016	.274	.009	.152	.009	.152	.009	.152				
.016	.016	.157	.017	.282	.009	.160	.009	.160	.009	.160	.017	.282	.008	.532
.020	.016	.165	.017	.290	.010	.168	.010	.168	.010	.168	.017	.290	.008	.540
.025	.030	.300	.019	.300	.010	.178	.010	.178	.018	.300	.018	.300	.008	.550
.032	.031	.314	.026	.439	.011	.192	.011	.192	.018	.314	.018	.314	.009	.564
.040	.033	.330	.027	.455	.019	.330	.019	.330	.027	.455	.019	.330	.013	.830
.050	.035	.352	.035	.602	.021	.352	.021	.352	.028	.477	.028	.477	.017	1.102
.063	.050	.503	.044	.753	.022	.378	.030	.503	.037	.628	.030	.503	.021	1.373
.071	.064	.644	.060	1.019	.023	.394	.038	.644	.045	.769	.045	.769	.025	1.644
.080	.066	.662	.068	1.162	.032	.537	.046	.787	.054	.912	.054	.912	.030	1.912
.090	.068	.682	.077	1.307	.033	.557	.055	.932	.062	1.057	.070	1.182	.034	2.182
.100	.083	.892	.093	1.579	.041	.704	.063	1.079	.071	1.204	.086	1.454	.038	2.454
.125	.100	1.000	.118	2.000	.052	.875	.074	1.250	.081	1.375	.096	1.625	.050	3.250
.156	.131	1.312	.151	2.562	.062	1.062	.084	1.437	.099	1.687	.129	2.188	.062	4.062
.188	.175	1.750	.221	3.750	.074	1.251	.110	1.876	.132	2.251	.155	2.625	.075	4.875
.250	.237	2.375	.323	5.500	.096	1.625	.176	3.000	.176	3.000	.206	3.500	.100	6.500

JOGGLE RUNOUT FACTORS FOR STEELS

THICK-NESS	1010 (B=4)		1020 1095 (B=4)		4130 (B=4) 1*				CORROSION RESISTANT (B = 4)			
					NORMALIZED		ANNEALED		ANNEALED ②		1/2 HARD	
	A	C	A	C	A	C	A	C	A	C	A	C
.016			.009	.157					.009	.157	.009	.157
.018	.009	.161			.017	.286			.009	.161	.017	.286
.020			.010	.165					.010	.165	.017	.290
.025	.010	.175	.018	.300	.018	.300			.010	.175	.018	.300
.032	.011	.189										
.036	.019	.320	.019	.320	.034	.570			.019	.320	.026	.445
.040	.020	.334	.020	.334	.034	.584			.020	.334	.027	.459
.050	.021	.350	.028	.475	.035	.600			.021	.350	.035	.600
.063									.022	.376	.037	.626
.065	.022	.380	.030	.505	.037	.630			.022	.380	.037	.630
.078	.031	.531	.039	.656	.046	.781			.031	.531	.046	.781
.080			.039	.666	.047	.791						
.090									.033	.563	.055	.938
.095	.033	.565	.055	.940			.033	.565				
.109	.042	.718	.057	.968			.042	.718				
.125	.044	.750	.059	1.000			.044	.750	.044	.750	.074	1.250
.156	.063	1.062	.077	1.312			.055	.937				
.188	.066	1.125	.096	1.625			.066	1.125	.066	1.125		
.250	.088	1.500	.118	2.000			.088	1.500	.083	1.500		

NOTE: - 1* - Factors for 4137, 4337 and 8630 steels are the same as for 4130 steels.

② - Factors for Titanium AMS4900 & AMS4901 are the same as for Annealed Corrosion Resistant Steel

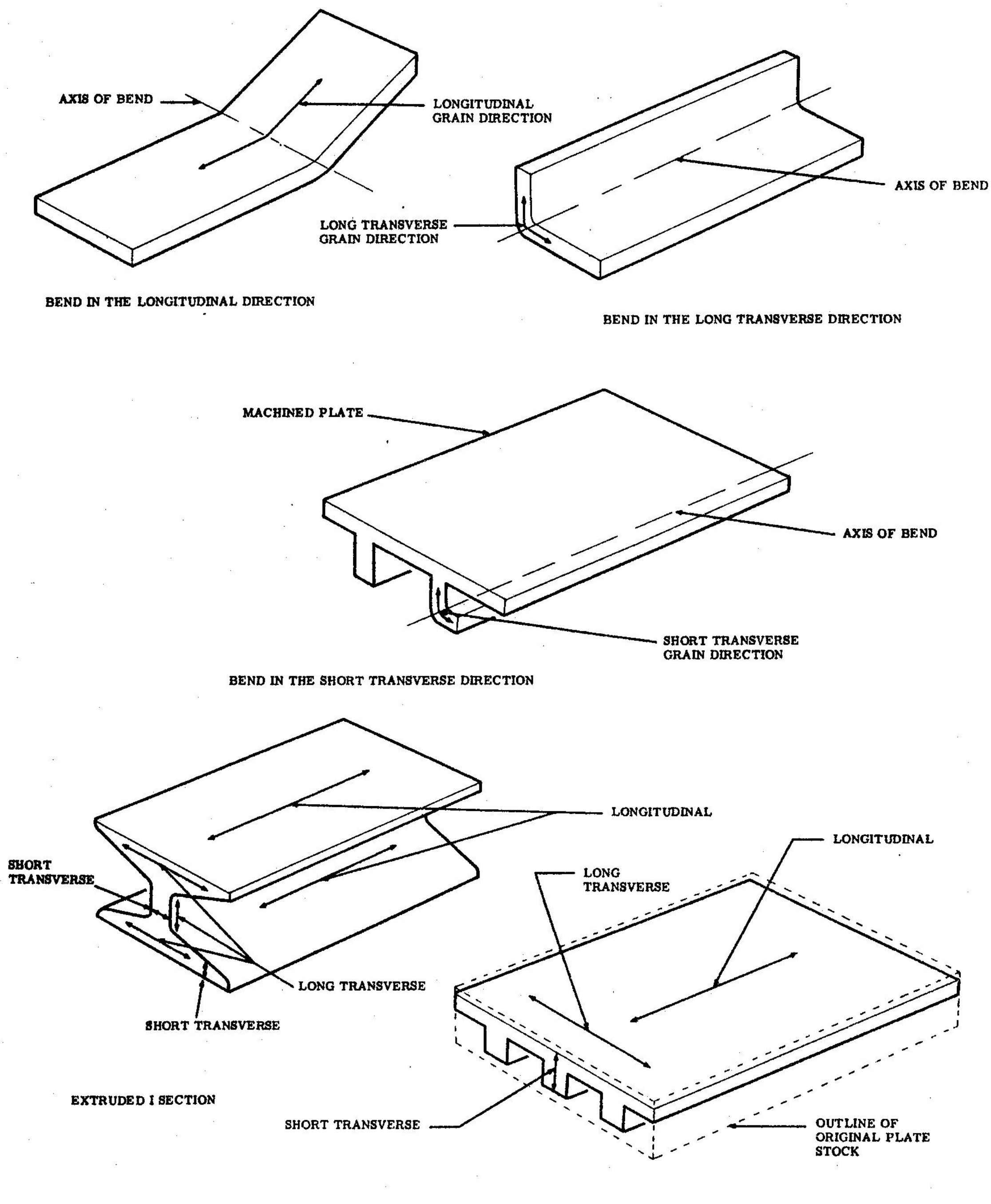


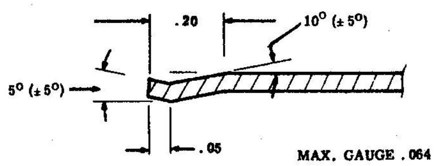
Figure 4 Definitions of Grain Direction for Bending and Forming

milled off only if called for by note on the drawing. The angular change may also be made in the original fillet radius of the flange. The material in the heel of the angle should be filed or milled off only if called for by drawing.

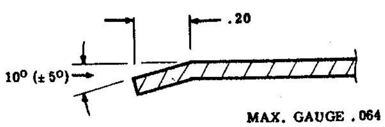
Sheet Metal Edge Crimps

10 The following types of edge crimp are commonly called on drawings:

(a) Type A for doors, skins etc., which are inside the mould line of the airplane, as a stiffening feature to keep such items flat between attachment points.



(b) Type B for fairings and doors which fasten to exterior surface of the airplane.

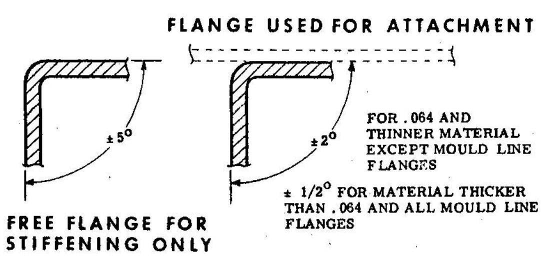


CAUTION

When marking on exhaust stacks, tail pipes or any part of a power plant, do not use pencil. Use only chalk. The use of pencil on metal surfaces that become heated can set up a condition of local case-hardening, a possible starting point for failure.

Tolerance on Flange Angles

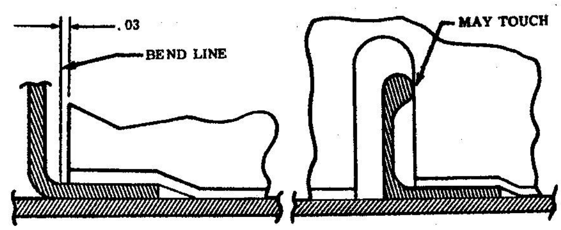
11 These tolerances apply to sheet metal



formed parts, unless otherwise specified on the drawing.

Clearance between Adjacent Parts

12 The distance between bend lines and adjacent parts may be .030 inch or more (plus or minus the tolerance specified in Paragraph 1, preceding). No minimum clearance between adjacent parts need be maintained at standard stringer cutouts provided that contact between stringer and frame does not cause distortion of one or the other. This applies to assembly conditions only. For repair purposes, clearances must be .030 inch or more.



Skin Gap Tolerances

13 Unless otherwise noted on assembly drawings, the gap tolerances between adjacent skins at butt joints must be as follows:

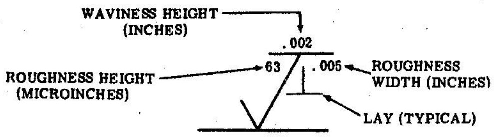
	Max. gap at any point
Fuselage	.090 inch
Wing and nacelle	
Spanwise (or direction generally transverse to airstream)	.090 inch
Chordwise (or direction generally parallel to airstream)	.120 inch
Chordwise for swept wings	.090 inch
Empennage	.060 inch

NOTE

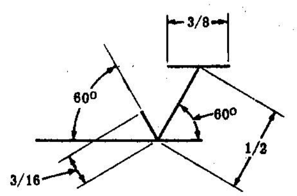
Skins are defined as parts forming the exterior surface of the aircraft.

14 These tolerances do not apply to doors, or to gaps between skin and extruded sections, i.e., skin and extruded trailing edge, etc. Unless otherwise noted on assembly drawings,

SURFACE ROUGHNESS, WAVINESS AND LAY ARE DESIGNATED BY THE USE OF THE FOLLOWING APPROVED SYMBOL:

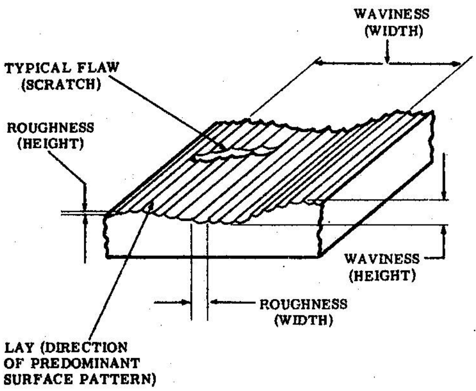


SYMBOL WITH DECIMAL EXAMPLES

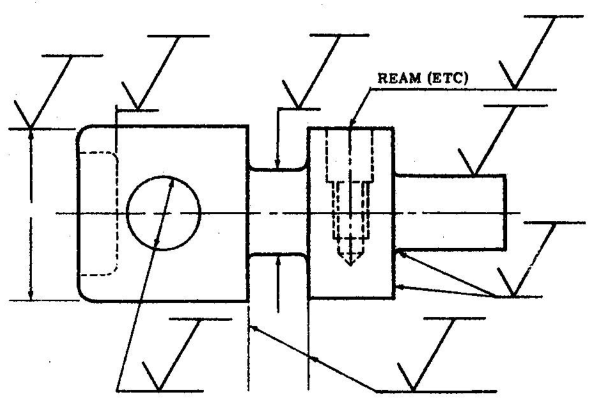


DIMENSIONS (TYPICAL)

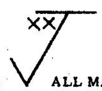
FLAG (OPTIONAL)



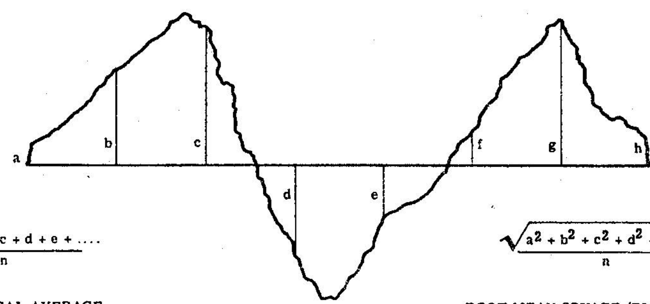
EACH PART OF SYMBOL DEFINED



APPLICATIONS OF SURFACE ROUGHNESS SYMBOL

FOR LIMITING ROUGHNESS OF NON-DESIGNATED SURFACES:  ALL MACHINED SURFACES EXCEPT AS NOTED.

ALL ROUGHNESS HEIGHT RATINGS INDICATE ARITHMETICAL AVERAGE DEVIATION FROM THE MEAN.
THE FOLLOWING ROUGHNESS VALUES IN MICRO INCHES ARE PREFERRED:
2000, 1000, 500, 250, 160, 125, 63, 32, 16, 8, 4, 2, 1.
ALL SINGLE VALUES INDICATE MAXIMUM ACCEPTABLE ROUGHNESS: ANY SMOOTHER SURFACE IS ACCEPTABLE.
IF TWO VALUES ARE GIVEN, THEN BOTH MAXIMUM AND MINIMUM ARE INTENDED.
WHEN THE SYMBOL IS USED IN CONNECTION WITH A DIMENSION IT AFFECTS ALL SURFACES DEFINED BY THE DIMENSION.
AREAS OF TRANSITION, SUCH AS CHAMFERS, FILLETS, ETC., MAY CONFORM TO THE ROUGHEST OF THE ADJACENT AREAS UNLESS OTHERWISE INDICATED.
ROUGHNESS VALUES MUST INDICATE FINISH BEFORE PLATING UNLESS OTHERWISE SPECIFIED.



$$\frac{a + b + c + d + e + \dots}{n}$$

ARITHMETICAL AVERAGE

$$\frac{\sqrt{a^2 + b^2 + c^2 + d^2 + e^2 + \dots}}{n}$$

ROOT MEAN SQUARE (RMS) AVERAGE

Figure 5 Surface Roughness Determination - NAS 30 make maximum gap between adjacent interior sheet metal parts (parts forming interior of aircraft) 0.060 inch at butt joints.

