AD/DHE/18 Amdt 5 — Tapered Crankshaft Inspection — 7/98

Applicability: Gipsy Major series engines fitted with a tapered crankshaft

Requirement:

1. Insitu ultrasonic inspection:

   In accordance with a procedure approved by the Authority, carry out an ultrasonic inspection of the crankshaft in the area forward of the thrust bearing flange.

2. Crankshaft inspection - Pre Mod G2495 crankshafts:

   (a) In accordance with a procedure approved by the Authority, carry out an ultrasonic inspection of the crankshaft in the area forward of the thrust bearing flange , and

   (b) carry out a magnetic particle inspection of the entire crankshaft utilising the wet continuous technique applied in a manner that both longitudinal and circumferential cracking will be detected, CAO 108.8 Appendix 1 refers.

3. Crankshaft inspection - Post Mod G2495 crankshafts:

   (a) Remove the Mod G2495 thrust bearing location nut sleeve, and

   (b) carry out a magnetic particle inspection of the entire crankshaft utilising the wet continuous technique applied in a manner that both longitudinal and circumferential cracking will be detected, CAO 108.8 Appendix 1 refers.

Compliance: Effective 18 June 1998:

1. Insitu ultrasonic inspection:

   Unless previously carried out;

   (a) within 25 hours time in service or at the next maintenance release inspection, whichever occurs first, and then

   (b) at 45 to 50 hours time in service following an inspection in accordance with Compliance requirement 1 (a).

Note 1: In service experience since the issue of AD/DHE/18 Amdt. 4 indicates the airworthiness of Gipsy Major tapered crankshafts in service can be reasonably established with two ultrasonic inspections. Therefore, engines in service which have already had two ultrasonic inspections of the tapered crankshaft, adequately satisfy Requirement 1 of this directive. No further insitu ultrasonic inspections are required.

2. Crankshaft inspection - Pre Mod G2495 crankshafts:

   Prior to installation of the crankshaft in an engine.

3 Crankshaft inspection - Post Mod G2495 crankshafts.

Prior to installation of the crankshaft in an engine.

This amendment becomes effective on 18 June 1998.

Background: This directive was originally issued to require a visual and a magnetic particle inspection (MPI) of the tapered crankshaft in the area forward of the thrust bearing flange. Amendment 4 replaced the visual inspection with repetitive insitu ultrasonic inspections. In service experience since the issue of Amdt. 4 has indicated the airworthiness of tapered crankshafts in service can be satisfactorily determined by two consecutive, insitu, ultrasonic inspections. In response, this amendment limits the insitu ultrasonic inspection requirement to two consecutive inspections.

In addition to the amended ultrasonic inspection compliance requirement, this amendment also includes a requirement to carry out an ultrasonic inspection of pre Mod G2495 crankshafts before installing that crankshaft in an engine. A Pre Mod G2495 crankshaft, recently inspected insitu by the ultrasonic inspection technique, was reported to be cracked in the area of the thrust bearing location nut threads. On removal of the crankshaft from the engine, and despite knowledge of the crack location, the crack could not be confirmed by MPI. An independent ultrasonic inspection confirmed the presence of a 6mm long by 3mm deep crack.

Amendment 4 of this Airworthiness Directive became effective on 22 July 1993.

Amendment 3 of this Airworthiness Directive became effective on 30 May 1993.

The original issue of this Airworthiness Directive became effective in August 1963.

Australian Government

Civil Aviation Safety Authority

Civil Aviation Order 108.8 (as amended)

Process control — magnetic particle inspection

made under subregulations 38 (1) and (2) of the *Civil Aviation Regulations 1988*.

This compilation was prepared on 24 October 2011 taking into account amendments up to *Civil Aviation Order 108.8 Amendment Instrument 2011 (No. 1)*.

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1 Application

1.1 This Civil Aviation Order specifies procedures relating to the inspection of aircraft, aircraft components and aircraft materials for flaws by magnetic particle methods, and is applicable in such circumstances as may be directed by the Director or an authorised person under the *Civil Aviation Regulations 1988*.

