Australian Government
Civil Aviation Safety Authority

CIVIL AVIATION ADVISORY PUBLICATION CAAP 33-02 v1.0

Non-destructive testing

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This Civil Aviation Advisory Publication (CAAP) provides guidance, interpretation and explanation on complying with the Civil Aviation Regulations 1988 (CAR) or a Civil Aviation Order (CAO).

This CAAP provides advisory information to the aviation industry in support of a particular CAR or CAO. Ordinarily, the CAAP will provide additional 'how to' information not found in the source CAR, or elsewhere.

Civil Aviation Advisory Publications should always be read in conjunction with the relevant regulations/orders.

IMPORTANT

The information provided in this CAAP must not be used in place of, or in contradiction of, instructions contained in an airworthiness directive, relevant manufacturer's instructions, or any other maintenance direction issued by CASA.

Audience

This CAAP applies to:

- holders of a certificate of approval (COA) issued under regulation 30 of the *Civil Aviation Regulations 1988* (CAR) to perform maintenance of aircraft or aircraft components
- holders of an airworthiness authority issued under paragraph 33B(1)(d) of CAR to perform non-destructive testing of aircraft or aircraft components.

Purpose

The purpose of this CAAP is to provide procedures for performing certain types of non-destructive testing of aircraft or aircraft components under the provisions of the CAR.

For further information

For further information on this CAAP, contact CASA's Airworthiness and Engineering Branch (Telephone 131 757).

Status

This version of the CAAP is approved by the Manager, Airworthiness and Engineering Branch.

Version	Date	Details
v1.0	December 2018	Initial CAAP.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this CAAP are listed in the table below.

Acronym	Description
AA	airworthiness authority
AC	alternating current
AMS	aerospace material specifications
AS	Australian Standard
ASTM	American Society for Testing and Materials
CAAP	Civil Aviation Advisory Publication
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
CAO	Civil Aviation Order
COA	certificate of approval
FWAC	full wave alternating current
HWAC	half wave alternating current
LPI	liquid penetrant Inspection
LPT	liquid penetrant test
MPI	magnetic particle inspection
MPT	magnetic particle testing
NDI	non-destructive inspection
NDT	non-destructive testing
OEM	original equipment manufacturer
PSI	pounds per square inch
QQI	quantitative quality indicator

1.2 References

Regulations

Regulations are available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Regulation 30 of CAR	Certificates of approval
Regulation 33B of CAR	Airworthiness authorities
CAO 100.27	Non-destructive testing authorities
CAO 100.5	General requirements in respect of maintenance of Australian aircraft

1.3 Advisory material

CASA's Advisory Circulars are available at http://www.casa.gov.au/AC

CASA's Civil Aviation Advisory Publications are available at http://www.casa.gov.au/CAAP

Document	Title
AS 2062	Non-destructive testing—Penetrant testing of products and components
AMS 2644	Inspection Material, Penetrant
AMS 3045	Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Ready-To-Use
AMS 3046	Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Aerosol Packaged
ASTM-E-1417	Standard Practice for Liquid Penetrant Testing
ASTM –E-1444	Standard Practice for Magnetic Particle Testing
ASTM –E-709	Standard Guide for Magnetic Particle Testing

2 Introduction

2.1 Applicability

2.1.1 The procedures for carrying out penetrant and magnetic particle inspection detailed in appendices A-I of this CAAP are approved maintenance data under paragraph 14.1 of the Civil Aviation Order (CAO) 100.5. The use of this maintenance data is subject to the conditions specified in Paragraph 14.2 of CAO 100.5, being:

- the maintenance data mentioned in paragraph 2A(2)(a), (b), (c) or (d) of the *Civil Aviation Regulations 1988 (CAR)* is inadequate for the purpose
- the person carrying out the maintenance on the aircraft, aircraft component or aircraft material first determines that the instructions are
  - appropriate to the aircraft, aircraft component or aircraft material to be maintained
  - directly applicable to the maintenance that is to be carried out
  - not contrary to, or inconsistent with the manufacturer's data, or any other applicable approved maintenance data mentioned in regulation 2A of CAR.

2.1.2 Subject to paragraph 14.1 of CAO 100.5:

- the procedures set out in appendices A-G of this CAAP may be used as acceptable means of compliance for procedures for the following standards
  - AS 2062
  - ASTM-E-1417 or a European equivalent
  - a generic European Standard for penetrant testing
  - United Kingdom Department of Defence standard for penetrant testing
- the procedures set out in Appendices H and I of this CAAP may be used as acceptable means of compliance for procedures for ASTM-E-1444 or a European equivalent. However, equipment and materials standards in ASTM-E-1444 should be used where specified in Chapter 4 of this CAAP.