SHRINKING (CRIMPING) OF ALUMINUM ALLOY

General

15 Shrinking (crimping) of aluminum alloy may be used as a supplementary fabrication and rework operation, subject to limitations, as follows:

16 The shrinking operation must not gouge, score or reduce the gauge of the material. Light marking is not objectionable providing the exterior appearance of the aircraft is not affected. Similarly, the edge of the shrunken material must not be notched. Where dimensions permit, notches may be removed by filing. Use of emery, files or burnishing, etc. is not permitted on shrunken surfaces. 75S alloy may be shrunk only in the O or W tempers.

SURFACE ROUGHNESS

General

17 Surface roughness is designated in inches and micro-inches, as shown in Figure 5. A micro-inch equals one millionth of an inch (.000001 inch). The abbreviation is mu. in. There are two methods of averaging the roughness dimension of an area, the arithmetical average, and the RMS (root mean square). The RMS has been widely used in American industry, but is being replaced by the arithmetical average. The latter is the method endorsed by the National Aircraft Standards Committee and is the method adopted in Britain. For the same set of dimensions, the RMS gives a result about 10% higher than the arithmetical average method.

TEMPIL PRODUCTS

General

18 The use of Tempilstik, Tempil pellets, or Tempilaq (Item 1) produced by Tempil Corporation, is a simple effective means of determining temperature accurately, (within 1% of the stated temperature). If the area is accessible, rub the part gently with the Tempilstik. If the area is inaccessible, apply a thin smear of Tempilaq, or a Tempil Pellet to the part. Temperature signal is the appearance of the first sign of liquid due to melting of the Tempil product.

HOT FORMING OF 26S (14S), 24S AND 75S ALUMINUM ALLOYS

General

19 When the design of parts made from 26S, 24S and 75S aluminum alloys is such that forming or straightening in the solution-heat-treated and fully-aged temper is necessary, and when the degree of forming or straightening is such that this cannot be done at room temperature without cracking, then the forming or straightening required may be carried out at an elevated temperature in accordance with the following instructions. Reforming is prohibited, except where specifically approved by engineering authority.

20 The instructions cover the requirements for the hot forming and hot straightening of 26S (14S) 24S and 75S aluminum alloys in the following solution-heat-treated and aged tempers only: (Obsolete temper designations are shown in brackets.)

(a) 26S (14S):-T6 (-T), -T61 (-T), -T62 (-T).

(b) 24S: -T3(-T), -T36(-RT), -T4(-T), -T42 (-T), -T6(-T80), -T62(-T80), -T81(-T8, -T81), -T86(-T86).

(c) 75S: -T6(-T).

Equipment

21 Material to be hot formed or to be hot straightened may be heated by any of the following methods:

(a) In linseed oil baths.

(b) In air furnaces.

(c) Through contact with hot tables.

(d) Through contact with dies and tools having insert heaters or strip heaters.

22 Maintain temperatures in the working zone of oil baths and air furnaces, and on the contact surfaces of hot tables, dies and tools within the temperature limits specified in Paragraph 23, following. To ensure that temperatures are controlled, use thermostatic switches or pyrometers. Manually-operated on-off switches may also be used, provided that Tempilstiks (Item 1) are employed to ensure that the maximum and minimum temp-

erature limits are not exceeded on the contact surfaces.

Procedure

23 Heat the material in or on the equipment specified in Paragraph 21, preceding, to the following temperatures:

(a) 26S (14S): -T6, -T61, -T62	325°(± 25°)F.
(b) 24S: All tempers listed in Paragraph 20 (b) preceding.	300°(± 25°)F.
(c) 75S: -T6	275°(± 25°)F.

24 Time at temperature must not exceed a total of one hour. This time is cumulative; for example, a 24S-T3 part may be heated to a temperature of 300°F for 10 minutes on one occasion, for 20 minutes on a second occasion and for 15 minutes on a third occasion, making the total time at temperature 10+20+15=45 minutes, which is less than the maximum specified. Use Tempilstiks (Item 1) or portable pyrometric equipment to check the surface temperature of all heated material immediately prior to forming or straightening.

HOT FORMING OF MAGNESIUM ALLOY (FS-1, AMC52S, AZ31x) TUBING

General

25 Magnesium alloy tubing which cannot be formed at room temperature may be hot formed using information and equipment as detailed following.

Flaring Equipment

26 Clamping dies of the flaring machine should be heated by electrical elements. Temperatures may be controlled by thermostatic units or Tempilstiks and off-on switches. As an alternative both the end of the tubing and the conically-shaped tool may be heated in hot linseed oil (Item 2) and transferred immediately to the flaring machine.

Bending Equipment

27 Bending blocks etc., may be heated by electrical units. Temperature control may be obtained by thermostatic units or Tempilstiks and off-on switches. The wiping mandrel need not be heated.

Temperature

28 The forming temperature of the tubing should be 450°(± 25)° F.

Procedure for Flaring and Bending

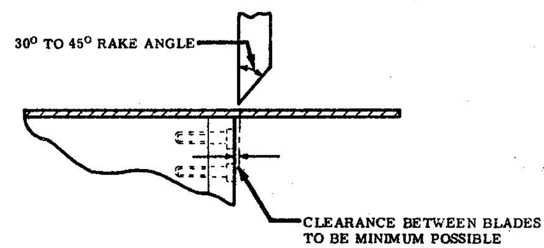
29 Both the flaring and bending operations are carried out in the regular manner. Where hot dies and cold tubing are used, allow sufficient time for the tubing to come up to temperature. Use Tempilstiks frequently. Prior to flaring, cut tube ends square and remove the burr. (Refer to EO 05-1-3/12).

30 After flaring, there should be no cracks present nor any scores which may lead to cracks. Bent tubing should be free from cracks, excessive orange-peel and other imperfections.

SHEARING OF MAGNESIUM ALLOY SHEET

General

31 The following instructions govern the shearing of magnesium alloy sheet:



(a) Sheet .064 inch and less in thickness may be sheared. Clearance between the shear blades must be as small as possible, just short of scoring the blades. A shearing or rake angle of 30° to 45° is recommended on the upper shearing blade.

(b) Sheet over .064 inch in thickness should be either sawn, or sheared oversize then sawn or filed to size in order to remove the cracked or burred edge.

TITANIUM

General

32 Titanium has a dull silver-grey colour similar to that of stainless steel. Several tests may be made to determine whether a part is titanium. Touched on a grinding wheel, titanium gives off white traces ending in brillant white

bursts. Moistened, it leaves grey-white marks when rubbed on glass. Some titanium parts now being used are identified by an etched part number and the word TITANIUM stamped and etched on the part. Titanium is approximately 60% heavier than aluminum and about 40% lighter than stainless steel. It is useful from a strength standpoint to approximately 600° F, while aluminum is useful to approximately 300° F.

33 Titanium is considerably harder than aluminum. Alloys and heat treatments produce hardness equivalent to that of some heat-treated steels. Titanium does not conduct heat as well as aluminum and is subject to hot spots when unevenly heated. It does not expand as much as most other common metals with an increase in temperature. Above 1000° F, oxygen and nitrogen are absorbed in titanium, causing embrittlement. It is therefore not considered suitable for structures encountering this temperature.

34 Titanium starts to melt in the vicinity of 3100° F. In its molten form it combines readily with oxygen and nitrogen and special precautions must be taken to avoid this by using vacuum furnaces. Because of its excellent corrosion resistance, comparable to that of stainless steel, and its resistance to many strong chemicals, titanium is desirable for many uses. Its resistance to sea water and marine atmosphere ranks with that of platinum and is superior to that of stainless steel.

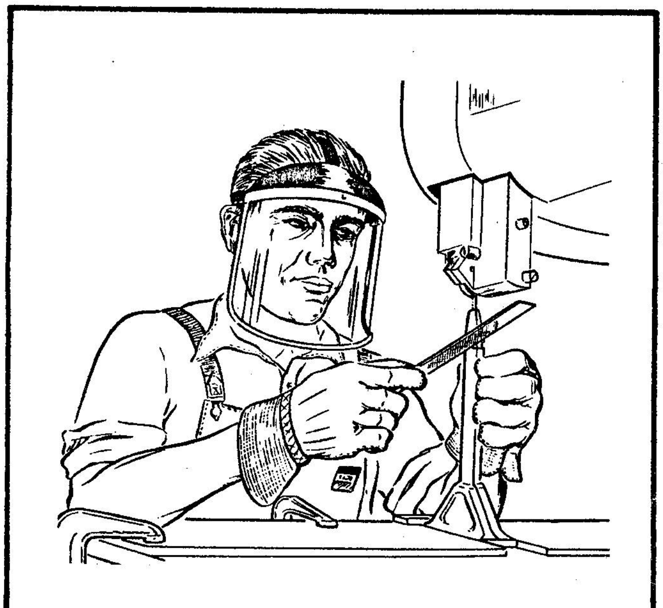


Figure 6 Protective Clothing Necessary

35 Hard coatings are formed at all temperatures. These coatings are very thin and virtually invisible at room temperatures, but discolour and thicken at high temperatures. The visible appearance of the hard coatings is as follows:

Room temperature - very thin coatings are formed.

300°F to 400°F - a light-grey adherent coat to formed.

600°F - straw colour.

800°F - purple.

1000°F - purple gone, metal darkened.

1200°F - dulled by slight deposit.

1300°F - light greenish-grey deposit.

36 Titanium is non-magnetic like aluminum and copper. Its electrical resistance is comparable to that of stainless steel.

NOTE

When performing machining operations on titanium, protective clothing should be worn, (see Figure 6).

Machining

37 Fundamental studies of chip formation and general behaviour of titanium in machining have led to the following observations:

(a) The low modulus of elasticity of titanium makes it necessary to hold both the work and the tool with exteme rigidity to avoid excessive chatter and vibration. For this reason machine tools used for titanium should be rigidly built and in first class condition.

(b) The chips produced when machining titanium are thinner than steel chips and are generally continuous. There is no built-up edge to the chip when titanium is being machined as there is with steel. This relatively thin chip and lack of built-up edge proves that the cutting force is concentrated on a relatively smaller portion of the tool tip, which results in higher temperatures and higher rates of wear. It has been found that tool tip temperatures are relatively more sensitive to speed and feed rates with carbide-tipped tools than with high-speed steel. In spite of this, it has been found that with proper coolants and tip, tool life, rates of metal removal and power requirements are about the same for Titanium alloys as for 1045 steel.

(c) Typical successful tool designs for various cutting operations are shown in Figure 7.

Drilling

38 Hard chrome plating on drills, taps and reamers reduces chip welding. High-speed steel drills with 5% cobalt give longer tool life than the conventional 18-4-1 grades. Drills should be sharp, short, rigid and slightly flatter than those used for stainless steel. Speeds are generally 12 to 15 surface fpm. Feeds vary somewhat in the vicinity of 0.003 to 0.008 inch per revolution. Sufficient power and pressure must be available to keep the drill from riding on the hole. For 1/4 inch diameter holes, 700 rpm may be used as speed guides. For No. 40 holes use 1200 rpm.

39 Assembly drilling may be more troublesome than drilling of detail parts because of the lack of a positive feed when portable drills are used. A practical lubricant for assembly drilling should have paste-like consistency to allow use in vertical or overhead positions. A mixture of beeswax and graphite may be used for this purpose. (See Figure 6).

Tapping

40 Three-flute, interrupted-tooth, spiral-point taps are satisfactory. Hand taps designed for stainless steel may be used. Speed and feed combinations from 12 to 15 surface fpm should be used. Broken tools, such as drills and taps, can be loosened to permit easier removal from titanium parts by submersion of the parts in a saturated solution of ferric ammonium sulphate (Item 3) or nitric acid (Item 4) which does not appreciably affect the titanium.

Reaming

41 Spiral-fluted, high-speed steel reamers have proved satisfactory. Carbide-tipped reamers give good results with a primary clearance of 10° to 15°. Slower speeds of 40 to 70 surface fpm are recommended for the initial reaming. Feeds of 0.005 to 0.020 inch per revolution can be used, increasing with the diameter.

Milling

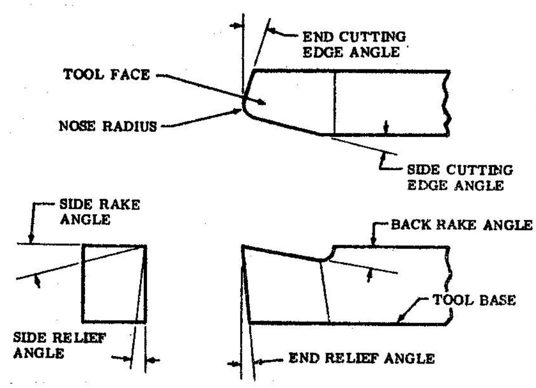
42 For milling, a cutter with a carbide grade similar to Carboloy 883 is recommended at a feed of 0.003 inch per turn in a climb milling operation, i.e., work below centre line of cutter. Dry milling is recommended with a 0° rake angle and a 45° lead angle.

Metal Preparation

43 Titanium blanks may be prepared for forming by shearing, sawing, nibbling or blanking.

Shearing

44 Edge cracking in the plane of the sheet has been observed in shearing operations. This condition can be minimized by the use of sharp blades, by close tolerance between blade and bed, and by hot shearing. Material up to 0.187 inch thick has been sheared on flat bed shears rated for 7-0 gauge mild steel.



Tool	Rake Angle		Relief Angle		Cutting Edge		Nose Radius
	Back	Side	End	Side	End	Side	
HSS - Lathe	0	24	6	6	6	15	.010
Carbide - Lathe	0	6	10	10	5	45	.015
HSS - Shaper	0	28	6	6	6	15.	.030

Figure 7 Typical Tool Angle Determination

Sawing

45 In sawing, lineal blade speeds of 4500 fpm and higher are used. At these speeds, the cutting action is accomplished mainly by friction, and the number and type of saw teeth is relatively unimportant. Conventional equipment may be used if blades are not permitted to ride and if fairly heavy pressures are applied. A similarity exists in sawing titanium and stainless steel, particularly regarding the tendency for the surface being cut to work-harden. Titanium is more likely to wear and clog the saw blade than stainless steel.