2 Definitions

In this Order:

continuous method means any method of magnetic particle inspection in which magnetic particles are applied to a part immediately before and during magnetisation, the application being stopped before the magnetising force is removed.

dry method means any method of magnetic particle inspection in which magnetic particles are applied to a part as a dry powder.

residual method means any method of magnetic particle inspection in which magnetic particles are applied to a part which has been magnetised but to which the magnetising force is no longer applied.

wet method means any method of magnetic particle inspection in which magnetic particles are applied to a part as a suspension in a liquid.

3 Equipment

3.1 The design and electrical capacity of the magnetic particle equipment used in accordance with this Order must be such as to permit the adoption of the procedures specified in subsection 5 of this Order.

3.2 The equipment must be provided with a means of controlling and measuring the magnetising current used. If this control is of a stepped kind, it must incorporate a sufficient number of steps to ensure that the current used is within the range -10% to +20% of the specified value.

3.3 When alternating current is used, it must not be employed for the residual method unless the equipment is provided with a switching device which ensures that the circuit is broken during the second or fourth quadrant (90° to 180° or 270° to 360° phase angle) of the current waveform.

3.4 Equipment used for demagnetising parts after inspection may be of any type provided it is capable of demagnetising the parts to the requirements of paragraph 7.1.

4 Materials

4.1 The magnetic indication particles used must have high permeability and low retentivity and must be a suitable blend of sizes and shapes to readily produce magnetic particle indications.

Note Magnetic flaw detection inks and powders complying with British Standard Specification BS.4069 are acceptable.

4.2 If colour contrast particles are used they must provide a good colour contrast with the part being inspected. If black particles are unsuitable, this requirement can be achieved by the use of coloured particles or by modifying the surface condition of the part to maximise the contrast.

4.3 Where maximum sensitivity of inspection is required for cracks resulting from service conditions, such as fatigue cracks, wet fluorescent magnetic particles in conjunction with the continuous ac method should be used.

5 Procedures

5.1 The inspection procedures used for a given inspection must be in accordance with those specified in the relevant Civil Aviation Order or approved maintenance document. When no inspection procedures are specified in these documents, Appendix I to this Order constitutes approved procedures.

Note A relevant approved maintenance document in this context would normally be a process manual or process specification issued by the manufacturer of the part being inspected.

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5.2 The magnetising current or flux density used for a given inspection must be that specified in the Civil Aviation Order or approved maintenance document relevant to the part being inspected or to another part of similar size and shape.

Note A relevant approved maintenance document in this context would normally be an overhaul manual or service bulletin issued by the manufacturer of the part or similar part.

5.3 For parts of essentially simple shape, magnetising current values may be computed using the methods specified in Appendix II to this Order.

6 Control of equipment and materials

6.1 A magnetic particle inspection must not be made unless the magnetic particle materials and equipment have been checked within the time and according to the procedures specified in Appendix III to this Order.

7 Demagnetisation after inspection

7.1 After inspection, parts must be so demagnetised that they do not cause a compass deflection of more than 3 degrees when placed at right angles to and 150 mm from an aircraft compass.

Note Large ferromagnetic parts may, even though demagnetised, cause a deflection of the compass needle to this extent or greater. In such cases, all surfaces of the part should be explored for evidence of free poles causing the direction of needle deflection to be reversed.

Appendix I

This Appendix specifies procedures for the performance of magnetic particle inspections.

1 Preparation of parts for inspection

1.1 Wherever possible parts must be disassembled before inspection.

1.2 The surface of all parts must be free from grease, oil, swarf, corrosion products, moisture or any other matter which interferes with the proper distribution and concentration of magnetic particles applied during inspection, or which would contaminate the inspection liquid used in the wet process.

1.3 Painted parts may be inspected without removal of the paint provided that the paint layer is continuous and even and does not exceed 0.1 mm in thickness. When current flow methods of magnetisation are to be used, paint must be removed from areas at which electrical contact is to be made.

1.4 Plated parts may be inspected provided that the thickness of plated layers such as chromium does not exceed 0.1 mm. Sensitivity will be slightly reduced, however, and some advantage may be gained from using dc magnetisation.

2 Magnetisation

2.1 Current flow method of magnetisation

(a) Copper braid, lead or other suitably malleable electrically conducting material must be used at the contact points between the equipment and the part to provide good electrical contact and minimise the danger of arcing.

(b) The flow of current must be of sufficiently short duration to prevent overheating of the part.