2.1.3 Where the original equipment manufacturer (OEM) or penetrant material manufacturer specifies alternate processing times, these should take precedence over guidance provided in this CAAP to the extent that there is any contradiction between the two sources.

3 Penetrant inspection

3.1 Requirements for conducting inspections

3.1.1 This chapter details the requirements to be followed as applicable in conjunction with Appendices A-G of this CAAP.

3.1.2 The intent of this procedure is to describe the minimum non-destructive testing requirements for aeronautical products. Where further technical clarification is required for a particular inspection a Level 3 technician may need to be consulted.

3.1.3 Accept/Reject indications shall be in accordance with the component's applicable overhaul manual and/or the aircraft manufacturer's guidance.

3.2 Preparation for penetrant inspection

3.2.1 Remove all coatings, such as paint, plating etc, that will prevent penetrant from entering the defect.

> **Caution**
>
> Testing of plated surfaces may hide/mask defects within the base material and therefore only detect defects that are surface breaking in the plating.

3.2.2 Do not use any method such as blending, grinding and sanding that could produce surface smear of the base metal, or otherwise obscure a surface-breaking defect. Plastic blasting media can be used if it does not cause deformation of the component’s surface for mechanical cleaning.

> **Caution**
>
> If mechanical working such as blending, grinding or sanding of the test surface has occurred it is possible that existing surface defects may no longer be open to the surface due to metal smearing. This occurs particularly with softer alloys such as aluminium and magnesium. In this instance consult the applicable engineering authority or part manufacturer as an acid etch may be required to re-expose any surface defects.

3.2.3 When pre-cleaning parts, use materials and processes that remove the contaminant without damaging the part. For guidance on the correct cleaning method, review the relevant component maintenance manual.

Caution

Industrial mechanical cleaners may contain extremely caustic compounds, which may be detrimental to aircraft quality metal parts.

3.3 Equipment requirements

3.3.1 Dip tanks are a series of tanks containing the penetrant materials used to process parts. Parts larger than the accessible dimension of the tank will need to be processed using a spray or brush method.

3.3.2 If spray application is required, electrostatic applicators, pressure spraying equipment and pressure pack aerosol containers may be used to apply penetrant materials to the part.

3.3.3 When using emulsifiers, ensure that the emulsifier concentration is in accordance with the manufacturer's recommendation whether the application is immersion (dip tanks), spraying or foam.

3.3.4 In addition to dip tanks or spray application equipment, the test procedures will require the following equipment:

- black (ultraviolet) light (capable of 1,000 μW/cm² minimum at 38 cm)
- light restricting cloak of an appropriate size
- marking media which won't damage the part, mirror and rule
- UV and white light meter
- process performance test pieces (testing and monitoring panels or similar) for systems other than pressure pack materials.

3.4 Quality control

3.4.1 All penetrant equipment and consumables must be maintained in accordance with the requirements of ASTM E-1417 and includes routine calibration and specific performance checks.

3.4.2 All figures and results of quality checks shall be annotated in a locally generated log at intervals detailed in the applicable table of ASTM E1417. The intensity output of black (ultraviolet) lights used for fluorescent penetrant inspection must be checked daily or before use, whichever is the longer time.

3.4.3 Battery operated UV lights (e.g. torches) are to be checked prior to inspection and immediately post inspection.

Warning

Ultraviolet (UV) radiation is harmful to the eyes and skin.

Refer to manufacture's product safety sheets and all relevant safety data sheets for liquid penetrant materials in use.

3.5 Viewing conditions

3.5.1 Fluorescent penetrant inspection requires a darkened area. This could be a purpose-built room or area that maintains ambient light below 2 foot candles (20 lux).

3.5.2 When inspections are conducted on the aircraft or engine or otherwise without the use of a purpose-built area, a light-restricting cloak may be used to cover the inspection area so as to produce a darkened environment.

3.5.3 Eye adaption - Allow a minimum of 1 minute for eye adaption when entering the darkened viewing area prior to inspecting processed components.

3.6 Recording results

3.6.1 Inspection results are to be recorded in the relevant work sheet, NDT report or aircraft maintenance logbook and are to be certified in accordance with CASA or company requirements noting the particular method selected from the appendices of this CAAP.