WARNING

Fire precautions are necessary because titanium powder burns similar to magnesium and is explosive when suspended in air.

46 Circular saws, with a hydraulic feed and clamp, operate with an upward cutter rotation and a star wheel chip remover. When bandsaws are used, heavy even pressures are necessary, with the widest band consistent with the contours. Special problems are wear of cutting edge of blade, wandering and seizing of blade, and the tendency of heat to close the saw slot around the saw. When power hacksawing, conventional equipment is satisfactory, provided heavy pressures are applied and the blade is not permitted to ride.

Nibbling

47 Nibbling is satisfactory but leaves an irregular edge which usually requires an additional smoothing operation.

Blanking

48 Blanking dies have been used satisfactorily on material up to 0.071 inch thick. Because of the apparent notch sensitivity of titanium, careful attention must be given to the edge condition of blanks before forming. Removal of burr is a minimum requirement. On the more difficult forming operations, filing or polishing of cut edges may be necessary.

Forming of Sheet

49 The formability of titanium is influenced by the following principal factors:

(a) High yield strength.

(b) Low ductility at room temperature.

(c) Sensitivity to rate of strain.

(d) Directional effects.

(e) Low ratio of uniform strain to necking strain (about half that of annealed stainless steel).

(f) Notch sensitivity.

(g) Non-uniformity of properties.

50 The directional effects resulting from sheet rolling are pronounced in bending titanium. When the axis of bend is perpendicular to the direction of rolling, tighter bend radii can be obtained than where the axis is parallel to the rolling direction. In forming, annealed unalloyed titanium behaves like 1/4 hard stainless steel of the 18 Cr-8 Ni type. Presently available titanium alloys, in the annealed condition, are similar to 1/2 hard 18-8 stainless steel. Only with great difficulty can work-hardened titanium be formed by conventional methods. To obtain maximum formability at a given strength level, the use of suitable alloys rather than work-hardened grades is required.

51 Titanium is sensitive to rates of forming. Slow rates are preferred in order to obtain maximum formability. The spring-back resulting from forming unalloyed titanium (70,000 psi yield strength) is approximately equal to that for 1/4 hard 18-8 stainless steel. In alloy titanium, spring-back is about 25% greater than with 1/2 hard 18-8 stainless steel. Hot forming is advantageous because it produces smaller bend radii, increased elongation and less spring-back and accommodates non-uniformity in material properties. (See Figure 8). Refer to Table of Bend Radii, EO 05-1-3/25. Press forming on the hydraulic press is generally more successful than on the mechanical crank type, because of its slower action. Handwork is difficult and undesirable. Heat is required for most handforming operations. Heated dollies and furnaces may be used.

Heat Methods

52 When hot working is required, proceed as follows:

(a) Heat the material 800° F to 1000° F, using the upper end of the range when the forming is severe. Air furnaces, electrically heated and controlled within ± 25° F of the operating temperature, are preferred over torch heating generally, and to obtain uniform heating are mandatory for large parts.

(b) Where torch heating is employed, keep the flame on the slightly oxidizing side and check the temperature with Tempilstiks. (Item 1).

(c) Where cracking or difficulty in forming is encountered on parts requiring two or more forming operations, stress relief, as shown in Paragraph 53, following, may also be used as a partial annealing treatment after any of the intermediate forming operations.

(d) Prior to stress relief, all parts must be vapour degreased in accordance with Paragraph 155, following.

Stress Relief

53 After the final forming operations, all formed titanium and titanium alloy parts (except as noted) must be stress relieved as soon as possible and, in any case, not more than two days after the forming operation has been completed. Stress relief is achieved by soaking the parts for 75 minutes at a temperature of 1000° F. Do not stress relieve the following types of parts:

(a) Dimpled sheets after dimpling.

(b) Parts handworked or straightened to remove stress relief warpage.

Forging Titanium

54 Titanium alloys can be forged without undue difficulty once the fundamentals governing the behaviour of titanium are understood and their significance fully appreciated. Titanium, and most of its forgeable alloys, possess a transformation temperature range similar to that of steel. The top of this temperature range is about 1650° F and the bottom about 1200° F. To obtain a fine grained structure necessary for good toughness, forging should commence not too far above 1650° F and should continue down to as near 1200° F as practical. This temperature range will vary with the specific alloy to be forged. Some operators find that forging below 1550° F tends to cause fracture. All are in agreement that excessive temperatures (over 1700° F) should be avoided. As much reduction as possible should be made between each re-heat and the number of reheats should be kept to a minimum. Re-treat temperature for finishing should be within the transformation temperature range.

55 Titanium absorbs oxygen when hot and does this more rapidly as the temperature is increased. This oxygen absorption can create a hard brittle skin on the forging. To keep this oxygen absorption to a minimum it is best to avoid excessive forging temperatures and to limit the soaking time at temperature to an absolute minimum. Salt bath heating might be useful in some cases.

56 Titanium alloys are somewhat sluggish in flow characteristics. They are generally comparable to 75S aluminum and require approximately the same design limitations. Titanium alloys require about the same forging capacity as 75S aluminum.

Joggling

57 Titanium and titanium alloys can be joggled readily at room temperature. Ratios of joggle run-out to depth (ratio of length to offset) can be obtained which compare favourably with the ratio (8 to 1) normally used for 1/2 hard 18-8 stainless steel. Lower ratios (4 or 5 to 1) can be obtained by heating the dies or parts or both.

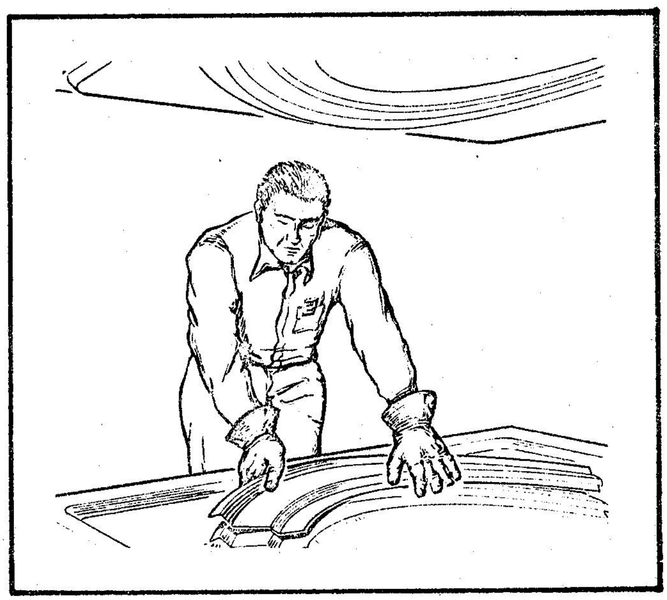


Figure 8 Heating of Blanks

Dimpling and Rivetting

58 For dimpling and rivetting procedures, refer to EO 05-1-3/5.

Welding and Brazing

59 Titanium and titanium alloys can be joined by inert-gas-shielded arc welding, resistance welding and brazing. During welding operations, their ability to absorb gases at high temperatures should be taken into account. Embrittlement during welding may be caused by the combination with these gases or a change in the crystal structure of the metal. Welding titanium to other metals has not generally been successful as yet. Fusion welding of current alloys forms brittle structures which cannot be eliminated except by slow, involved heat treatment. Oxy-acetylene and metal-arc welding are impractical as yet. Chemical cleaning is necessary only where unusual amounts of heat-treat scale are present. The blue or straw-coloured discolouration does not normally cause difficulty. Refer to Paragraphs 64 to 67 following, for cleaning procedures.

Inert-gas-shielded Arc Welding

60 Titanium must be protected from oxygen and nitrogen while being arc welded. Procedures have been developed for manual and automatic welding, both with tungsten and consumable electrodes. A water-cooled copper back-up may be used, but an inert-gas-shield back-up is usually superior. A trailing shield is recommended to provide an inert cover over the hot weld area when welding at high travel speeds with a consumable electrode.

Spot and Seam Welding

61 Satisfactory spot and seam welds can be made in unalloyed titanium, the higher-strength all-alpha alloys, and low-alloy beta alloys, using standard equipment and procedures. Because of the short welding time and the proximity of the sheets being welded, an inert atmosphere is unnecessary. Titanium, in the clean, as-rolled condition, welds readily. Removal of annealing scale and hot forming oxides is necessary. Under most conditions, high-strength welds with moderate ductility can be obtained. A ductility ratio (tensile to shear strength) of about .03 can be expected with unalloyed titanium. Lower ratios are obtained with titanium alloys. Single-phase a.c. spot-welders, such as are used on stainless steel, are suitable for spot-welding titanium. Spot-weld strengths are about the same as those obtained with annealed stainless steel.

Brazing

62 Brazing with a low-melting filler may be particularly advantageous in joining titanium, since exposure to high temperatures in welding is undersirable. Titanium can be brazed with most of the commercial brazing alloys and with pure silver, but the joints produced are generally brittle. Good wetting action can be obtained with induction and furnace brazing in argon without a flux, and with furnace and torch brazing in air with a flux. To minimize the formation of brittle alloy between titanium and the braze metal, a short brazing time is recommended. The joining of other metals to titanium by use of this method is feasible. Pure silver or copper alloy may be applied to titanium with a Heliarc torch, using a very high frequency a.c. welder. Soldering of titanium has not yet been successfully developed for production purposes. Methods of precoating titanium with silver and other materials for soldering are under investigation.

Heat Treating

63 The only heat treatments now feasible for titanium are the stabilizing of forged parts at 1100° F to 1300° F, and stress relieving. (Refer to Paragraph 53, preceding.)

Cleaning and Finishing

64 Light, adherent scale formed on titanium in air below 1300° F can be removed by acid solutions such as:

Nitric Acid (Item 4)	47%
Hydrofluoric Acid (Item 5)	2%
Nitric Acid	10%
Hydrofluoric Acid	2%
Hydrofluoric Acid	10%
Hydrochloric Acid (Item 6)	3%
Hydrofluoric Acid	2%
Sulphuric Acid (Item 7)	10 to 15%

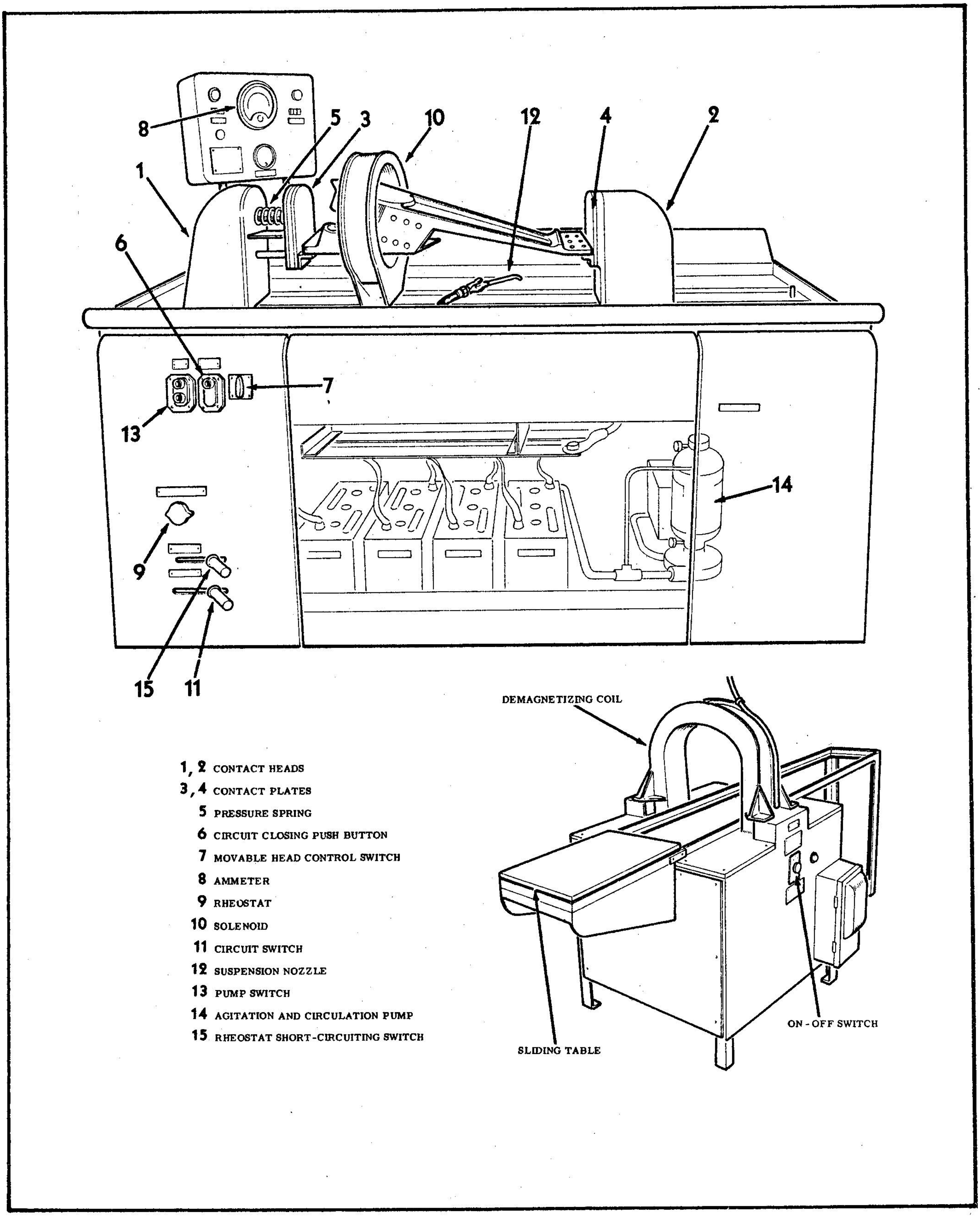


Figure 9 Magnaflux Testing Machine

65 The solution mentioned first is preferred because it dissolves less metal and is less likely to cause hydrogen embrittlement. The following conditions are recommended.

Composition: Nitric acid 48(±2)% to
Hydrofluoric acid 2(±1/2)%
Time: 10 to 20 minutes
Temperature: 80° (±10°)F

66 Comparing the various pickling solutions, those containing the least nitric acid offer the greatest danger of hydrogen embrittlement of the titanium being pickled. Heavy scale formed at temperatures above 1300°F is removed best by molten sodium hydride salt baths at 700°F. Bath temperature must be controlled carefully, because titanium reacts violently with molten salt baths at temperatures above 1000°F. Hot hydrofluoric acid solutions, (5% at 170° to 200°F), will also remove heavy scale but may remove too much titanium metal.

