Chapter 2

MARKING OF METALS AND ALLOYS

CONTENTS

Introduction

1 Materials and parts supplied under MOD contracts will call for identification markings on aircraft detail parts, assembled parts, major components, equipments and systems, so that their condition and modification state may readily be verified.

2 Such detail parts etc., are normally identified to their related drawings by marking on them the relevant component, assembly or detail drawing number and issue number.

3 Additionally, major components are to bear an allotted serial number and modification record plate.

4 Due to the danger of damage in the form of metal fatigue, such markings are to be made with extreme care and under competent supervision.

Highly stressed parts

5 The application of identification marks to regions of high stress, especially high strength aluminium alloys and high tensile steels, is prohibited.

6 In such cases, the design authority will give consideration to the provision of temporary, or permanent identification by means of:

6.1 Transfers.

6.2 Adhesive labels.

6.3 Wired, or clipped on tags.

7 Where such types of identification are approved for use, the design authority is to ensure that:

7.1 The materials are compatible.

7.2 That the use of compounds tending to develop or assist corrosion is avoided.

7.3 That protection is provided against the defacing or erasure of the markings.

Salvaged parts and components

8 Parts and components salvaged from aircraft components and assemblies, and found to be satisfactory for further use, are to have the additional symbol 'S' applied by the same method as the original markings.

Reconditioned parts and components

9 Reconditioned parts are to have the additional symbol 'R' applied by the same method as the original markings.

Temporary markings

10 When marking components during manufacture or repair, which are subject to high temperatures in service, the use of lead pencils, wax crayons, or any medium which will leave a carbon deposit, may result in carburisation and embrittlement of the affected area. This may lead to subsequent failure of the component concerned.

11 Blackboard, or common chalk, may produce a deep etching effect on the component when later subjected to heat.

12 The use of these materials for the temporary marking of such components is, therefore, prohibited. Tailor's, or french chalk (talc), are the only permitted materials.

Exemption from marking requirements

13 A.V.P.970 Chap. 407 details certain parts, the nature of which makes it impracticable to apply a part number or stamp, and the methods of identifying such parts, e.g. AGS fasteners, in suitably marked sealed containers.

Pipe lines

14 Pipe lines, electrical conduits and tubing, are to be marked in accordance with BS.3M23, but the optional colour marking is not to be applied.

Tubes

15 When brass identification labels are to be soldered on to suitable steel tubes, a non-corrosive flux to DTD599 is to be used.

16 The solder is to be continuous around the whole of the label.

ACID ETCHING

WARNING ...

THE CHEMICAL REAGENTS USED IN THIS PROCESS ARE HIGHLY CORROSIVE. IT IS OF THE GREATEST IMPORTANCE TO PREVENT THE REAGENT FROM COMING INTO CONTACT WITH THE SKIN, CLOTHING OR ANY ARTICLE WITH THE EXCEPTION OF THE WORK IN HAND.

Introduction

17 This process is widely used for marking hardened or delicate parts. Its use on light alloys is forbidden.

CAUTION ...

As the reagent may have harmful effects on the material, supervisors are to ensure that the type of acid, and the method of application is approved for the particular class of material to which it is applied.

18 The etching fluid is to be applied to the surface of the part either:

18.1 By a glass pen fitted with a rubber suction cap (or rubber stamp) or

18.2 By coating the surface with an acid-resistant, e.g. beeswax or paraffin wax, scribing the characters and applying the acid.

19 When acid etching metal and alloys, but not light alloys, a suitable reagent can be made by adding concentrated nitric acid (NHO_3) to an equal volume of water.

WARNINGS ...

(1) THE ACID MUST INVARIABLY BE ADDED TO THE WATER, NOT VICE VERSA.

(2) THE ACIDS USED IN THESE PROCESSES ARE HIGHLY CORROSIVE. SUPERVISORS ARE TO ENSURE THAT ALL PERSONNEL ARE AWARE OF THE FOLLOWING PROCEDURES.

20 The acids must always be stored in glass bottles or containers with ground glass stoppers.

21 After use the stoppers are to be firmly refitted in the bottles or containers from which they were removed. Bottles and containers are to be clearly marked to denote their contents, and stored in accordance with the supplier's instructions.