4 Magnetic particle inspection

4.1 Testing ferrous aeronautical products

4.1.1 This chapter outlines the general requirements to be followed when conducting inspections as detailed in Appendices H and I of this CAAP.

4.1.2 The intent is to provide the minimum requirements for testing ferrous aeronautical products that are reasonably simple in geometry, such as bolts or shafts, although this does not necessarily preclude more irregular shapes items from being inspected. Where a complex item(s) requires testing with multiple thickness changes, or for any other issues relating to the inspection, a Level 3 NDT technician should be consulted for further advice.

4.1.3 Accept/Reject indications shall be in accordance with the aeronautical products applicable manual.

Warning

Magnetic prods must not be used on aircraft or aircraft components**.**

Dry powder magnetic particles should not be used on aircraft components because it is difficult to remove the residue from the inspection surface.

4.2 Preparation for magnetic particle inspection

4.2.1 In some circumstances, the use of blasting media may be needed to mechanically clean components before they can be inspected. Media can include:

- glass beads
- aluminium oxide
- plastic media.

4.2.2 When pre-cleaning parts, use materials and processes that remove the contaminant without damaging the part. For guidance on the correct cleaning method review the relevant OEM cleaning data for the part. Generally, blasting media that does not cause plastic deformation of the component's surface is suitable for pre-cleaning. Aluminium oxide120 grit is a common and acceptable blasting media although it is not suitable for use with hard-chromed surfaces.

Caution

Garnet grit is highly likely to cause deformation of a component surface and is not suitable for cleaning aircraft-quality metals.

Industrial mechanical cleaners may contain highly caustic compounds that may be detrimental to aircraft-quality metal parts.

4.3 Surface coatings and plating

4.3.1 There is no requirement to remove surface coatings before a magnetic particle inspection as long as the component's surface paint or plating meets all of the following criteria:

- is in good condition
- does not interfere with the inspection
- does not degrade the ability to identify defects
- any plating or paint is less than 0.1 mm thick.

Caution

The sensitivity of the magnetic particle method decreases as the paint or non-conductive coating thickness increases so it is preferable to remove the coating. On critical components subject to high stress or cyclic loading it is highly recommended that all coatings are removed. Consultation with the appropriate engineering authority may be required.

Although it is not necessary to remove nickel plating from a component's surface before inspection, personnel should be aware that nickel is magnetic and may provide false indications.

4.3.2 When using direct current magnetism, all paint must be removed in the contact areas to prevent arcing.

4.3.3 Removal of any coatings applies to in-service parts only and not to newly manufactured parts.

4.4 Quality control

4.4.1 All magnetic particle equipment and consumables must be maintained in accordance with the requirements of ASTM E-1444 and includes routine calibration and specific performance checks.

4.4.2 All figures and results of quality checks shall be annotated in a locally generated log at intervals detailed in the applicable table of ASTM E1444. Pay particular attention to the

daily checks (black light intensity, system performance check and wet particle concentration level).

> **Warning**
>
> Ultraviolet (UV) radiation is harmful to the eyes and skin.
>
> Refer to manufacture's product safety sheets and all relevant safety data sheets for magnetic particle materials in use.

4.5 Fixed bench inspection

4.5.1 Components that are forged, cast, drawn, welded or machined with irregular shapes are best inspected for surface defects using fixed bench equipment.

4.5.2 Magnetic particle testing using a fixed bench requires the following minimum ancillary equipment:

- black and white light meter
- 100 mL pear-shaped centrifuge
- tool steel ring (Ketos ring) or known cracked specimen
- flexible type II laminated strips
- magnetic field indicator (dial type)
- shunt meter for ammeter verification
- black (ultraviolet) light (capable of 1,000 μW/cm² minimum at 38 cm)
- fluorescent particle mixture conforming to AMS 3045
- inspection lights, mirrors and magnifiers
- marking media that will not damage the part
- notched shims such as Quantitative Quality Indicator (QQI) shims
- Hall Effect Gauss meter (optional, used for determining field strength).

4.5.3 The general inspection method involves fluorescent wet continuous method magnetising in two directions, circular and longitudinal, using either:

- full wave alternating current (FWAC)

  or
- half wave alternating current (HWAC).

Note: Direct current (DC) shall only to be used when explicitly requested by the applicable engineering authority or CASA.

4.5.4 Tensile or shear bolts and pins should be inspected for surface defects using the fluorescent wet continuous method using FWAC or HWAC longitudinally magnetised in a coil.