67 Abrasive cleaning is usually restricted to forgings, bars and heavy plate. Shot and grit may be embedded in soft unalloyed titanium and subsequent salt bath or acid pickling is recommended to remove such particles less they cause surface defects. To prevent iron pickup, wire brushing should also be used with caution. When grit-blasting is required, use artificial garnet-type silica-free fused aluminum oxide grit (Item 8, 9 or 10).

68 Grit may be re-used, provided that it has not become contaminated with more than 10%, by weight, of metal. Air pressure must not exceed 50 psi.

Defect Inspection

69 Inspection for defects must be carried out by one of the following methods, special attention being given to edges, holes, etc:

(a) Fluorescent dye penetrant.

(b) Visible dye penetrant.

MAGNETIC PARTICLE INSPECTION MAGNAFLUX

General

70 Magnetic particle inspection is a non-destructive test on magnetizable metals for the detection of defects, such as cracks, seams, laps and inclusions. This test is used particularly for all vital and highly-stressed aircraft parts as a major process inspection and as a required overhaul inspection for the detection of incipient service failures.

Magnetic Test

71 In this test, a magnetic field is induced in the test piece by passing a direct current either through the piece or through a conductor which passes into or through a hole in the piece, or through a coil around the piece. Any interruption on the induced field by a defect in the piece produces a magnetic gap or leakage field attracting iron powder which is applied to the piece. The first method induces a circular field, the second a longitudinal field. The powder can be dusted on the part in dry form or suspended in a light oil and flowed over the specimen by means of a hose. The liquid suspension may also be used on a bath into which the part is dipped. Thus the iron particles are given mobility for response to the magnetic gap or leakage field, where they align themselves along the defect.

Inspection Machines

72 The magnetizing apparatus, (see Figure 9), is constructed to provide uniform controlled operation. The magnetic flux is produced by direct current from generators, storage batteries or rectifiers. The apparatus is capable of inducing, in the piece under inspection, a magnetic flux of suitable intensity in the desired direction by either the longitudinal or circular method. For the longitudinal method, the magnetic flux is induced in the piece by placing the piece in a magnetic field between the poles of electromagnets, or in a solenoid or coil carrying suitable currents. For the circular method, the magnetic flux is induced in the piece by means of a low-voltage high-amperage current passed through the piece, or through a conductor which passes into or through a hole in the piece. A demagnetizing apparatus, (see Figure 9), is required consisting of suitable units such as an open coil or box-type demagnetizer or other means, and having the necessary capacity for the satisfactory demagnetization of all types of pieces inspected.

Magnetic Field Indicator

73 A magnaflux field indicator, (manu-

factured by Williams & Wilson Ltd. Montreal), is required for checking for residual magnetism after demagnetization.

Preparation of Parts Prior to Inspection

74 Prior to inspection by the magnetic particle process, prepare parts as follows:

(a) Remove grease and oil by wiping with a cloth dampened in cleaner (Item 14) or by rinsing in cleaner.

(b) Grit or sand blast rough forgings, if this will facilitate inspection.

(c) Grit blast or wire brush welded assemblies to remove scale and weld spatter.

(d) Prime parts where it is necessary to provide a light coloured background for indications.

(e) Seal off portions of part and assemblies which might be damaged by the magnetic fluid, or which are so shaped that accumulations of the magnetic substance could not be removed. Use hard grease or wood plugs for sealing.

Make-up of Magnetic Fluid

75 Black or red magnetic fluid for the process is made by mixing black Magnaflux No. 7 (Item 15), or red Magnaflux No. 9 paste (Item 16), with kerosene (Item 17) to provide 1.2 to 1.8 ounces, by weight, of magnetic solids per Imperial gallon of fluid applied to parts.

Inspection

76 For all routine work, inspect by the non-fluorescent process (Magnaflux). Carry out inspection by the wet continuous method. Wet implies that a fluid containing magnetic particles is applied to the part by immersion or hose stream. Continuous (as opposed to residual) implies that the current is applied while the part is immersed in the magnetic fluid or just after the hose stream has been removed and the part is thoroughly covered with the magnetic fluid. For the non-fluorescent process with the wet continuous method, use black magnetic fluid for light-coloured parts, and red magnetic fluid for dark-coloured parts. Where the wet continuous method would not give as sensitive an indication as desired, or where there is danger of the magnetic fluid becoming entrapped without complete removal, carry out inspection by the non-fluorescent process with the dry continuous method. Dry implies dry magnetic iron oxide powder is applied to the part by sprinkling. Apply the magnetizing currents shown in the following table during the inspection process:

For the longitudinal method on all parts.	1800 amperes where the magnetizing coil contains 5 turns. 2250 amperes whree the magnetizing coil contains 4 turns.
For the circular method on solid and hollow cylindrical parts.	1000 amperes per inch of outside diameter.
For the circular method on other than cylindrical parts.	1000 amperes per inch of the maximum cross section diagonal (see Note) perpendicular to the direction of current flow.

NOTE

For parts having varying cross-sections, the term maximum cross-sectional diagonal implies that the longest diagonal is considered for each section. The maximum of these longest diagonals is used as a basic for determining the current.

77 Complete inspection must consist of the following:

(a) The production of indications by one or more magnetizing operations in a longitudinal and/or circular direction. The operations must be so conducted that the lines of force produced lie approximately at 90° to any defect which may exist.

(b) An examination of the indications produced in accordance with Paragraphs 86 to 91, following.

(c) An examination to ensure that the article that has passed inspection is marked with the letter (m), dyed or tagged to indicate that it has passed the magnetic particle inspection. The stamped letter (m) is the preferential method of marking, however dye or tags may be used on articles with finished surfaces.

Machine Operations (Circular Magnetization)

78 Clamp the part between the contact heads by moving the adjustable head toward the fixed head until its spring pressure regulator automatically stops the motion.

(a) Place the knife switch in the position marked CONTACT PLATES.

(b) Set the magnetizing circuit rheostat for the required current value.

(c) Use hose to flow the magnetic particle fluid, (refer to Paragraph 75, preceding), over the whole surface of the part. The appearance of the fluid is a visual check on the degree of agitation or concentration of the particles in the fluid.

(d) Cut off application of fluid and at the same instant, press the main contactor delivering the magnetizing current shot to the part.

Inspection

79 Inspect the part for magnetic particle indications. Use the auxiliary light and magnifying glass if necessary.

Demagnetization

80 Demagnetize parts between successive magnetizing operations when necessary to obtain proper indication of defects.

Machine Operation
(Longitudinal Magnetization)

81 Throw the knife switch to the magnetizi coil and position the coil with respect to the part. The current circuit now goes through the coil and the longitudinal magnetic field induced in the part is axial for detection of defects transverse to the part axis. Set the magnetizing circuit rheostat to supply the current necessary for longitudinal magnetization and repeat procedure in Paragraphs 78 (c) and (d), 79 and 80.

Magnaglo

82 Use the fluorescent process (Magnaglo) only where the non-fluorescent process is difficult or impracticable (e.g. on internal bores, on areas where a non-fluorescent particle is hard to see, etc.). Conduct this test in a suitable darkened booth or similarly darkened area with a black light source, provided for the fluorescent process, consisting of a No. H-100-SP4 100-watt black light and Magnaflux No. ZB-3901 filter, (both supplied by Williams & Wilson Ltd., Montreal).

83 Magnetic fluid for the fluorescent process is made up by mixing Magnaglo No. 10 paste (Item 18) with kerosene, (Item 17) to provide 0.12 to 0.48 ounces, by weight, of magnetic solids per Imperial gallon of fluid applied to parts.

Demagnetization

84 After inspection (i.e., after the final magnetizing operation), demagnetize parts completely by means of the equipment provided. Parts may also be demagnetized between successive magnetizing operations, if this improves indications. After final demagnetization, use a Magnaflux field indicator to verify that proper demagnetization has been achieved. Always demagnetize all parts tested.

Cleaning after Inspection

85 After inspection and demagnetization, clean parts thoroughly with cleaner (Item 14) to remove all magnetic fluid or powder. Remove hard grease or wood plugs used for sealing. Clean off the residual grease with cleaner.

Interpretation of Indications

86 All indications resulting from magnetic particle inspection are not defects, or injurious to the functioning of the part inspected. Under certain conditions, grain-flow lines, superficial tool marks, work-hardened areas, etc., are revealed. Therefore, interpretation of indications requires experience and judgement.

Structural Parts

87 Examine suspected structural parts to determine the nature of the flaws. Defects which are confined to the surface, such as laps or gouges, may be removed by grinding, provided that machined surfaces are not damaged nor structural strength impaired. After grinding, the parts must be re-inspected. Rejected parts which cannot be salvaged in this manner must be reduced to produce.

Rejectable Defects on Bolts and Screws

88 The following defects on bolts and screws are cause for rejection:

(a) Seams, inclusions, nicks or gouges deeper than .010 inch on the head.

(b) Cracks in the fillet from head to shank. Longitudinal seams only, up to .005 inch deep, are acceptable in this area.

(c) Transverse indications in the shanks, threads or fillet.

(d) Cracks resulting from heat treatment.

(e) Grinding cracks on the shank or threads.

89 Nearly all failures of bolts and screws occur in the areas shown in Figure 10. Indications in these areas should be given the most careful examination, whereas indications outside these areas are of lesser importance.

Rejectable Defects on Nuts

90 Longitudinal cracks in nuts, which are deeper than .005 inch on the outside or inside and penetrate into either end face, are cause for rejection.

Non-rejectable Defects on all Parts

91 The following false indications and minor defects are not cause for rejection of parts:

(a) False indications, such as magnetic writing (this indication appears as a characteristic scrawl) which may be accidentally produced by rubbing one part against another, thus producing magnetic leakages on the surface of either part. If in doubt, parts should be demagnetized and re-inspected. The indication should not then reappear.

(b) Leakage of flux at the ends of longitudinally magnetized pieces or at abrupt changes of section.

(c) Indications of cold work or hard and soft spots.

(d) Normal machine or die marks.

(e) Inclusions, (refer to Paragraph 92, following).

(f) Minor nicks, scratches or pits.

(g) Minor longitudinal indications in the shank or threads of bolts or screws or on the outside of nuts.

(h) Minor transverse indications on nuts.

(j) Unimportant flaws in nut anchoring ears or small forming tears in lock retaining ears of Boots type nuts.

INCLUSIONS

General

92 Inclusions are foreign materials formed by impurities in the metal during processing. They exist in the form of fine, reasonably straight lines and lie in the direction of rolling in bar stock, or in the direction of grain flow in forgings. Inclusions can be very short or relatively long and, as found by magnetic inspection, may lie below the surface of the part.

Method of Distinguishing

93 To distinguish between a crack and an inclusion, use the sharp edge of a pocket knife blade. The blade will be snagged by a crack. However, the blade test is not always positive and where doubt exists, use the fluorescent penetrant or dye Penetrant method.

Disposition

94 Parts containing inclusions may be considered acceptable for use on the following basis:

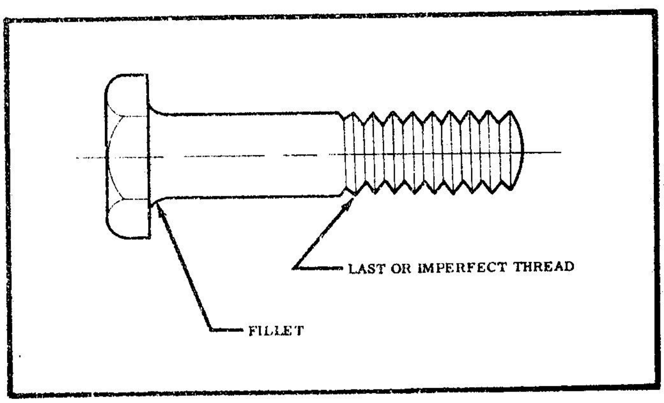


Figure 10 Critical Areas in Bolts and Screws

(a) There is no restriction in the number of inclusions in any one part, nor in the length of any one inclusion.

(b) Inclusions which are not in the same line, running in the direction of rolling or forging, must not be closer to one another than 1/2 inch when there is an overlap nor closer than 1/4 inch when there is no overlap, (see Figure 11).

(c) Inclusions must be fine or sharp line-like in width.

(d) Parts containing one or more inclusions running into fillets, corners, holes, changes in section, etc. are not acceptable.

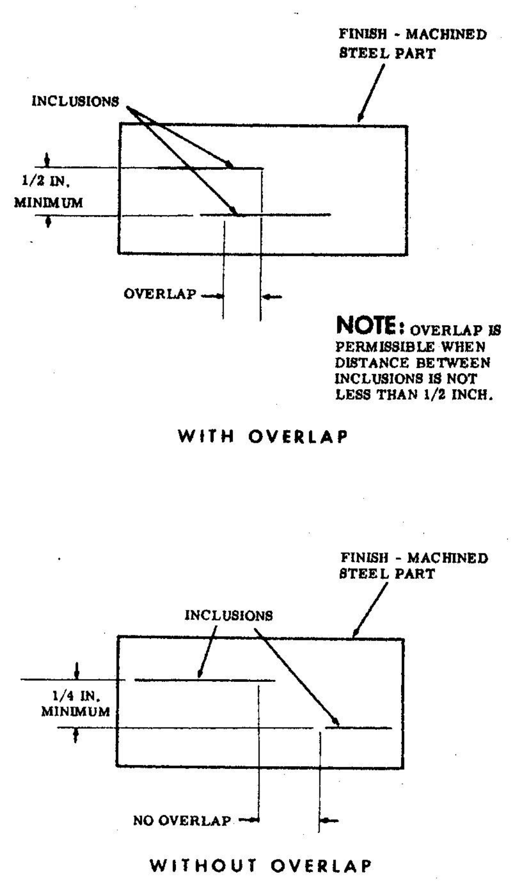


Figure 11 Acceptability of Inclusions

(e) Unless a sub-surface defect is suspected of being a crack for some special reason, it should be considered an inclusion.

B-1955 MAGNETIC INSPECTOR

General

95 The model B-1955 magnetic inspector is similar to the Magnaflux in operation and provides a means of inspection and demagnetization in the same portable unit. It is provided with two handles, an adapter with two spring-type battery clips for attachment to a d.c. supply, iron oxide paste (Item 19) mixed with cleaner (Item 14), an applicator for the solution, a magnifying glass and a compass for determining complete demagnetization after inspection.

Preparation of Parts

96 Clean parts thoroughly and remove scratches or corrosion pits by polishing prior to inspection.

Preparation of Solution

97 Mix iron oxide paste (Item 19) provided, with one gallon of cleaner (Item 14). Ensure the mixture is thoroughly agitated before filling the applicator.

Alternating-current Operation

CAUTION

Before connecting the equipment to the a.c. supply, ensure that the aircraft or its component is properly grounded, and that the magnetic inspector is grounded to the part to be tested.