First aid

22 In the event of acid burns, the casualty is to be removed from the immediate area, and a copious supply of cold water directed at the injury. The casualty is to be referred to a Medical Officer as soon as possible.

Note ...

No oils, creams or other substances are to be applied to the site of the injury.

23 Suitable precautions are to be taken to avoid splashes or spillage of the acids in the workshop area. Where this does occur, the spillage is to be neutralised using either washing soda, or ammonia if available.

WARNING ...

SUPERVISORS ARE TO ENSURE THAT OPERATORS ARE AWARE OF THE DANGERS OF INHALING THE FUMES GIVEN OFF BY ETCHING FLUIDS.

24 Copper sulphate ($CUSO_4$), commonly known as 'bluestone', can be successfully employed in marking steel tools:

24.1 The crystals should be ground into powder, and a pinch of common salt added.

24.2 The mix is then moistened with a small quantity of water to obtain a small amount of saturated solution.

25 Table 1 details the composition of the various etching fluids for use with particular metals and alloys

TABLE 1 ETCHING FLUIDS FOR PARTICULAR METALS AND ALLOYS

Metal or alloy	Etching fluid
Brass	Concentrated nitric acid (NHO_3)
Carbon Steel	Nitric acid (NHO_3) Water
Copper	Nitric acid (NHO_3) Sulphuric acid (H_2SO_4)
Hard steel	Nitric acid (NHO_3) Water
High speed steel	Nitric acid (NHO_3) Acetic acid (CH_3COOH)
High chromium steel	Concentrated hydrochloric acid (HCl)
Lead	Concentrated nitric acid (NHO_3)
Nickel steel	Nitric acid (NHO_3) Hydrochloric acid (HCl)
Steels, corrosion-resistant and nitriding	Water Selenious acid Nitric acid (NHO_3) Hydrochloric acid (HCl)

(continued)

TABLE 1 ETCHING FLUIDS FOR PARTICULAR METALS AND ALLOYS (continued)

Metal of alloy	Etching fluid
Steels, other than corrosion-resistant or nitrided steels	Water Selenious acid Copper sulphate crystals ($CuSO_4$) Concentrated nitric acid (NHO_3)
Zinc	Hydrochloric acid (HCl) Water

Procedure

26 Thoroughly clean the surface to be marked until it is perfectly free from oil, grease or moisture.

Note ...

Where an anti-corrosive protective has been applied, an area sufficient for the marking only is to be cleaned.

27 Brush on a thin coating of acid-resistant material, e.g. of molten beeswax, forming a lip round the edges of the marking area.

Note ...

The thinness of the coating is to prevent the formation of air locks. To facilitate this operation, there should be only a slight temperature difference between the item to be marked and the molten wax.

28 Leave the wax to set hard. (It will be found convenient at this stage to similarly coat a piece of test material).

29 Using a fine-pointed scriber, cut the required characters into the waxed surface, so that the metal is bared but not scratched.

30 Apply the etching fluid with a glass rod as follows:

30.1 The etching fluid should be allowed to fall in droplets until the exposed material is completely covered.

30.2 The glass rod is not to touch the workpiece.

30.3 Care is to be taken not to apply an excess of etching fluid.

30.4 The glass rods are not to be used with more than one type of etching fluid.

31 The previously coated test piece is to be similarly treated. The operator is to examine the test piece to ensure that a sufficient period of time has elapsed to allow the marks to become clear and permanent.

32 On completion of the marking operation, all traces of the etching fluid and acid-resistant material are to be removed by washing thoroughly in hot water, using a stiff brush.

Note ...

If necessary, any remaining traces of acid-resistant material may be removed with petrol.

33 The marked work piece is to be dried and examined. Should any symbol be illegible, the process is to be repeated.

CONTROLLED GRIT BLASTING

CAUTIONS ...

(1) This process is unsuitable where contamination by the abrasive material can occur, e.g. on ball, needle or roller bearings, and hollow parts.

(2) This process is not normally permissible on magnesium or manganese alloy parts.

Introduction

34 In this process, marks are produced by applying a controlled jet of abrasive material in conjunction with rubber or plastic stencils to specific areas.