4.5.5 All other items require circular and or longitudinal magnetisation as detailed at Appendix H.

4.6 Inspection on components with a magnetic yoke

4.6.1 Magnetic particle testing on aircraft components with a magnetic yoke requires the following minimum ancillary equipment:

- black and white light meter
- black (ultraviolet) light (capable of 1,000 μW/cm² minimum at 38 cm)
- light restricting cloak of an appropriate size
- marking media which won't damage the part, mirror and rule
- hand-held AC/HWAC magnetic yoke
- type II laminated strips (or equivalent)
- AMS 3046 fluorescent particle mixture
- Magnetic field indicator (dial type)
- notched shims such as Quantitative Quality Indicator (QQI) shims
- Hall Effect Gauss meter (optional, used for determining field strength).

4.6.2 While fixed benches are to be used in preference over hand held magnetic yokes, the yoke may be used in AC mode to conduct magnetic particle inspections on aeronautical product where fixed benches are not practical. The component can be inspected for surface defects either in -situ or removed from the aircraft.

4.6.3 Inspection is by two magnetisations, 90° apart, using the fluorescent wet continuous method.

4.6.4 If fixed bench is required by the approved data then applicable engineering authority will need to be consulted for approval to use alternative equipment.

4.6.5 Direct current (DC) shall not be used without the explicit approval of the applicable engineering authority or CASA.

4.7 Magnetic field strength

4.7.1 Adequate field strength shall be determined by one of the following methods:

a. Utilising a part/s with a known or artificial defects of the same size, type and in the same location as that to be expected,

   or

b. Using a notched shims such as Quantitative Quality Indicator (QQI) shims, as detailed in ASTM E 1444,

   or

c. Using a Hall Effect Gauss meter ensuring a minimum of 30 gauss at part surface- refer ASTM E 1444 for guidance,

   or

d. Using formula's detailed in Appendix H and I in conjunction with either a. or b. or c.

4.7.2 Utilising a reference piece with a known defect of the size, type and in all the locations that is to be expected is the preferred way to establish correct field strength. However, such a part is often not available. If using a Hall Effect Gauss meter or QQI shims alone it is good practice to use the calculations in Appendix H to establish a starting point.

4.8 Notched shims/QQI(s)

4.8.1 QQI's are low carbon steel shims that contain artificial flaws. They are used to determine field direction for magnetic particle inspections and to ensure that the required level of magnetism has been achieved.

4.8.2 QQI's are placed with etched flaw side facing item and held in place with adhesive tape or suitable adhesive. More than one shim may be required when inspecting items with complex geometry or varying thicknesses. If using calculations start with the lower setting and slowly increase current until indication on shim appears. Refer ASTM E 1444 for further guidance.

4.9 Laminated strips

4.9.1 Type II laminated strips (or equivalent) should only be used to identify field direction for magnetic particle inspections as they are not a reliable measure for determining adequate levels of magnetism.

4.9.2 The strip is placed in direct contact with the surface of the item and orientated at 90° to the direction of the applied magnetic field.

4.10 Demagnetisation

4.10.1 After conducting magnetic particle testing on an aircraft component, the component must be demagnetised to less than 3 gauss.

4.10.2 Using the fixed bench, parts may be demagnetised in AC mode where such a function exists. To ensure effective demagnetisation and the ability to measure any remaining gauss, parts should be longitudinally magnetised before they are demagnetised.

4.10.3 Demagnetisation can also be achieved by applying an FWAC magnetic yoke to the aircraft or component’s surface and withdrawing it away slowly to a distance of 900 mm.

4.11 Recording results

4.11.1 Inspection results must be recorded in the relevant work sheet, NDT report or aircraft maintenance logbook. These should be certified in accordance with CASA's or the company's requirements, noting the particular method selected from the appendices of this CAAP.

Appendix A

Medium sensitivity water washable fluorescent penetrant

A.1 ASTM E-1417 TYPE 1, Method A, Level 2

A.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP:

a. Prepare the surface as described by the approved data.
b. Mask the internal passages.
c. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4°C to 52 °C.