98 Plug in a.c. supply, either 110 or 220 volts, and place part to be inspected in bore of the magnetic inspector. If part is greater than 5 inches in diameter, place it beside the magnetic inspector.

NOTE

The magnetic inspector should not be left switched on for more than 5 minutes or a thermal cut-out switch, incorporated in the unit, will automatically open the circuit to prevent overheating, and hold it open until the unit has cooled.

99 With current on, apply solution to area to be inspected, (refer to paragraph 97, preceding). The area of greatest flux density is the area closest to but not within the bore of the coil. Area to be inspected must be within area of greatest flux intensity. Move magnetic inspector or part as required. A surface defect will be outlined by a build-up of the iron oxide solution defining the defect, and can then be further examined with the magnifying glass.

Demagnetization

100 After inspection, demagnetize the part as follows:

(a) With power on, draw the part slowly and completely through the field to a point where no magnetic attraction can be felt. If part is too large, or fixed, move the magnetic inspector from the part.

(b) Check for residual magnetism, using compass. Repeat ,previous operation if magnetism remains.

(c) Switch power off.

(d) Disconnect unit from outlet.

(e) Remove ground wire.

Direct-current Operation

101 The DC method of inspection is desirable for checking small parts that can be passed through the coil. In this method the part is magnetized for as long as required and then removed from the magnetic inspector for inspection. Grounding the unit is unnecessary when using DC.

102 Attach extension cord to 24-28 volt DC supply. Insert part in the field of the magnetic inspector. Switch on for a few seconds, switch off and remove part. Ensure adequate magnetization using compass. Apply iron oxide solution and examine part. Repeat above procedure changing axis of part in flux of magnetic inspector.

Demagnetization

103 Repeat procedure in paragraph 102, preceding, using AC power.

Post-inspection Procedure

104 Clean parts thoroughly, using cleaner (Item 14). Dry, using clean cloths (Item 20). Inhibit against corrosion, (refer to EO 05-1-3/23, and blank off openings until ready for re-assembly.

INSPECTION PENETRANT

105 Penetrant inspection is intended for use with parts and assemblies when the material defects or discontinuities are open to the surface e.g., cracks, cold shots, laps and porosity, which may be harmful to the part or basic material. Penetrant inspection is particularly suited to materials where the use of bulky equipment requiring electricity for operation would be impractical.

106 Classification - The penetrant inspection materials shall be of the following groups, each group consisting of one or more families of items.

CAUTION

Each family shall be furnished complete by one manufacturer:

(a) Group I - Consisting of a solvent - removable visible dye penetrant remover (solvent) and a dry, or nonaqueous wet developer.

(1) 6850-21-841-7376 - Inspection penetrant cleaner, solvent type group 1 (16 0z. aerosol container).

(2) 6850-21-804-4782 - Inspection penetrant cleaner solvent type group 1 (1 pint).

(3) 6850-21-841-7373 - Inspection penetrant visible dye solvent removeable group 1 (16 oz. aerosol container).

(4) 6850-21-804-4783 - Inspection penetrant visible dye, solvent removeable group 1, (1 pint).

(5) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(6) 6850-21-819-3732 - Inspection penetrant developer wet, group 1, 2, 3, 4, 5, 6, (lb.) 5 lb. tins.

(7) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.) 5 lb. tins.

(b) Group II - Consisting of a postemulsifiable visible dye penetrant, an emulsifier, and a dry, wet, or nonaqueous wet developer.

(1) 6850-21-819-3731 - Inspection penetrant cleaner, emulsifier group 2 (16 oz.) aerosol container.

(2) 6850-21-819-3729 - Inspection penetrant visible due, postemulsifiable group 2 (16 oz.) aerosol container.

(3) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(4) 6850-21-819-3732 - Inspection penetrant developer wet, group 1, 2, 3, 4, 5, 6, (lb.).

(5) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.).

(c) Group III - Consisting of a water-washable visible dye penetrant and a dry, wet or nonaqueous wet developer.

(1) 6850-21-819-3730 - Inspection penetrant visible dye, water-washable group 3 (1 gal.).

(2) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(3) 6850-21-819-3732 - Inspection penetrant developer, group 1, 2, 3, 4, 5, 6, (lb.).

(4) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.).

(d) Group IV - Consisting of a water-washable fluorescent penetrant and a dry, wet or nonaqueous wet developer.

(1) 6850-21-819-3734 - Inspection penetrant fluorescent water-wash type group 4 (1 gal.).

(2) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(3) 6850-21-819-3732 - Inspection penetrant developer wet, group 1, 2, 3, 4, 5, 6, (lb.).

(4) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.).

(d) Group V - Consisting of a postemulsifiable fluorescent penetrant, on emulsifier, and a dry, wet or nonaqueous wet developer.

(1) 6850-21-819-3735 - Inspection penetrant fluorescent postemulsifiable, group 5 (16 oz.) aerosol container.

(2) 6850-21-841-7375 - Inspection penetrant fluorescent postemulsifier, group 5, (45 gal.) drum.

(3) 6850-21-819-3737 - Inspection penetrant cleaner emulsifier, groups 5 and 6 (1 gal.).

(4) 6850-21-841-7374 - Inspection penetrant cleaner emulsifier, groups 5 and 6 (45 gal.) drum.

(5) 6850-21-841-7377 - Inspection penetrant cleaner emulsifier, groups 5 and 6 (16 oz.) aerosol container.

(6) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(7) 6850-21-819-3732 - Inspection penetrant developer wet, group 1, 2, 3, 4, 5, 6, (lb.).

(8) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.).

(f) Group VI - Consisting of a high sensitivity postemulsifiable fluorescent penetrant, an emulsifier and a dry, wet or nonaqueous wet developer.

(1) 6850-21-819-3736 - Inspection penetrant fluorescent high sensitivity, postemulsifiable group 6 (16 oz.) aerosol container.

(2) 6850-21-819-3737 - Inspection penetrant cleaner emulsifier group 5, 6, (1 gal.).

(3) 6850-21-841-7377 - Inspection penetrant cleaner emulsifier, groups 5 and 6, (16 oz.) aerosol container.

(4) 6850-21-841-7374 - Inspection penetrant cleaner emulsifier groups 5 and 6 (45 gal.) drum.

(5) 6850-21-804-4784 - Inspection penetrant developer nonaqueous wet, group 1, 2, 3, 4, 5, 6, (16 oz.) aerosol container.

(6) 6850-21-819-3732 - Inspection penetrant developer wet, group 1, 2, 3, 4, 5, 6, (lb.).

(7) 6850-21-819-3733 - Inspection penetrant developer dry, group 1, 2, 3, 4, 5, 6, (lb.).

(g) Group VII - Consisting of a solvent-removable fluorescent penetrant, a remover and a nonaqueous wet developer.

107 The group I, group II and group III, visible dye penetrant materials, and groups IV, V and VI, fluorescent dye penetrant material, supersede and are suitable for use in conjunction with type II, visible dye penetrant and type I fluorescent dye penetrant.

Fluorescent Penetrant Inspection

108 Fluorescent penetrant inspection is a method of examining materials and parts whereby surface defects to small to be easily seen by regular inspection methods are rendered readily detectable. Fine cracks, porosity, laps and seams open to the surface are examples of such defects. This method is not used generally in the RCAF because an experienced observer and special equipment are required.

109 The following instructions describe when the various fluorescent method Type I shall be used:

GROUP IV

(a) Method A - Water - washable fluorescent penetrant.

(1) Inspecting large volumes of parts.

(2) Discontinuities are not wider than their depth.

(3) Surfaces are very rough (sand castings).

(4) Inspecting large areas.

(5) Inspecting threads and keyways.

(6) The lowest fluorescent penetrant sensitivity is sufficient to detect the defects inherent.

GROUP V

(b) Method B - Post-emulsifiable fluorescent penetrant.

(1) Inspecting large volumes of parts.

(2) A higher sensitivity than method A, is desired.

(3) The part is contaminated with acid or other chemicals that will harm water washable penetrants.

(4) Discontinuities are wider than their depth.

(5) Variable, but controlled, sensitivities are necessary so that non-detrimental discontinuities can be passed over while harmful discontinuities are detected.

(6) Inspecting parts which may have defects that are contaminated with in-service soils.

(7) Inspecting for stress or intergranular corrosion (use highest sensitivity penetrant).

(8) Inspecting for grinding cracks.

GROUP VI - VII

(c) Method C - Fluorescent penetrant removed by solvent.

(1) Spot inspection.

(2) Water-rinsing method is not feasible because of part size, weight, and surface condition. Only highest sensitivity fluorescent penetrant shall be used to indicate fatigue cracks and stress and intergranular corrosion.

Dye Penetrant Inspection

110 The dye penetrant inspection method is used to detect surface cracks, porosity and through leaks, Examples of such defects

includes shrinkage cracks and shrinkage porosity, cold shots, fatigue cracks, grinding and heat treatment cracks, seams, forging laps and burst; lack of bond between joined metals and through leaks in thin-walled castings, welds or tanks. This method has been selected for general application because of the value where critical inspection is required, the portability and simplicity of equipment and the ease of application and interpretation of results.

111 The following instructions describe when the various dye methods Type II shall be used:

(a) Methods A (Group III) - Water washable visible dyes penetrants.

(1) The lowest sensitivity is desired.

(2) Inspecting large volume of parts.

(b) Methods B (Group II) - Post-emulsified dye penetrant.

(1) More sensitivity is desired than water washable visible penetrants can provide.

(2) Inspecting large volumes of parts.

(c) Method C (Group I) - Solvent-removed visible dye penetrant.

(1) Spot inspection.

(2) When water-rinsing method is not feasible because of parts size, weight, and surface condition.

(3) Small volumes of parts.

112 For the applicable inspection, penetrant methods refer to EO 105-1-2B.

113 Deleted.

TINNING AND SOLDERING

General

114 The following materials and procedure must be used in tinning and soldering steel, corrosion resistant alloys, copper and copper alloys.

(a) Use solder (Item 23) in wire or in bar form with or without rosin core, as required.

(b) Use a high melting point solder (Item 24) when soldering ethylene glycol radiators and other parts subject to higher temperatures than lead and tin solders would stand. It may be obtained in wire, bar and granulated form.

(c) For tinning and soldering in a pot, liquid fluxes are most suitable. With a soldering iron or acetylene torch, paste type fluxes are used most successfully since greater fluidity and adherence are secured. Fluxes (Items 25, 26 and 27) are recommended for general use.

Preparation of Work

115 All materials must be absolutely clean. This is the most important and necessary operation in all soldering and tinning. Paint, oil and grease, etc. are removed as outlined in paragraphs 155 to 158, following:

Tinning Procedures

116 Treat areas to be tinned as follows:

(a) Dip area to be tinned into liquid soldering flux. Use flux, (Item 26) for brass, bronze, and copper; and flux (Item 27) for carbon steel, low alloy steel and corrosion resistant alloys. Flux (Item 27) contains acid, and special care must be taken in the rinsing operation.

(b) Transfer to molten solder pot and hold there until the temperature of the molten solder has been reached.

(c) Remove from solder pot and shake or knock off excess solder.

(d) Rinse thoroughly in frequently changed water, preferably hot. It is desirable that parts be immersed for at least 15 minutes. Brush or wipe to remove clinging flux. Where red flux has been used, a 10% soda ash (Item 28) solution must be used as a neutralizing bath, followed by a clean water rinse and drying. The importance of proper rinsing cannot be too strongly emphasized as residual flux will be a source of future corrosion.

Tinning Details

117 When tinning, note the following details:

(a) Threaded fittings: Immerse in flux and solder just far enough to cover threads.

(b) Preventing tinning in localized areas: Where it is desirable not to have an area tinned, masking may be effected by the application of chalk, (Item 29) talc (Item 30) or soda ash (Item 28) to the surface. A small amount of petroleum oil may be added to the powders as a binder if desired. Subsequent to tinning, solvents and hot water washing must be used to remove any residual powder or oil.

Soldering Procedures

118 The soldering procedure is as follows:

(a) Surfaces to be joined must be free from dust or dirt films.

(b) Preheat, if convenient, to about 200° F.

(c) Apply a small amount of flux to each surface, using approved fluxes as specified in Paragraph 114, preceding. On previously tinned surfaces, keep flux to minimum.

(d) Place together surfaces to be joined. The separation must not exceed .010 inch unless authorized by engineering authority. Highest strength joints are secured when the separation is between .001 inch and .005 inch.

(e) Heat the joint, using soldering iron or torch.

(f) When the joint is hot, place a small amount of solder at the edge. With proper heating and fluxing, the solder should melt and be drawn quickly into the space between the surfaces by capillary action. Such action is termed sweating or sweat soldering. Only enough solder should be added to just fill the space. It is the solder between the surfaces which gives strength to the joint, not the solder on the outside or piled around the edge. Excess solder may be removed while still in the semi-liquid (plastic) stage by wiping with a cloth.

(g) Allow the solder to solidify.

(h) After solidification and cooling, clean the joint thoroughly by wiping, using cleaner (Item 14).

Soldering Special Details

119 For the soldering of special details proceed as follows:

(a) Sealing of hydraulic assemblies: Where drawings call for hydraulic parts to be joined and sealed by sweat soldering, the following requirements must be observed:

(1) Perform operations quickly to prevent corrosion on all unplated parts.

(2) Tin all surfaces to be joined prior to assembly, (refer to Paragraphs 116 and 117, preceding).

(b) Where threaded areas or press fits are joined proceed as follows:

(1) Preheat the parts to melt the solder on the tinned surfaces.

(2) Assemble the parts, tighten threaded joints fully and seal by the addition of sufficient solder to fill the joints. Do not add an excess. Sufficient torch heat must be applied during the above operations to keep the solder in a molten state but do not overheat.

(3) Flux the joint edge, using paste flux to ensure perfect sealing.

(4) Allow parts to cool. Clean thoroughly.

Soldering Electrical Parts

120 For assembly of electrical parts, use rosin core solder (Item 23) only. Both the

liquid and paste fluxes contain chemicals, the corrosive action of which is accelerated by electricity. After soldering, remove traces of rosin by wiping with carbon tetrachloride (Item 31). Refer to EO 05-1-3/9, for further soldering details.

Soldering Oxygen Tubing

121 Refer to EO 05-1-3/12, for instructions regarding the soldering of oxygen high pressure tubing.

Cable Soldering

122 Only soft solder (Item 23) and liquid soldering flux (Item 26) may be used for control cable soldering. For cable soldering procedures, refer to EO 05-1-3/10.