35 The depth of marking produced is slight, and is, therefore, unsuited for parts to which a protective finish will subsequently be applied.

36 The process may be employed to good advantage in certain circumstances, e.g. the marking of transparent plastics and hard anodised surfaces.

37 The type, size and grade of abrasive material, air pressure, and period of application, is normally specified on the relevant part drawing or operation instruction sheet.

ELECTRICAL ARC ENGRAVING

Introduction

38 This form of marking is of two types, viz:

38.1 The constant contact process.

38.2 The intermittent contact process.

39 Since either method may cause deterioration of the adjacent metal, approval is to be sought before application.

CAUTION ...

The deleterious effect of electrical arc engraving can seriously affect the fatigue strength of the part so marked, since the material is subjected to severe localised overheating. The use of either method is therefore forbidden for aircraft components, highly stressed components, and materials of thin section.

40 In either method, the process is very simple. The piece to be engraved forms part of a low voltage electrical circuit, which is completed when contact is made at the marking point by means of an electrical engraving pencil. This creates an arc which fuses the metal, so producing an indelible mark.

Procedure

41 The are to be marked must be thoroughly cleaned and free of grease, rust and paint.

42 The marks to be engraved should be spaced out in pencil prior to the marking operation.

43 The point of the electrode (comprised of a short length of hard drawn copper wire) is to be examined, and sharpened or replaced as necessary. The electrical engraving pencil is to be tested upon a piece of material similar to that being worked upon, to determine the pressures required to produce a certain depth of mark and the rate of movement.

45 The electrical engraving pencil is then applied to the workpiece.

Notes ...

(1) In general use, etching by the intermittent process is preferable, as there is less risk of burning the surface of the material surrounding the marking(s).

(2) The electrical engraving pencil should not be used continuously for a long period. If felt by the hand to be producing excessive heat, it is to be allowed to cool off before continuing.

ELECTRO-CHEMICAL ETCHING

Introduction

45 This method of marking is generally restricted to:

46.1 Corrosion-resistant (stainless) steels.

46.2 Aluminium and its alloys.

46.3 Titanium and its alloys.

46.4 Copper based alloys.

46 Briefly, the process consists of making the desired marks utilising the principle of electrolysis. Essentially, the mark(s) produced conform to the characters or symbols cut in a stencil, which is placed on the metal surface of the workpiece.

47 The electrolyte, contained in a holder, pen, or capsule acting as one electrode, is fed through a pad and contacts the metal surface through the stencil.

48 A low voltage, low current is then passed for a few seconds, the time usually being measured by means of an automatic timing device. The circuit is completed by the metal being marked acting as the second electrode.

49 The process is simple and easy to apply, and, in general, has no significant effect on the strength of metal parts.

50 The colour and depth of marking is directly related to:

50.1 The voltage and current.

50.2 The direction and duration of current flow.

50.3 The electrolytic etching fluid used.

50.4 The type of stencil employed.

Notes ...

(1) A paper stencil will have a life of approximately 200 impressions.

(2) A plastic stencil will have a life of approximately 2000 impressions.

(3) In either case, the stencils should be discarded if, on examination, they are found to be distorted or ruptured.

(4) The electrolyte holders are to be used with the same electrolytic etching fluid throughout their life.

(5) The pads are to be kept moist with electrolyte and renewed if discoloured.

Procedure

WARNING ...

THIS TYPE OF EQUIPMENT EMPLOYS LETHAL VOLTAGES, AND CARE MUST THEREFORE BE TAKEN WHEN USING THIS EQUIPMENT.

51 Check all electrical plugs, sockets and earth pins to ensure good electrical contact.

52 Reference is to be made to the proprietary process specification or equivalent written instructions agreed by the design and inspection authorities. These instructions are to include:

52.1 Details of operation.

52.2 Washing with a neutralising agent.

52.3 Current settings to produce one of three basic markings, viz:

52.3.1 A dark mark by the use of a.c. which first etches out the metal and then re-deposits it as a stable and adherent oxide.

52.3.2 A light mark, by etching out the metal using d.c.

52.3.3 A dark mark, by depositing a stable oxide using d.c.

52.4 Polarity

52.5 Time settings.

52.6 Electrolytes to be used with the particular metal or alloy.

Note ...