2.2 Threading bar method of magnetisation

(a) When using a threading bar to inspect a tubular component with a closed end, such as a cylinder barrel, precautions must be taken to ensure good electrical contact at the blind end of the part with both the threading bar and the equipment.

(b) When the part to be inspected is considerably larger in diameter than the threading bar, the bar may be positioned away from the axis of the part. In such cases, only that area of the part adjacent to the threading bar and contained within a circle concentric with the bar and of diameter equal to that which formed the basis of computing the magnetising current value in accordance with Appendix II of this Order, must be inspected at any one time.

2.3 Coil method of magnetisation

(a) Unless the magnetism current required has been computed for the part placed centrally in the coil in accordance with Appendix II, parts must be placed adjacent to the inside surface of the coil.

(b) Only those surfaces of the part within the coil and protruding not more than 0.25 mm either side of the coil must be inspected at any one time.

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(c) The pitch of the turns of the magnetising coil used must be as small as practicable.

2.4 Magnetic flow method of magnetisation

(a) The pole pieces of permanent magnets or electromagnets used for the magnetic flow method must be adjustable to conform with the surface of the part to be inspected so as to provide an area of contact as large as possible. The area of contact should be not less than the cross sectional area of the smallest component of the magnetic circuit.

(b) To ensure a sufficient flux density for inspection, the surface to be inspected must first be magnetically saturated, as shown by furring. Saturation may be accomplished by adjusting the current through the coil of the electromagnet, in the case of a permanent magnet, adjusting the spacing of the pole pieces. The flux density should then be reduced until furring just disappears.

Note For guidance, when permanent magnets or electromagnets without provision for varying the pole spacing are used, the pole spacings of magnets of 15 kg and 25 kg lift should not exceed 100 mm and 150 mm respectively.

3 Application of magnetic particles

3.1 Wet continuous process

The magnetic particle suspension must be applied to all surfaces of the part which are to be inspected. It must be flowed over the part to produce a smoothly flowing layer and must be applied immediately before and during magnetisation. The application must cease before magnetisation is terminated to avoid washing away lightly held flaw indications.

3.2 Wet residual process

After the part has been magnetised to saturation, the magnetic suspension must be applied. The application may be by flow coating but preferably by immersing, gently agitating and gently withdrawing the part from a well-mixed bath.

3.3 Dry process

The magnetic particles must be caused to be present as a cloudy suspension in air adjacent to all surfaces to be inspected while the part is being magnetised.

4 Inspection

4.1 When non-fluorescent magnetic particles have been used, inspection must be undertaken under good conditions of white light illumination, providing an intensity of not less than 1080 lumen m^{-2} or 100 foot candle, at the surface to be inspected, when measured with a Weston Light Meter, Model 703, type 51 or equivalent. Excessive reflection from polished surfaces must be avoided.

4.2 When fluorescent magnetic particles have been used, parts must be inspected under ultraviolet light in conditions of darkness or near darkness. Inspection lamps must contain a filter to minimise the intensity of visible light and harmful ultraviolet light of wavelength less than 3,000A whilst permitting maximum transmission of ultraviolet light of wavelength approx. 3,650A.

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4.3 The intensity of ultraviolet light illumination at the surface to be inspected must be not less than 970 lumen m^{-2} (735µ Wcm^{-2}) 90 foot candle when measured with a Weston Light Meter, Model 703, type 51 or equivalent or with an Ultraviolet Products Inc. Ultraviolet Meter, Model J-221 or equivalent.

4.4 Before undertaking inspection in a darkened booth, a minimum period of 5 minutes must elapse after the inspector enters the booth to permit dark adaptation of his eyes.

5 Demagnetisation

5.1 After final inspection and before final cleaning, all parts must be demagnetised.

5.2 After demagnetisation, parts must be removed from the vicinity of the magnetising and demagnetising equipment to avoid remagnetisation.

5.3 Ring shaped or very short components may require their effective magnetic shape to be changed by the use of extension pieces or shunts across their diameters, during demagnetisation, in order to achieve an acceptable degree of demagnetisation.

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Appendix II

This Appendix specifies methods for computing magnetising current values for parts of essentially simple shape.

1 Circular magnetisation

1.1 For circular magnetisation of round sections using current flow, the current used must be 30 amp. ac or 40 amp. dc per mm diameter. For non-circular sections, the current used must be 10 amp. ac or 13 amp. dc per mm of perimeter of the cross-section.