SILVER BRAZING (TORCH)

General

123 All parts to be silver brazed must be cleaned and prepared as outlined in the following paragraphs.

Cleaning

124 All parts to be brazed must be cleaned prior to assembly. (Refer to Paragraphs 155 to 158, following.)

125 Dip copper alloys (brass and bronze) in a solution containing 45% sulphuric acid (Item 7), 7% nitric acid (Item 4) and 48% water by volume. As a final operation, all parts must be cleaned with carbon tetrachloride (Item 31) or in trichlorethylene (Item 32) vapour immediately prior to assembly.

Procedure for Brazing

126 Preparation of parts for brazing is as follows:

(a) Prior to assembly apply flux (Item 33) to all surfaces to be joined.

(b) Assemble parts so that the clearance between the mating surface is within the limits specified on the drawing. Never use interference fits. Staking, pinning, rivetting, tack spot welding or tack arc welding may be used when permitted on the drawing.

(c) Apply sufficient silver brazing alloy (Item 34) in close proximity to one edge of each joint to completely fill the largest clearance encountered on the drawing. For joints having one end inaccessible to visual inspection, apply filler metal at the blind end. For joints having all edges accessible to visual inspection, apply filler metal (Item 34) manually during torch brazing.

Brazing

127 Braze parts as follows:

(a) Heat the joint above the melting and flowing temperature of the brazing alloy but not hotter than is required to make an acceptable joint and in no case hotter than 1600° F.

(b) After brazing, air cool parts to 400° F or less.

(c) Remove flux from brazed parts, as soon as possible after brazing, by immersing the parts in water at 160° to 212° F, for 40 minutes minimum, followed by rinsing in clean running water.

(d) Never heat silver brazed parts above 800° F after brazing.

NOTE

Al brazed joints must have a bond visibly complete at all edges and not recessed more than 10% of the joint depth.

ALUMINUM BRAZING

General

128 Aluminum brazing may be used as a method of joining 2S, 3S, 52S, or 61S aluminum alloy wrought materials and 43, 355 and 356 aluminum alloy castings. Joint types are restricted to corner, fillet, sleeve or inverted flange. Straight butt or flange types are not permitted.

Cleaning

129 Clean all parts thoroughly. Remove oil, grease, dirt and paint as detailed in Paragraphs 155 to 158, following.

Fluxing

130 Prepare flux (Item 35) by mixing the dry powder with water to form a thin paste. Apply by brushing in sufficient quantity to cover the area to be joined. Where desired, flux may be applied to the brazing wire (Item 36).

Brazing Operations

131 Heat the parts with an oxy-hydrogen or oxy-acetylene torch, using a tip of sufficient size to bring the work rapidly up to heat. Use sufficient heat and filler metal (Item 36) to ensure full penetration in all joints.

CAUTION

Avoid underheating or overheating as either of these will result in undercutting or excessive pitting of the material.

Flux Removal

132 Immediately after brazing, remove flux from the parts as follows:

(a) Immerse for 10 minutes in a 10% solution by weight of sulphuric acid (Item 7). Operate at room temperature.

(b) Remove parts from the acid and rinse thoroughly in clean hot or cold water.

(c) Ensure that parts are completely dry. Compressed air or hot air may be used if desired.

Inspection after Brazing

133 Ensure that brazed rivets are surrounded by a smooth uniform fillet and that sheet material surrounding the rivet is not grooved or pitted. Full penetration and smooth fillets must be evidenced in all points, with no pitting.

CLEANING OF METALS

General

134 The following instructions, including material and equipment used for the cleaning of metals, are to be followed for most satisfactory results. The metals covered include aluminum and magnesium alloys, copper and copper alloys, and ferrous alloys.

ALUMINUM AND MAGNESIUM ALLOYS

Mild Alkaline Cleaner

135 The cleaner (Item 37) is an approved type containing a suitable wetting agent and specifically designed for the cleaning of aluminum and magnesium alloys in agitated, heated tanks. It has a detergent effect strong enough to render prior treatment unnecessary unless the parts are coated with oil and grease. The solution is alkaline in reaction and is inhibited against attack on aluminum and magnesium. Oil, grease, etc., must not be allowed to gather on the surface of the solutions. Remove by skimming, overflow or other suitable methods. This method of cleaning is limited to detail parts unless, in assemblies, complete drainage, rinsing and drying can be obtained in pockets, joints etc. Otherwise, vapour degreasing must be used. Refer to Paragraphs 155 to 157, following.

Equipment

136 Use cleaning tanks made of steel, cement or earthenware. Heating coils must be provided. Provision must be made for agitation of the solution by compressed air or other means.

Procedure for Cleaning

137 The concentration of the alkaline cleaner (Item 37) should be 7-1/2 ounces per Imperial gallon. The temperature should be 180° F minimum. Immerse the parts in the solution in such a manner as to permit free circulation at the surfaces being cleaned. Leave immersed long enough to clean the parts completely. Rinse immediately in cold water, then hot water and allow to dry.

Mechanical Cleaning

138 Use mechanical cleaning only as a last resort to remove light or heavy corrosion. Remove corrosion by using approved polishing compounds (Item 38) and buffing wheels or cloths. Treat magnesium surfaces, cleaned by any of the above methods, with a chrome pickle solution as specified in EO 05-1-3/23. Treat aluminum surfaces, where possible, with a 10% chromic acid solution (Item 39) except in those areas where anodizing or chromodizing has purposely been omitted (i.e. integral fuel tank areas, etc.).

Etching

139 Etching may be used for the removal of corrosion from detail parts made of aluminum or magnesium alloys. This method may also be used on assemblies if it is assured that all traces of the etching solution can be removed. Use a shallow wooden tank or an earthenware crock to hold the hydrofluoric acid - gum tragacanth solution, which can be applied with an ordinary paint brush. Motor-driven mixers of the paint mixing type are preferred for stirring the solution.

Preparation

140 For brushing, prepare the solution as follows to make approximately one Imperial gallon:

(a) Add five ounces, by weight, of gum tragacanth (Item 40) to one pint of denatured alcohol (Item 41) and stir to a smooth consistency.

(b) To one Imperial gallon of boiling water, slowly add the gum - alcohol solution, stirring constantly, until a smooth paste is produced. This usually required about fifteen minutes.

(c) Cool the paste to room temperature and then transfer to the tank specified in Paragraph 139, preceding.

(d) Add one-half pint of hydrofluoric acid (Item 5) slowly and with constant stirring.

CAUTION

Use oversize containers to avoid foaming over when adding the gum - alcohol solution to the boiling water.

Operation

141 Brush on copious amounts of solution. Avoid processing too large an area at one time. Keep the solution in motion on the aluminum by constant brushing. Rinse thoroughly in clean, cool water and dry by air blast.

NOTE

Solution must be fresh at all times. If any unused hydrofluoric acid - gum solution remains after 24 hours, discard.

REMOVAL OF AIRCRAFT FINISHES

General

142 Materials used for paint removal are corrosive, toxic and flammable. Safety precautions for doping, painting and paint removal, must be followed during use of these materials, (refer to EO 00-80-4/19). Paint removers can be made from various chemicals and the composition of a particular remover will determine the severity of its attack on material other than paint. Some strippers will dissolve aluminum, stain metals, craze plastics, rot rubber, weaken adhesives and damage wood and fabric. Materials used for the stripping of aircraft finishes are therefore chosen to provide fast efficient removal within safety limits for the aircraft.

Cleaning prior to Paint Removal

143 The action of paint remover is impaired by the presence of oil, grease, mud and other foreign materials on the surfaces. For the same reason, soap films must be thoroughly rinsed from the surfaces. Prior to paint removal, clean surfaces with liquid soap, (refer to EO 50-10-1). The use of emulsion cleaner for aircraft (EO 50-10A-2A) is to be avoided prior to paint removal, since this material leaves a residual oily film which interferes with the action of the remover. After washing and rinsing, the surfaces must be allowed to dry thoroughly. The action of paint remover, is completely stopped in the presence of a film of water.

Protection of Surfaces from Paint Remover

144 Removable parts which consist wholly or in part of plastic, rubber, wood, fabric or non-metallic material must be removed prior to paint stripping. Fixed parts which are subject to damage by paint remover should be masked with wax or by means of other adequate cover. These parts include:

(a) Plastic surfaces (windows, canopies).

(b) Rubber surfaces (de-icer boots, tires).

(c) Fabric surfaces (rudder, ailerons, elevators).

(d) Loop antenna and housing.

145 Instructional stencilling, decals, transfers, warning signs, etc. must be protected by masking or replaced after the stripping operation.

Method of Masking

146 Paper customarily used for masking purposes is ineffective protection against paint remover. For masking use wax (Item 47), as follows:

(a) Using masking tape (Item 48) outline the area to be masked.

(b) Melt the wax (Item 47) and brush a thick coat over the area. The application temperature of wax should be approximately (150° F). Higher temperatures may deform plastic.

(c) Remove masking tape.

(d) After the paint remover has been flushed from the surface, both wax and loosened paint can be removed by a stream of water under pressure.

NOTE

Paint removers, thinners and solvents can seriously deteriorate runways and flooring made from asphalt or similar type material. Choose a work area which will not be damaged by these materials.

Paint Removal Procedure for Metal Surfaces

147 Agitate paint remover (Item 46) thoroughly to break up and disperse lumps of wax which may have separated from the mixture. Remaining lumps may be removed by straining through a 16 mesh screen.

148 The remover may be streamed or brushed on the surfaces. For flow-on application, the material may be fed from a simple pressurized fluid tank to a non-atomizing spray nozzle. An atomized spray must not be used since the volatile solvent will be lost. Paint remover is applied as a wet coat, starting from the highest point on vertical or sloping surfaces and working progressively downwards. Maintain a wet coat throughout by additional applications of remover.

149 The stripping action is usually complete within fifteen minutes. Various films behave as follows:

(a) Enamel surfaces will wrinkle and lift within 5 to 15 minutes.

(b) Lacquer surfaces usually do not wrinkle but are softened by solvent action of the remover in 8 to 10 minutes. Test the lacquer film for slippage and remove it from the metal when loose.

(c) Wash down zinc chromate surfaces, without top coat applied, as soon as possible after loosening of the primer is observed, otherwise the primer may set up on the metal and become very difficult to remove. After rinsing and drying, any primer still remaining on the metal may be re-treated with paint remover.

150 Flush off the stripped paint, using warm water at 100° F under 150 pounds pressure. Cold water at hydrant pressure may be used. Start at the bottom of the surface and work upwards, keeping the water off the unwashed portions. Re-application of paint remover may be required in order to soften and remove completely abnormally thick layers of paint. After flushing, the surfaces must be allowed to dry thoroughly before paint remover is re-applied.

151 Complete the removal of paint and paint stripper from crevices and around rivets by brushing with a stiff fibre brush wetted with a mixture of three parts water to one part ethyl acetate (Item 49). Do not use a wire brush. Wipe dry immediately with a clean cloth (Item 20). Blow out all seams on the stripped surfaces and clean out any paint remover which may have run down inside the fuselage. Rinse and inspect any equipment contacted by the paint remover and replace damaged parts where necessary. Dispose of stripped paint in accordance with regulations governing the disposal of combustible waste.

NOTE

Paint remover (Item 46), or other strippers containing ethylene or methylene dichloride may not be used to remove paint from metal surfaces containing metal to metal bonded joints. Use of such materials seriously weakens the shear strength of the joints. Paint removal from these surfaces is to be accomplished only by use of strippers approved for this specific use or by use of thinners.

Removing Paint from Fabric Surfaces

152 Thinner (Item 50) is to be used for removal of the finish from fabric covered surfaces prior to refinishing. Paint remover is not to be used because it will deposit a residue in the fabric which will cause early failure of the refinished surface. The fabric is to be kept wet with thinner until the coating is softened and removed by scraping with a rounded putty knife or similar dull instrument.

Removing Paint from Wood Surfaces

153 If simple sanding to remove irregularities and to roughen the surfaces is inadequate, paint remover (Item 46) may be used. Avoid prolonged contact of the stripper with the bare wood, since the wood will absorb some of the wax and make good refinishing difficult. The loosened paint is scraped away with a dull instrument and the remaining paint and stripper is to be removed from the wood surfaces with thinner (Item 50). Water must not be used to rinse off the remover since water will cause wood to swell. After the solvents have evaporated, the surface must be sanded with fine sandpaper prior to refinishing.

CAUTION

Ground aircraft. Keep away all sources of sparks and flame. Protect eyes and skin. Rinse contacted areas at once with water. Avoid applying paint remover in the hot sun. Avoid soaking parts in paint remover. Keep masked areas and markings free from remover. Keep paint remover one inch or further away from the edge of plexiglas. Do not use caustic cleaning compounds, metal scrapers, wire brushes or emery cloth for paint removal from aluminum or magnesium surfaces. Read and follow EO 00-80-4/19.

Cold Cleaners

154 The following cold cleaners are approved for use on aircraft exteriors:

(a) Mulsirex (Item 42) and Mulsine (Item 43) are to be used following the manufacturers instructions.

(b) Steam aero brightening agent (Item 44) is approved for all cleaning of aluminum alloys following paint stripping operation. The compound must be dissolved in boiling water, using three-quarters of an ounce of the compound to one Imperial gallon of water. Spray the mixture on with steam gun cleaning equipment.

Vapour Degreasing Equipment

155 The following equipment must be available for vapour degreasing:

(a) An approved type tank equipped with heating and condensing coils.

(b) Thermostatic controls to maintain the outlet water temperature in the condensing system at 95° to 105° F, and the temperature of the heating system at 188° to 195° F.

(c) Stabilized trichlorethylene (Item 32).

Vapour Degreasing of Tubes and Ducts

156 Place tubes and ducts into the degreaser, individually or in bundles, as nearly vertical as possible. Flush clean, hot (160° F minimum) degreaser fluid through each unit until the parts are clean. The volume of liquid used must be sufficient to ensure that the complete internal area is in contact with liquid throughout the flushing operation. Allow complete drainage to take place. Ensure that degreasing fluid (Item 32) does not remain trapped in bends, etc. After this treatment, seal parts until ready for installation in the aircraft.

Vapour Degreasing of other Equipment

157 Load parts into the degreaser so that the greatest surface area is exposed to the vapour. Contact with the vapour must continue until condensation on the parts ceases. Parts must be lowered into and raised out of the degreaser not faster than 7 to 11 feet per minute.

CAUTION

Avoid inhaling trichlorethylene vapour. Smoking or the presence of flames in the vicinity of the degreaser is prohibited.

Organic Solvents

158 When vapour degreasing or alkaline degreasing is not practical, trichlorethylene (Item 32), carbon tetrachloride (Item 31)

naphtha (Item 51) or other suitable organic solvents may be used with a clean cloth to remove oil and grease.