> **Caution**
>
> Do not allow penetrant to dry.
>
> Over-removal of the surface penetrant shall require the part to be cleaned and reprocessed.

d. Dwell time is 15 to 30 minutes.
e. Water wash for a maximum of 2 minutes:
   i. Use a coarse spray (or a water soaked clean rag for local application).
   ii. Avoid over-washing. Stop washing when a low background fluorescent level is observed under UV light.
f. Dry part to be inspected. Time should be kept to the minimum time required to dry the part:
   i. All parts are not to exceed 60 °C to 70 °C.
   ii. Remove from heat as soon as dry.
   iii. Shop air at 24 ± 2 psi at 30 cm can be utilised to aid drying.
g. Apply developing powder to the surface or part using a thin, even, translucent coat.
h. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60
Dry powder	10	240

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturers' instructions for guidance.

i. Inspect the part within the maximum dwell time for the developer type used on completion of step (h) under UV light.
j. Inspect under white light to ensure non-relevant indications are cleared.
k. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to washing with warm water and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix B

High sensitivity water washable fluorescent penetrant

B.1 ASTM E-1417 Type 1, Method A, Level 3

B.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP:

a. Prepare the surface as described by the approved data.
b. Mask the internal passages.
c. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

> **Caution**
>
> Do not allow penetrant to dry.
>
> Over-removal of the surface penetrant shall require the part to be cleaned and reprocessed.

d. Dwell time is a minimum of 20 minutes.
e. Spray water wash for a maximum of 2 minutes:
   i. Use a coarse spray.
   ii. Avoid over-washing. Stop washing when a low background fluorescent level is observed under UV light.
f. Dry part to be inspected. Drying time should be kept to a minimum time required to dry the part:
   i. Parts not to exceed 60 °C to 70 °C.
   ii. Remove from heat as soon as dry.
   iii. Use of shop air at 24 ± 2 psi at 30 cm can be utilised to aid drying.
g. Apply developing powder to the surface or part using a thin, even, translucent coat.
h. Develop for the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60
Dry Powder	10	240

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturers' instructions for guidance.

i. Inspect the part or surface within the maximum dwell time for the developer type used on completion of step (h) under UV light.
j. Inspect under white light to ensure non-relevant indications are cleared.
k. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to washing with warm water and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix C

High sensitivity solvent removed fluorescent penetrant

C.1 ASTM E-1417 Type 1 Method C Level 3

C.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP.

C.1.2 For conditions where the temperature of the part to be inspected is between 5 °C and 10 °C, the dwell time for the penetrants shall be 20 minutes minimum:

a. Prepare the surface as described in the approved data.
b. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

Caution

Do not allow penetrant to dry.

c. Dwell time is 10 to 30 minutes.
d. Wipe off excess penetrant:
   i. First use dry cloth to remove excess penetrant.
   ii. Then under UV light use cloth moistened with penetrant remover to remove remaining penetrant.
e. Dry the surface or part ensuring that the penetrant remover has flashed off prior to the application of the developer.
f. Apply developer by spray from pressure can using a thin, even, translucent coat.
g. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturers' instructions for guidance.

h. Inspect the surface or part within 60 minutes of completion of step (g) under UV light.
i. Inspect under white light to ensure non-relevant indications are cleared.
j. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to using approved cleaning solvents and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix D

Ultra-high sensitivity solvent removed fluorescent penetrant

D.1 ASTM E-1417 Type 1 Method C Level 4

D.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP:

D.1.2 For conditions where the temperature of the part to be inspected is between 5°C and 10°C, the dwell time for the penetrants shall be 20 minutes minimum.

a. Prepare the surface as described by the approved data.
b. Apply penetrant:
    i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
    ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

Caution

Do not allow penetrant to dry.

c. Dwell time is a minimum of 30 minutes.
d. Wipe off excess penetrant:
    i. Use a dry cloth to remove excess penetrant.
    ii. Use a cloth moistened with penetrant remover under UV light to remove any residual penetrant.
e. Dry surface or part ensuring that the penetrant remover has flashed off prior to the application of the developer.
f. Apply developer using a thin, even, translucent coat.
g. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturers' instructions for guidance.

h. Inspect the surface or part within 60 minutes of completion of step (g) under UV light.
i. Inspect under white light to ensure non-relevant indications are cleared.
j. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to using approved cleaning solvents and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix E

Medium sensitivity post emulsified fluorescent penetrant

E.1 ASTM E-1417 Type 1 Method D Level 2

E.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure[1] must be used in conjunction with Chapter 3 of this CAAP:

a. Prepare the surface as described by the approved data.
b. Mask the internal passages.
c. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

> **Caution**
>
> Do not allow penetrant to dry.

d. Dwell time is a minimum of 20 minutes.
e. Using a coarse spray, apply penetrant pre-rinse for the minimum time required to achieve bulk surface penetrant removal.
f. Immerse in emulsifier (dip tank):
   i. Emulsifier times and concentrations should be as per the manufacturer's instructions; however, immersion time shall not exceed 2 minutes.