1.2 For circular magnetisation using the threading bar method, the current must be computed as in para. 1.1 above with respect to the outside diameter or periphery of the part.

2 Longitudinal magnetisation

For longitudinal magnetisation using the coil method, when the part to be inspected is positioned adjacent to the inside surface of the coil, the current used must be computed from:

$$A = \frac{45{,}000}{T(L / D)};$$

and when the part to be inspected is positioned in the centre of the coil from:

$$A = \frac{1700.R}{T[6(L / D) - 5]};$$

where A = current in amperes, dc or ac

L = length of part

D = diameter or major cross-sectional dimension of the part (measured in the same units as L above)

T = number of turns in the coil

R = radius of coil in mm.

These formulae are based on experiment and apply when the following conditions are met:

(a) the cross-sectional area of the part is not greater than one tenth of that of the coil;

(b) the part of the section or part to be inspected at the time is not more than 0.5 m long;

(c) the relative permeability of the part is 500 or greater;

(d) the part has an L/D ratio of between 2 and 15.

Appendix III

This Appendix specifies procedures for the control of magnetic particle materials and equipment.

1 Overall sensitivity test

1.1 The overall effectiveness of the equipment, materials and procedures used must be tested at intervals of not more than 7 days.

1.2 The test must be performed by inspecting demagnetised samples containing known natural or artificial defects and assessing whether there has been any deterioration in the clarity of the indications obtained.

1.3 If deterioration has occurred, the magnetic particle ink and equipment must be tested separately to determine where the fault lies and appropriate rectification action taken.

2 Magnetic particle inks

2.1 Magnetic particles inks must be tested for the concentration of magnetic particles in suspension at least daily in the case of equipment in constant use, and in other cases before use.

2.2 The tests performed must be in accordance with the following procedures: (Equipment required: ASTM pear-shaped 100 ml centrifuge tube, Gaetz or equivalent, with a stem calibrated in 0.1 mls.)

(a) let pump run for several minutes to agitate the suspension thoroughly;

(b) flow the bath mixture through hose and nozzle to clear the hose;

(c) fill the centrifuge tube to the 100 ml line;

(d) place the tube in its stand and leave for 30 minutes;

(e) read the volume of the magnetic particle sediment.

2.3 The volume of the sediment should be within the range 0.1 ml–0.5 ml (preferred range 0.17 ml–4.25 ml) for fluorescent particles and 1.3 ml–2.4 ml for non-fluorescent particles. If the volume obtained is outside these limits, the bath concentration must be adjusted accordingly and the test repeated.

2.4 The condition of the ink should be assessed by examining the sediment for clumping, texture and colour or fluorescence. If contamination is suspected, a test for sensitivity as described in paragraph 1 of this Appendix must be performed. If an unsatisfactory result is obtained, the ink must be discarded.

3 Ultraviolet lamps

Ultraviolet lamps together with their filters must be tested, not less than once every 3 months, for the intensity of ultraviolet light output. The intensity must be not less than 1350 lumen m^{-2} (1020μ Wcm^{-2}) or 125 foot candle when measured with a Weston Light Meter, Model 703, type 51, or equivalent, or an Ultra-Violet Products Inc. Ultraviolet Meter, Model J-221 or equivalent, placed 380 mm from the surface of the filter.

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4 Equipment ammeters

Ammeters used for recording the current used during inspection must be calibrated by an accredited laboratory utilising a transfer standard traceable to the National Measurement Institute not less than once every 2 years.

Note to Civil Aviation Order 108.8

The Civil Aviation Order (in force under the *Civil Aviation Regulations 1988*) as shown in this document comprises *Civil Aviation Order 108.8* made as indicated in the Table below.

Table of Orders

Year and number	Date of registration on FRLI	Date of commencement	Application, saving or transitional provisions
CAO 108.8 Instrument 2007	17 December 2007 (*see* F2007L04653)	18 December 2007 (*see* s. 2)	
CAO 108.8 2011 No. 1	7 September 2011 (*see* F2011L01821)	8 September 2011 (*see* s. 2)	

Table of Amendments

ad. = added or inserted am. = amended rep. = repealed rs. = repealed and substituted

Provision affected	How affected
CAO 108.8	rs. CAO 108.8 Instrument 2007
Appendix III	am. CAO 108.8 2011 No. 1