Cleaning Exterior of Aircraft

159 To clean the exterior of the aircraft, proceed as follows:

(a) Remove excess sealing compounds, grease, etc., using solvent such as lacquer thinner (Item 52) or ethyl acetate (Item 49).

(b) Clean the aircraft by spraying with an approved brightener, (Items 42, 43 and 44) and scrub thoroughly with a bristle brush.

(c) Rinse with water, preferably warm.

COPPER AND COPPER ALLOYS

General

160 Clean copper and copper alloys by one of the methods described in the following paragraphs.

Mechanical Cleaning

161 Use light sand-blasting, wire brushing or similar mechanical methods to remove light oxide and tarnish from copper and copper alloys. Use organic solvents, (refer to Paragraph 158, preceding), to remove oil and grease.

Sulphuric Acid Cleaning

162 Clean parts which are heavily scaled as a result of brazing or soldering in a 10% sulphuric acid solution for 20 to 30 minutes at room temperature. Rinse with hot water and dry in an oven at 200 to 250° F, or with compressed air.

FERROUS ALLOYS

General

163 Ferrous alloys are cleaned by any one of the methods outlined in the following paragraphs.

Mechanical Cleaning

164 Remove heavy scale, oxide film or rust by sandblasting or wire brushing until parts are clean. Sand-blast lightly, using a non-metallic grit (Item 10). Non-metallic must not contain more than 10% by weight of iron contamination when used on stainless steel parts. Stainless steel parts require passivation after sandblasting. Thin gauge sheets and parts to be resistance welded must not be sandblasted.

Degreasing

165 Degrease excessively greasy parts before sand-blasting by using Royalite (Item 56). This material is designed for the cleaning of ferrous alloys in agitated heated tanks. Use a concentration of 6 ounces per Imperial gallon at a temperature of 180° F minimum and vapour degrease as specified in Paragraph 156 or 157, preceding. Organic solvents may also be used, as specified.

Removal of Scale, Oxide Film and Rust from Non-stainless Steels

166 Non-stainless parts which cannot be conveniently cleaned by the grit blast methods specified in Paragraph 164, preceding, shall be pickled as specified herein. If required, degrease parts according to Paragraph 165, preceding, before pickling. Use a leadlined or other suitable tank to hold the acid solution.

Operations

167 Pickle heavily scaled parts in a mixture of two parts sulphuric acid (Item 7), one part hydrochloric acid (Item 6) and ten parts tap water at a temperature of 160° to 180° F. Use a pickling solution containing an approved wetting agent (Item 55) and an inhibitor (Item 54). After pickling, rinse parts thoroughly in agitated clean water.

Wetting Agent

168 Ridosal (Item 55) wetting agent is approved for the above solution. One Imperial pint of Ridosal should be added for every thousand gallons of solution.

Inhibiting Agent

169 Rodine (Item 54) is approved for inhibiting non-stainless steel pickling solutions. The amount added should be .5% by volume of the total amount of concentrated acid used.

Relief of Hydrogen Embrittlement

170 Refer to EO 05-1-3/23, for instructions regarding the relief of hydrogen embrittlement.

Pickling of Stainless Steels

171 Pickling may be performed only on thin gauge stainless steel parts where blast cleaning would cause distortion. Otherwise, blast cleaning is to be used throughout.

Equipment

172 Use a tank lined with a suitable acid resistant material such as bitumastic, Koroseal etc.

Procedure

173 Immerse parts or assemblies in solution of 12% nitric acid (Item 4) and 6% hydrofluoric acid (Item 5), by volume, at room temperature until free from rust or scale. Rinse parts thoroughly in clean, agitated water, then dry in an air blast and passivate, (refer to Paragraph 175, following).

Pickling of Formed Stainless Steel Parts

174 Pickle lead or Kirksite-die formed parts (a passivating solution may be used) before any subsequent heating operation is performed. The pickling need only take place until the evolution of gas bubbles ceases.

Passivation

175 As a final operation, assemblies for exhaust systems, such as stacks, collector rings, preheaters, supports for rings, etc., must be immersed in a 50% solution of nitric acid (Item 4) at room temperature for a period of two hours. As an alternative a 20% nitric acid solution at 130° (±5°) F for 40 minutes may be used.

Electro-cleaning

176 Use electro-cleaning whenever specified.

Equipment

177 Use a steel tank provided with iron heating coils and with nickel plated steel cathode bars approximately four inches wide suspended from nickel-plated copper conductor bars placed along the two long sides of the tank. Place the anode conductor bar, from which the parts to be cleaned are suspended, midway between the cathode conductor bars. Provide adequate transverse ventilation for this tank.

Operation

178 Clean the degreased parts in an electro-cleaner of the following composition:

(a) Sodium carbonate (Item 28), 5 ounces per Imperial gallon of water.

(b) Trisodium phosphate (Item 57), 5 ounces per Imperial gallon of water.

(c) Sodium hydroxide (Item 58), 1/2 ounce per Imperial gallon of water.

179 In the electro-cleaning process, make the parts the anode for 3 to 5 minutes at a current density of approximately 50 amperes per square foot. At this current density, a vigorous evolution of hydrogen gas occurs. To secure proper cleaning action ensure that the temperature of the solution is 195° F or more. Rinse parts in warm water immediately after cleaning.

NOTE

Magnet C cleaner (Item 59) is an approved substitute for the electro cleaner specified above. It should be used on the basis of 12 ounces per Imperial gallon.

Relief of Hydrogen Embrittlement

180 Refer to EO 05-1-3/23, for instructions regarding the relief of hydrogen embrittlement after electro-cleaning.

Cleaning of Springs

181 Prior to plating, grit-blast scaled springs, using a fine grit (Item 10) and an air pressure of 40 to 50 psi, or clean by vapour degreasing. Other methods require approval of engineering authority.

HEAT-RESISTANT ALLOYS OTHER THAN STAINLESS STEELS

General

182 Clean heat-resistant alloys, such as Hastelloy CN-155, Inconel, etc. as described in the following paragraphs.

Degreasing

183 Degrease by either of the methods described in Paragraphs 156 and 157, preceding.

Removal of Scale and Welding Flux

184 Remove scale and welding flux by pickling in a solution of 50% (by volume) concentrated nitric acid (Item 4) and 10% (by volume), of concentrated hydrofluoric acid (Item 5), at room temperature for 5 to 30 minutes, until all scale and flux are removed. The removal may be accelerated by scrubbing parts with a brush. Rinse parts thoroughly in clean, agitated (hot or cold) water, and follow by completely drying in an air blast. For selective pickling, degrease the areas to be protected as described in Paragraphs 156 and 157, preceding, and follow by coating with Unichrome stop-off lacquer (Item 60).

ELECTROFILM DRY LUBRICANT

General

185 Use the following procedure for the application of Electrofilm dry lubricant to parts when called for by drawing. This procedure does not cover the Electrofilm process for electrical resistance heating compounds.

Preparation of Parts

186 Prior to the application of the Electrofilm compound, parts must be treated as follows:

(a) Non-stainless steel and cadmium plated parts: Phosphate treat in accordance with Part 23, following.

(b) Stainless steel, chromium and nickel plated parts, copper and copper alloys: Grit-blast very lightly using Blastite (Item 10), Arrowblast (Item 9) or equivalent aluminum oxide grit with a No. 100 grit size. Passivate stainless steel parts after blasting in accordance with Paragraph 175, preceding.

(c) Aluminum and aluminum alloys: Anodize in accordance with EO 05-1-3/23, except that the rinsing after anodizing must be done in cold water instead of hot water.

(d) Magnesium alloys - Apply dichromate treatment (Dow No. 7) in accordance with EO 05-1-3/23.

Thermosetting Plastics

187 Grit-blast very lightly at an air pressure of 40 to 50 psi using aluminum oxide grit (Item 9 and 10) with a No. 100 grit size. After any of the above treatments, do not hold parts longer than 24 hours prior to the application of the dry lubricant. Handle in such a manner that the parts do not become contaminated with grease or dirt.

Application of Electrofilm Compound

188 Dilute the compound (Item 61) with solvent (Item 62) or para-dioxane (Item 63) on the basis of 4 parts solvent to 1 part of compound, measured by volume. Mix thoroughly and then strain to remove any particles which do not become dispersed.

189 Using a Binks gun (Model 15), a Binks nozzle (Type D76S) or equivalent and an air pressure of 20 to 30 psi, spray the parts to give a coating thickness of .0003 to .0005 inch. When the fit of the parts is very close, as indicated by drawing, a smaller coating thickness may be applied. The compound should come out of the nozzle in the form of a very fine mist. Agitate the mixture in the spray gun constantly to prevent separation from taking place. Air agitation may be used. Always spray in a spray booth due to the toxic nature of some of the compounds.

190 Where it is impractical to use a spray gun, coat parts by immersion in a mixture diluted in accordance with Paragraph 188, preceding. Remove any drops or tears which develop after the compound is allowed to drain. Spray where possible.

191 When required, mask parts in the same manner as for painting processes. The masking tape should be removed prior to baking.

Curing of Electrofilm Compound

192 Cure the electrofilm compound as follows:

(a) For copper and copper alloys, and steel parts both plated and unplated, bake at 400° (±25°)F for forty-five minutes.

(b) For aluminum, aluminum alloy and magnesium alloy parts, bake at 300°(±25°)F for one and one-quarter hours.

(c) For thermosetting plastics, bake at 250°(±25°)F for two hours.

Quality Requirements

193 After the preparatory treatment described in Paragraphs 186 and 187, preceding, the parts must be clean and uniform in appearance. Non-stainless steel parts, plated and unplated, must not appear too grainy after the phosphate treatment. After spraying the compound and prior to and after baking, the coating must be uniform in appearance, free from tears, voids, etc. After baking, the coating is to be resistant to finger-nail scratching.

194 The cured coating must pass the following adhesion test:

(a) Firmly apply the adhesive surface of fresh tape (Item 64) to the coated surface to be tested and remove the tape in one abrupt motion.

(b) The adhesion of the coating is considered satisfactory if no flakes or large particles of the film adhere to the tape. A faint uniform covering of powdery material adhering to the tape shall not be cause for rejection.

195 No additional finish is required for those surfaces of the parts which have been coated with Electrofilm.

ANTI-CHAFING MIXTURE

General

196 The procedure to be followed and materials used for the lubrication of such parts as engine cowling chafing pads in order to reduce wear due to chafing and abrasion is detailed in the following paragraphs.

Preparation

197 Make up the lubricating mixture by mixing 1 part of powdered graphite (Item 53) with 2 parts of fresh Bostik C cement (Item 65) to give a paste of suitable consistency for brush application.

Procedure

198 Apply the lubricating mixture with a paint brush and allow to dry before assembling the parts. When removal of the anti-chafing compound is required, benzol may be used.

APPLICATION OF NON-PEELABLE PLASTIC COATING TO AIRCRAFT EXTERIORS

General

199 Use the following procedure for the application of non-peelable plastic coating to the exterior of the aircraft.

(a) Thoroughly clean and polish the aircraft with approved cleaner (Item 45).

(b) To obtain best results, remove any residual cleaning compound from around rivets heads, skin laps, etc.

(c) Degrease small areas at a time, using brush-wash thinners (Item 68) and clean cloths.

(d) Spray plastic coatings (Item 66 or 67) at a temperature of 70°F, using 45 to 55 psi air pressure, keeping the nozzle about one foot away from the surface being coated. One return pass of the spray gun will normally assure complete coverage.

(e) When necessary, reduce the plastic solution to spraying consistency by the addition of thinners recommended by the supplier.

(f) The sprayed coating should be smooth, free from orange peel and about 0.0005 inch thick.

This plastic coating will retard corrosion but will not prevent it indefinitely. Stored or parked aircraft should be examined periodically. The treatment prescribed is for unprimed and unpainted aluminum, aluminum alloy and steel but not for fabric surfaces.

(g) When it is desired to remove the film, use brush-wash thinners (Item 68) and cloths (Item 20).

PREPARATION OF EXTERIOR SURFACES OF AIRCRAFT FOR LOCAL PAINTING

General

200 The procedure to be followed in the cleaning of exterior surfaces of aircraft prior to the application of paint, lacquer, insignia or exterior markings when the rest of the aircraft is to be left bare, is to be found in the following paragraphs.

Cleaning of Exterior Surfaces

201 Remove any paint, lacquer, primer, etc. Remove any superficial corrosion with cleaner, (Item 45) then proceed as follows:

(a) Apply the compound, over an area approximately two feet square, with a clean cloth that has been dipped in water and wrung out.

(b) Rub vigorously with a crosswise motion until corrosion is removed.

(c) Remove excess cleaner with clean, dry cloth (Item 20). Change the wiping cloth frequently.

202 For large areas, spray the surface with a mixture of 1 part of Mulsirex (Item 43) to 7-1/2 parts of cleaner (Item 14). Allow to stand for approximately twenty minutes and then wash down with a steam jet. Etch the metal surface with phosphoric acid treatment as specified in EO 05-1-2AH. Proceed as follows:

(a) Treat assemblies containing magnesium parts with extreme caution. The etchant readily attacks magnesium and must not be allowed to contact any magnesium parts.

(b) Apply the etching solution with a swab or brush and allow to remain on the surface for one to two minutes. Keep the etchant out of seams and faying surfaces.

(c) The etching action usually causes a white frosting of the surface, and the etchant should be kept off areas not to be painted. For insignia and exterior markings, etch the complete area on which the insignia or markings are to be applied. Ensure that the surface etched is no larger than required. The frosting can be removed by polishing when necessary. The etchant also has a solvent action on primer and paint and should not be allowed to contact primed or painted surfaces.

(d) Scrub the surfaces lightly and rinse thoroughly with water.

CAUTION

Ensure that any etchant in seams and faying surfaces is completely removed.

(e) Dry surfaces thoroughly. Use an air hose to blow water out of all joints, seams, etc.

(f) Wear rubber gloves when using the etchant (Item 69). If acid gets on the skin, immediately wash with water. Refer to EO 00-80-4/2 for safety precautions.

(g) Spray the surface with zinc chromate primer (Item 70). (Refer to EO 05-1-3/23).

(h) Apply paint, lacquer, insignia or exterior markings in accordance with the exterior finish drawing for the particular aircraft.

APPLICATION OF DECAL (MAT9-1 TYP EXTERIOR SURFAC

General

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the application of decals s: Warm weather application

(h) Work out any blister with squeege puncture with pin and work out

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replace decals which, after ion, exhibit any of the following defect

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adhesion or inadequate edge contact.

(d) Damag

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PREPARATION OF EXTERIOR SURFACE OF AIRCRAFT PRIOR TO CAMOUFLAGING

General

212 The procedure to be followed for the preparation of the exterior surface of the aircraft prior to camouflaging or other overall painting is to be found in the following paragraphs.