Note: Emulsifier must be compatible with the penetrant being used i.e. from the same manufacture and penetrant system.

   ii. These immersion times must be adhered to.

> **Caution**
>
> If applying emulsifier by spray, ensure the emulsifier concentration used is per the manufacturer's recommendation.

g. Post water rinse using a coarse spray to remove emulsifier from the parts surface:
   i. Avoid over-washing by monitoring the process under a UV light.
h. Dry part to be inspected. Drying time should be kept to the minimum time required to dry the part:
   i. Parts not to exceed 70 °C.
   ii. Remove from heat as soon as dry.
   iii. Use of shop air at 24 ± 2psi at 30 cm can be used to aid drying.

i. Apply developing powder to the surface or part using a thin, even, translucent coat.
j. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60
Dry powder	10	240

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturer's instructions for guidance.

k. Inspect the surface or part within the maximum dwell time for the developer type used on completion of step (i) under UV light.
l. Inspect under white light to ensure non-relevant indications are cleared.
m. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to washing with warm water and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix F

High sensitivity post emulsified fluorescent penetrant

F.1 ASTM E-1417 Type 1 Method D Level 3

F.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP:

a. Prepare the surface as describe in the approved data.
b. Mask the internal passages.
c. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

> **Caution**
>
> Do not allow penetrant to dry.

d. Dwell time is a minimum of 30 minutes.
e. Using a coarse spray, apply penetrant pre-rinse for the minimum time required to achieve bulk surface penetrant removal.
f. Immerse in emulsifier (dip tank):
   i. Emulsifier times and concentrations should be as per the manufacturer's instructions; however, dwell time shall not exceed 2 minutes.

Note: Emulsifier must be compatible with the penetrant being used i.e. from the same manufacture and penetrant system.

g. The maximum emulsion time is not to be exceeded.

> **Caution**
>
> If applying emulsifier by spray, ensure the emulsifier concentration used is per the Manufactures' recommendation.

h. Post water rinse using a coarse spray to remove emulsifier from the parts surface:
   i. Avoid over-washing by monitoring the process under a UV light.
i. Dry part to be inspected. Drying time should be kept to the minimum time required to dry the part:
   i. Parts not to exceed 70 °C.
   ii. Remove from heat as soon as dry.
   iii. Use of shop air at 24 ± 2psi at 30 cm can be used to aid drying.

j. Apply developing powder using a thin, even, translucent coat.
k. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60
Dry powder	10	240

Notes:

1. Components not inspected within the maximum dwell time shall be cleaned and reprocessed.
2. Refer to manufacturers' instructions for guidance.

l. Inspect the surface or part within the maximum dwell time for the developer type used on completion of step (j) under UV light.
m. Inspect under white light to ensure non-relevant indications are cleared.
n. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to washing with warm water and blow out passages and cavities with dry air. Once cleaned, inhibit part per manufacturer's instructions.

Appendix G

Ultra-high sensitivity post emulsified fluorescent penetrant

G.1 ASTM E-1417 Type 1 Method D Level 4

G.1.1 This procedure is approved as an acceptable means of compliance for the performance of fluorescent penetrant inspection. This procedure must be used in conjunction with Chapter 3 of this CAAP:

a. Prepare the surface as described by the approved data.
b. Mask any internal passages.
c. Apply penetrant:
   i. Coat all surfaces to be inspected ensuring 100% coverage. Apply by dip/spray or brush.
   ii. Penetrant, component and ambient temperature shall be in the range of 4.4 °C to 52 °C.

> **Caution**
>
> Do not allow penetrant to dry.

d. Dwell time is a minimum of 30 minutes.
e. Using a coarse spray, apply penetrant pre-rinse for the minimum time required to achieve bulk surface penetrant removal.
f. Immerse in emulsifier (dip tank):
   i. Emulsifier times and concentrations should be as per the manufacturer's instructions; however, dwell time shall not exceed 2 minutes.

Note: Emulsifier must be compatible with the penetrant being used i.e. from the same manufacture and penetrant system.

   ii. Do not exceed the maximum emulsification time.