Where magnesium or magnesium alloys are involved, the precautions necessary to ensure complete removal of the etchant, and the subsequent use of a suitable corrosion preventative over the marked area, are to be fully detailed.

53 A number of proprietary electro-chemical types of equipment are available, and the respective manufacturer's operating instructions are to be complied with.

54 The normal average depth of etch marking produced (using either a.c. or d.c.) does not exceed 0.05 mm (0.002 in).

Notes ...

(1) The use of d.c. for deposit marking does not normally produce an adherent deposit, and is mainly used for making an easily removable temporary mark.

(2) When the use of d.c. for permanent marking is specified, the workpiece is to be made anodic.

MACHINE ENGRAVING

53 In this process the identification marks are produced by a mechanically guided rotary cutter or grinder, normally controlled via a pantograph.

56 The process is occasionally used for stressed parts manufactured from high grade steels or aluminium alloys, and for engraving information or instructions on placards and name plates.

57 The mark dimensions are limited by the size of the pantograph and of the cutter used.

58 The cutter or grinder used must be rounded, to avoid producing sharp corners or cuts.

59 The depth of the marks is normally kept to the minimum compatible with clarity.

MARKINGS FORMED BY MOULDS OR DIES

60 Raised, embossed or depressed markings are formed in the material during stamping or pressing, and are to be located in an area not subsequently machined.

61 In those instances where the part is reversed in the die and struck from both sides, the grain of the material in the vicinity of the marking may be distorted, leading to weakness in the finished part. This possibility must be considered prior to adopting this method.

METAL STAMPS/STAMPING

Introduction

62 The use of metal stamps for marking purposes on aircraft, or similar service equipment is a matter to be undertaken only after careful consideration, and executed with extreme care under qualified supervision.

63 It has long been established that the indentations caused by such stamps (and centre punches), can lead to a considerable reduction in fatigue resistance, with consequent premature failure of the component involved.

64 The damage usually takes the form of minute fractures, detectable only by microscopic, X-ray or ultra-sonic examination.

Procedure

65 Steel marking stamps, whether applied by percussion (hand or machine), or rolling methods (using a box holder), are not to be used in the following circumstances.

65.1 On aluminium alloy sheet thinner than 20 swg (0.915 mm/0.036 in).

65.2 High stress parts made from steel with an ultimate tensile strength in excess of 850 MN/m^2 (55 ton f/in^2). Reference is to be made to the relevant Air Publication for the equipment.

65.3 Where the required information has been omitted from the drawing, or where doubt exists as to the suitability of parts for stamping, the matter is to be referred to a senior engineer officer for decision.

66 Where the use of metal stamps is approved, the following points are to be noted.

66.1 The stamps used are not to be larger than is necessary for clarity.

66.2 The stamps are to be shaped to produce a 'U' impression rather than a 'V' form.

66.3 Worn stamps are not to be used, since the additional hammering necessary to obtain a clear impression may weaken the material.

66.4 During any stamping operation, the part is to be adequately supported by a backing block with a smooth surface.

66.5 The impression in the material is to be positioned so as to avoid edges, holes, narrow or highly stressed parts, changes in material section, or pronounced surface contour changes.

66.6 Where practicable, such stampings as part number and final inspection etc., are to be placed close together, to facilitate checking.

66.7 After using metal stamps, or similar equipment, the part marked is to have an authorised corrosion-preventative (suitable for the particular material) applied to the affected area.

VIBRATORY PERCUSSION MARKING

67 An electrically or pneumatically operated hand tool with a vibrating needle or stylus is used. Table 2 details those currently in service.

68 Marking by this process avoids the local overheating caused by electrical arc engraving, and, if lightly applied, has little adverse effect on the fatigue strength of metal parts.

69 The use of this process is not normally permitted in highly stressed components or locations.

TABLE 2 VIBRATORY PERCUSSION MARKING TOOLS

Type	RAF Ref. No.	Maker	Model
Electric (mains)	1B/6087	Burgess	Powerlite
Pneumatic	3AP/2093345	Desoutter	OP 2

Printed for Her Majesty's Stationery Office
by I.S.I. Washington
Demand No. 8032088, 538, 1/81, 1909 (13776-4)