Cleaning of Exterior Surface

213 To clean surfaces which have previously been coated with zinc chromate primer or other finishes, strip in accordance with Paragraphs 147 to 151, preceding, until they are completely free of primer or paint. Then proceed as follows:

(a) Clean by spraying with one of the cold cleaners (item 42 or 43) and rinse thoroughly with hot water until the exterior metal surfaces are free from oil, grease, dirt, waxy substances, etc.

(b) Wipe surfaces with clean cloths and thinner (Items 50 or 52).

214 Prepare and apply the etch primer (Item 73) as follows:

(a) The etch primer is supplied as a two component product which should be mixed in the ratio of four parts resin component to one part acid component. The ingredients must be measured accurately.

(b) Mix the components of etch primer at a temperature below 90°F. Limit the quantity to be mixed to the amount which will be used within four hours. Discard any primer not used within four hours.

(c) Both acid and resin components must be thoroughly agitated before mixing. Add acid component to resin to obtain maximum adhesion from etch primer.

(d) Slowly add one part by volume of the acid component, with constant stirring, to four parts by volume of the resin component. The acid component must be added slowly to prevent immediate jelling of the mixture. Never add the resin component to the acid component.

(e) When thoroughly mixed, reduce the etch primer with thinner (Item 72) to a viscosity of 28 to 30 seconds on a Zahn No. 2 cup. Mix one part of acid component with four parts of resin component and thin the resulting mixture with 1-1/2 to 2 additional parts of thinner (Item 72).

NOTE

It is extremely important that the surfaces of the parts be perfectly clean before the application of the etch primer.

(f) Apply one wet coat of etch primer. Do not attempt to obtain thin films by holding the spray gun at an exaggerated distance from the work or to get full hiding, as poor adhesion will result in both cases.

(g) Allow etch primer to air-dry for the minimum time specified in Figure 13 before the application of zinc chromate primer (Item 70).

(h) Apply one two-way coat zinc chromate primer in the conventional manner and allow to air dry for the minimum time specified in Figure 13. For spraying, the zinc chromate primer is thinned with toluene (Item 68) to a viscosity of 24 to 26 seconds on a Zahn No. 2 cup. Approximately two gallons of toluene will be required for each gallon of zinc chromate paste.

(j) Sand the primed surfaces, using fine emery paper. After sanding, the surface of the primer must be smooth.

(k) Remove dust from the sanding operation by blowing with an air hose followed by cleaning with tack-rags. Prepare tack-rags by immersing clean cheese cloth in spar varnish (Item 74) which has been diluted with cleaner (Item 14) and allowed to dry until just tacky.

(m) Apply camouflage enamel in accordance with the applicable finish drawing. Apply a mist coat of the enamel followed after 10 or 15 minutes, with a normal wet coat. For spraying, thin the enamels to a viscosity of 28 - 30 seconds on a Zahn No. 2 cup.

Retouching

215 The following are the instructions for retouching at various stages:

NOTE

Materials such as plastics, rubber, etc., must be masked before retouching. On completed aircraft, remove the canopy during paint removal.

(a) When it is necessary to refinish a bare spot, taper the edges of the old finish adjacent to the bare spot by sanding. Spot the etch primer in over the bare area and feather slightly over the old finish to as small a distance as possible.

(b) When it is necessary to refinish a local area of the etch primer (Item 73), remove the

Primer	Hours Min.	Hours Max.
Drying time for etch primer	1/4	4
Drying time for zinc chromate primer applied over etch primer	1/2	24

NOTE

Where parts coated with zinc chromate primer cannot be given a finish coat within the maximum time specified, the surface of the primer must be cleaned with solvent (Item 14), before the enamel is applied.

Figure 13 Primer Drying Time

finish in the area desired and recoat. No intermediate chemical film or etch treatment is necessary.

(c) When it is necessary to refinish a local area after the etch primer and zinc chromate primer have both been applied, remove the finish and replace the etch primer. Exercise care to prevent overspray on surrounding areas. After removal of any such overspray, apply the zinc chromate primer as usual.

CHROMODIZING

General

216 Chromodizing is a process used to improve the adherance of paint to clad material. It is used as a base for zinc chromate and other paints. The following instructions are to be used when chromodizing is required as part of the finishing process.

Chromic Acid Tanks

217 Chromic acid tanks must be made of mild steel or other approved materials and must contain heating coils to maintain the temperature of the solution at 120° to 140°F. Clamp, racks, wire and other fixtures used for suspending parts in the chromic acid tank must be made of aluminum.

Rinse Tanks

218 Rinse tanks must be provided for hot water and for cold water. The hot water must be maintained at 180° to 212°F. The tanks must be of the recirculating type, able to maintain a constant supply of clean water and must be fitted with skimming troughs.

Preparation and Maintenance of Chromic Acid Solution

219 Prepare the chromic acid solution as follows:

(a)	Chromic acid (Item 39)	52.5 pounds
(b)	Nacconal NR wetting agent (Item 71)	1 pound
(c)	Water	100 Imperial gallons.

220 When making up the initial solution or adding chemicals to the existing solution, agitate the tank by compressed air until it is certain that the solution has become uniform. Where chromic acid is to be added, dissolve the acid crystals in a bucket of water, add to the tank and agitate.

Cleaning of Parts Prior to Chromodizing

221 Clean by vapour degreasing or with alkaline cleaner, followed by rinsing in cold water, in accordance with Paragraphs 135 or 155, preceding. When the latter method is used, no water breaks are to be present after rinsing.

Chromodizing

222 Immerse parts in the chromic acid solution for 5 (±1) minutes and rinse, first in cold water then in hot water.

Material Specifications

223 For table showing item numbers, materials, specifications and manufacturer, see Figure 14.

Item No.	Material	RCAF Ref.	Specification	Manufacturer
1	Tempil Products	33C/647, 648, 649		Tempil Corp., 132 W 22nd., St., New York City, New York.
2	Oil, Linseed	33/344	1-GP-2A	
3	Ferric Ammonium Sulphate			
4	Acid, Nitric	33C/2	15-GP-34	
5	Acid, Hydrofluoric			Technical Grade
6	Acid, Hydrochloric	33C/1	15-GP-33	
7	Acid, Sulphuric	33C/4	15-GP-8a	
8	Alundun X No.100			Norton Co., Chippawa, Ontario.
9	Arrowblast No.100			Norton Co., Chippawa, Ontario.
10	Blastite, Aluminum oxide grit			Canadian Carborundum Co., Niagara Falls, Ontario.
11	DELETED			
12	DELETED			
13	DELETED			
14	Cleaner	33C/182	3-GP-8	
15	Magnaflux No. 7 Black	33C/629		Magnaflux Corp., 5931 Northwest Highway, Chicago.

Figure 14 (Sheet 1 of 5) (Issue 1) Table of Material Specifications

Item No.	Material	RCAF Ref	Specification	Manufacturer
16	Magnaflux No. 9 Red	33C/628		Magnaflux Corp., 5931 Northwest Highway, Chicago.
17	Kerosene	34A/217	3-GP-3	
18	Paste, Magnaglo No. 10			Magnaflux Corp., 5931 Northwest Highway, Chicago.
19	Paste, Iron oxide			Magnaflux Corp., 5931 Northwest Highway, Chicago.
20	Rags Wiping Coloured	33CM/12	36GP-1A	
21	DELETED	33C/750		
22	Developer, Dy-Chek			B.W. Deane & Co., 3620 Namur, Montreal.
23	Solder, 50-50	30B/400	QQ-S-571 Comp. Sn50	
24	Solder, High melting point	30B/NIC		
25	Flux, Soldering, Paste	33C/		Canada Metal Co., 721 Eastern Ave., Toronto.
26	Flux, Soldering, Liquid Blue	33C/		Canada Metal Co., 721 Eastern Ave., Toronto.
27	Flux, Soldering, Liquid Red			Canada Metal Co., 721 Eastern Ave., Toronto.
28	Sodium Carbonate, Anhydrous	33CM/28	15-GP-5a	
29	Chalk, French	33C/11	MAT-2-1	
30	Talc	33C/11	MAT-2-1	
31	Trichloroethylene	33C/163	MIL-T-7003	

Figure 14 (Sheet 2 of 5) (Issue 1) Table of Material Specifications

Item No.	Material	RCAF Ref	Specification	Manufacturer
32	Trichlorethylene	33C/163	MIL-T-7003	
33	Flux		AAF11316	
34	Brazing Alloy, Silver	30B/616	QQ-S-561 Grade 4	
35	Flux, Alcoa No.33			Aluminum Co. of Canada, 1700 Sun Life Bldg., Montreal.
36	Filler Metal, Alcoa No. 716			
37	Alclean			Canadian Hanson & Van Winkle, 15 Morrow Ave., Toronto.
38	Compound, Polishing, Aluminum	33C/689	MIL-P-6888	
39	Acid, Chromic	33C/494	O-C-303	
40	Gum Tragacanth			P.N. Soden Co. Ltd., 2143 St. Patrick, Montreal.
41	Alcohol, Denatured	34A/216	3-GP-530	
42	Mulsirex			B.W. Deane & Co., 3620 Namur, Montreal.
43	Mulsine			B.W. Deane & Co., 3620 Namur, Montreal.
44	Brightening Agent, Steam Aero			B.W. Deane & Co., 3620 Namur, Montreal.
45	Cleaner	33C/690	MIL-C-25179	
46	Paint remover	8010-21-809-7051	31-GP-278	
47	Wax, Paraffin	33C/93		
48	Tape, Masking	33G/99 104	UU-T-106A	

Figure 14 (Issue 1)(Sheet 3 of 5) Table of Material Specifications

	Material	RCAF Ref	Specification	Manufacturer
49	Ethyl Acetate	33C/294	C31-302	
50	Thinner, Cellulose Nitrate Finishes	33A/466	1-GP-50C	
51	Benzol or Naphtha	33C/653, 34A/218	TT-N-95 3-GP-27a	
52	Thinner, Lacquer	33A/98	1-GP-4a	
53	Graphite, Powdered	34A/208	3-GP-805	
54	Inhibiting Agent, Rodine No. 82			American Chemical Paint Co., Walkerville, Ont.
55	Wetting Agent, Ridosal No. 591			American Chemical Paint Co., Walkerville, Ont.
56	Roylite No. 134-A			Canadian Hanson & Van Winkle, 15 Morrow Ave., Toronto.
57	Trisodium Phosphate	33CM/29	2-GP-31	Commercial Grade
58	Sodium Hydroxide	33CM/19	15-GP-7a	Commercial Grade
59	Cleaner, Magnet C			Canadian Hanson & Van Winkle, 15 Morrow Ave., Toronto.
60	Lacquer, Unichrome Stop-off No. 323			Canadian Hanson & Van Winkle, 15 Morrow Ave., Toronto.
61	Compound, Lube-Lok No. 4856			Electro-film, 7116 Laurel Canyon Blvd., N. Hollywood.
62	Solvent, Lube-Lok No.4000			Electro-film 7116 Laurel Canyon Blvd., N. Hollywood
63	Para-Dioxane			Technical grade
64	Tape, Adhesive, Pressure Sensitive, Water Resistant	33G/5,6	43-GP-3a Grade B Type2	

Figure 14 (Sheet 4 of 5) Table of Material Specifications

	Material	RCAF Ref.	Specification	Manufacturer
65	Adhesive General Purpose	33G/8	20-GP-18A	BB Chemical Co., Box 1447, Montreal.
66	Spray, Plastic Krylon No. 200			Simpson Machinery Ltd., 2180 Wilson, Montreal, Quebec.
67	Coating, Plastic, Clear Gloss	33A/		International Paints, 6700 Park Ave., Montreal.
68	Thinner, Toluol	33A/467	TT-T-548A	
69	DELETED			
70	Primer, Zinc Chromate	33A/462	MIL-P-6889A	
71	Detergent General Purpose	33CM/7930-21-803-6785	2-GP-103	
72	Thinner, Etch Primer Ethanol	34A/6810-21-802-3438	MIL-C-15328A	
73	Coating, Pretreatment Etch Primer		MIL-C-15328A	
74	Varnish, Spar	33A/475	TT-V-119	
75	Decal	US Federal Specification 7690	AT9-1 e III	Minn. Mi g & Mfg. Londo Ont
76	Tape, Apr Scotch DELETED	33G/81 21-8 DELETED		DELETED & Mfg.
77	Lac	2. 44	1-GP-1 (Type 1)	nn. Mining & Mfg. London, Ontario.
78	Methyl Ethyl Ketone	33C/520	15-GP-52	
79	Alodine 1200	33C/770		American Chemical Paint Co.
80	DELETED			

Figure 14 (Issue 3) (Sheet 5 of 5) Table of Material Specifications

TAIL PIPE ALUMINIZATION RE-IDENTIFICATION

General

224 Following a blade failure in the compressor section of an axial flow engine, aluminum spatter will form in the tail cone and tail pipe. To change the colour of this spatter so that future failures can be detected the solution as specified below is to be applied to the affected parts.

Preparation

225 Slowly add to one gallon of water 4 oz of Alodine 1200; (Item 79). When completely dissolved add to this solution 1/2 fluid oz. of concentrated nitric acid; (Item 4). To accurately measure and weigh ingredients for less than 1 gallon of solution it is recommended that the facilities of a station hospital laboratory be used.

NOTE

This operation is to be done slowly to ensure ingredients are completely compounded.

Storage

226 Acid resistant polyethylene or stainless steel type 321/347 tight sealing containers (local procurement) are to be used for storage of this solution. During actual application the solution may be contained in glass vessels. The solution is not to be used if it has remained in the glass container for more than eight hours. To facilitate storage it is recommended that only one quart of solution be prepared at one time.

Application

227 Application is as follows:

(a) Remove tail pipe from aircraft.

(b) Ensure area to be treated is clean and free from grease and oil. Degrease by scrubbing with a clean cloth dipped in trichlorethylene or carbon tetrachloride.

(c) Rotate tail pipe so that affected area is at the bottom.

(d) Apply the solution to the affected area by means of a nylon brush or a swab made from a piece of clean cloth tied to a suitable stick and keep in a thoroughly wetted condition allowing the solution to act on the spatter until a coating with a golden brown colour appears. The colour may appear in from one to five minutes depending on the temperature of the part, and the freshness of the solution.

(e) Neutralize the solution by washing the treated area thoroughly with clean water and dry by means of a dry cloth and air blast. Before discarding the swab, wash thoroughly.

228 This method of treatment is not to be used for removing the aluminization from tail pipes undergoing repair or overhaul. Care is to be taken to ensure that powder or solution does not come in contact with aluminum alloy parts.

CAUTION

Safety precautions as per EO 00-80-4/26 paragraphs 27 to 47 are to be observed.