> **Caution**
>
> If applying emulsifier by spray or foam, ensure the emulsifier concentration used is per the manufacturer's recommendation.

g. Post water rinse using a coarse spray to remove emulsifier from the parts surface:
   i. Avoid over-washing by monitoring under UV light.
   ii. For large complex parts use dip wash prior to spray.
h. Dry part to be inspected. Drying time should be kept to the minimum time required to dry the part:
   i. Parts not to exceed 70 °C.
   ii. Remove from heat as soon as dry.

iii. Use of shop air at 24 ± 2psi at 30 cm can be used to aid drying.

i. Apply developing powder ensuring a thin, even, translucent coat.

j. Develop per the following table.

Developer Type	Minimum Dwell Time (Minutes)	Maximum Dwell Time (Minutes)
Non-aqueous wet	10	60
Dry powder	10	240

Notes:

Components not inspected within the maximum dwell time shall be cleaned and reprocessed.

Refer to manufacturers' instructions for guidance.

k. Inspect the surface or part within the maximum dwell time for the developer type used on completion of step (j) under UV light.

l. Inspect under white light to ensure non-relevant indications are cleared.

m. Clean the surface or part of any residual penetrant or developer by manually cleaning the developer off prior to washing with warm water and blow out passages and cavities with dry air. Once cleaned, Inhibit part per manufacturer's instructions.

Appendix H

CASA/MPI/1 – MPI procedure using a magnetic particle bench

H.1 Introduction

H.1.1 ASTM-E-1444 establishes a requirement to use a dedicated procedure for the inspection of parts. This procedure is approved as an acceptable means of compliance for the performance of magnetic particle inspection utilising a magnetic particle bench. This procedure must be used in conjunction with Chapter 4 of this CAAP.

H.2 Limitation of this procedure

H.2.1 This procedures sensitivity to detecting small defects will be diminished as surface coating thickness increases. Refer to section 4 Preparation for magnetic particle inspection.

H.3 Inspection procedure

H.3.1 Ensure all applicable quality control checks and surface preparation assessments have been carried out as per Chapter 4 of this CAAP.

H.3.2 Inspection personnel must observe a minimum of one minute dark adaptation before carrying out the inspection.

H.3.3 Longitudinal magnetisation shall be applied last to allow the detection of residual magnetic fields after demagnetisation.

H.3.4 Circular magnetism

a. Ensure QQIs are securely in place as required.
b. Place the part between the heads. To reduce the risk of arcing, ensure part is clamped firmly and the ends are free of nonconductive coatings such as paint.
c. Calculate current levels by utilising 300 A to 800 A per 25 mm of cross-section or diameter.
d. If using a offset central conductor, (i.e. not centrally located in the part) where the conductor is placed against the inside wall of the part, the current levels of 300 A to 800 A per 25 mm shall apply, except that the total diameter shall be the sum of the diameter of the central conductor place twice the wall thickness of the part, or
    i. Effective diameter = diameter of central conductor + 2 x wall thickness of part.
e. To ensure the total circumference of hollow parts are inspected the part may need to be rotated about the axis of the conductor. The effective region of examination when using an offset central conductor is equal to four times the diameter of the conductor. Refer ASTM E 1444 for further guidance and illustration.
f. Begin inspection by inspecting the smaller cross-sections first, working to the larger diameters (higher amperages) using AC. Using the lower end of the calculated current magnetise part at increasing increments until QQI indication begins to show.
g. Once adequate magnetic flux has been obtained, carry out the inspection using the fluorescent wet continuous method utilising AC ensuring a minimum of 2 pulses at 0.5 seconds are applied to the part.
h. Ensure the fluid is gently flowed over the part and is ceased simultaneously, or slightly, before applying the magnetising current. This sequencing will ensure proper particle retention over any defects and prevent particles from being washed away from any potential indications.

i. Inspect the part for defect indications. Crack indications will appear as sharp, well-defined lines. Near surface and some non-relevant indications will appear broad and fuzzy and generally follow part geometry. Mark all cracks and any suspect defect indications for further evaluation.

H.3.5 Longitudinal magnetism

a. Ensure QQIs are securely in place as required.
b. Place the part against the inside of the coil.
c. Determine current (I) level by utilising the following formula:

$$NI = \frac{K}{L/D} (\pm 10\%)$$

Where:
N = Number of turns in the coil
I = Amperes required through the coil
K = 45,000 permeability constant
L = length of the part
D = the part diameter of the part.

d. The formula is a guide only and is based on the cross-section of the part being less than 10% of the coil opening and having a length to diameter ration of greater than 2 and less than 15. Consult ASTM E1444 for any other scenario.
e. Effective magnetising field is approximately 150 mm either side of the coil. Additional shots will be required on longer parts to ensure full inspection coverage.
f. Begin inspection by inspecting the smaller cross-sections first, working to the larger diameters (higher amperages) using AC. Magnetise part at increasing increments until QQI indication begins to show.
g. Once adequate magnetic flux has been obtained, carry out the inspection using the wet fluorescent wet continuous method utilising AC ensuring a minimum of 2 pulses at 0.5 seconds are applied.
h. Ensure the fluid is gently flowed over the part and ceased simultaneously or slightly before applying the magnetising current. This proper sequencing will ensure proper particle retention over any defects and prevent particles from being washed away from any potential indications.
i. Inspect the part for surface defect indications. Crack indications will appear as sharp, well-defined lines. Near surface and some non-relevant indications will appear broad and fuzzy and generally follow part geometry. Mark all cracks and any suspect defect indications for further evaluation.

Note: The use of a Hall Effect Gauss meter is also acceptable method to establish adequate levels of magnetism as well as utilising a part having known or artificial defects of type, size and location specified in the acceptance requirements. Refer to ASTM E1444 for correct use.

H.4 Visual inspection

H.4.1 Perform a visual inspection of defects and suspect defects utilising a suitable magnifying device.

H.4.2 Any confirmed defect indication is cause for part rejection.

H.5 Post-inspection

H.5.1 Ensure inspected components are cleaned and demagnetised; ensuring the residual magnetism in the part does not exceed 3 gauss.

H.5.2 Ensure QQI's and any other foreign material used is removed from component.

Appendix I

CASA/MPI/2 – MPI procedure using a portable magnetic yoke

I.1 Introduction

I.1.1 ASTM-E-1444 establishes a requirement to use a dedicated procedure for the inspection of parts. This procedure is approved as an acceptable means of compliance for the performance of MPI utilising a portable magnetic yoke. This procedure must be used in conjunction with Chapter 4 of this CAAP.

I.2 Limitation of this procedure

I.2.1 This procedure may not detect surface breaking defects of less than 2 mm in length or under surface coatings greater than 0.13 mm thick.

I.3 Pre-inspection preparation

I.3.1 Ensure any applicable quality control checks and surface preparation assessments have been carried out as outlined in Chapter 4 of this CAAP.

I.4 Inspection procedure

I.4.1 The inspection personnel must have a minimum of one minute dark adaptation before carrying out the inspection as follows:

a. Ensure QQI's are securely in place as required.
b. Place the yoke legs across the inspection area with the yoke legs spaced approximately 10 cm apart.
c. Apply the AC magnetising current and spay the magnetic particle fluid on to the surface for several seconds. Continue to energise the yoke for several seconds after ceasing the application of the magnetic ink. This proper sequencing will ensure proper particle retention over any defects and prevent particle from being washed away from any potential indications.
d. Leg spacing may need to be adjusted to a point where the QQI indication just begins to show as there is a potential to over magnetise some parts if leg spacing is too close (see Note 1).
e. Inspect the part for surface defect indications.
f. Crack indications will appear as sharp, well-defined lines. Near surface and some non-relevant indications will appear broad and fuzzy and generally follow part geometry. Mark all cracks and any suspect defect indications for further evaluation.
g. Where defect orientation is unknown, rotate the yoke through 90° and repeat Step c (see Note 2).
h. When the inspection is complete, demagnetise the part in accordance with Chapter 4.6.1 above and ensure the residual magnetism in the part does not exceed 3 gauss.

Notes:

1. The use of a Hall Effect Gauss meter is also an acceptable method to establish adequate levels of magnetism as well as utilising a part having known or artificial defects of type, size and location specified in the acceptance requirements. Refer Chapter 4 and ASTM E1444 for correct use.
2. Bolts, shear pins and similar shaped items only require magnetizing through their longitudinal axis.

I.5 Visual inspection

I.5.1 Perform a visual inspection of defects and suspect defects utilising a suitable magnifying device.

I.5.2 Any confirmed defect indication is cause for part rejection.

I.6 Post-inspection

I.6.1 Ensure inspected components are cleaned and demagnetised ensuring the residual magnetism in the part does not exceed 3 gauss.

I.6.2 Ensure QQI's and any other foreign material used is removed from component.