1.Module details

Module name

MAGNETIC PARTICLE TESTING

Nominal duration

Two modules.

It is anticipated that a learner holding the prescribed entry level skills will achieve the module purpose in 70 to 80 hours.

Module codes

MT02 (EA607)

Discipline code

Non-Destructive Testing (Code to be allocated)

2. Module purpose

To provide a detailed understanding of the principles, procedures and applications of magnetic particle testing and competence in the use and interpretation of magnetic particle test methods.

3. Prerequisites

Nil. However learners should be studying, or have completed training in the NDT method(s) for which certification is being sought.

4. Relationship to competency standards

This module meets the training requirements for Level 2 qualification in magnetic particle testing under AS3998-1992 "Non-destructive Testing - Qualification and Certification of Personnel - General Engineering" and AS-3669-1989 "Non-Destructive Testing - Qualification and Registration of Personnel - Aerospace".

Currently no national competency standards have been established at national level. However, the learning outcomes in this course relate to ASF level 5-6.

5. Content

Historical background; basic description and scope of the magnetic particle test.

Flux leakage and orientation and dependence of test; principle of demagnetisation.
Advantages, limitations of the test.

Magnetism

Types of magnetism; domain theory of magnetism; permanent magnets; magnetic lines of force, poles.
Electrically induced magnetic fields and their characteristics; field distribution in magnetic and non-magnetic conductors and in coils.
Magnetic properties, hysteresis loops.
Magnetic materials, para-magnetics dia-magnetics, ferro-magnetism.
Magnetic circuits, permeability, reluctance, magnetising force, flux density.
Relative permeability of common engineering materials.
Ease of magnetisation.

Principles of the test

Magnetic discontinuity, leakage fields.
Significance of discontinuity/flux orientation.

Methods of magnetisation

Permanent magnets, electrically induced magnetic fields.
Current flow, threaded bar. coil, magnetic flow, induced current, transient current methods.
Methods of demagnetisation.
Types of equipment. Portable, stationary,
Automated etc., equipment features, advantages, limitations;
Equipment for demagnetisation;
Field meters; flux indicators.

Magnetising current

Nature and properties of the various types of magnetising current: AC, HWR, FWR, DC.
Current requirements for testing.
Types of ammeters.
Relationship RMS, peak and average currents.
Skin effect. Dangers of AC for residual methods.

Flux density & distribution

Optimum current density for current flow and threaded bar methods with round and square sections.
Current compromise for varying cross-section.
Flux distribution with current flow for AC and DC.
Current determination for current flow methods
Coil magnetisation.
Self demagnetising effect.
Length/diameter ratio.
Determination of ampere-turns for AC, DC, HWR & FWR.
Effect of part placement in coil.
Flux density determination.
Effect of contact to test piece with current flow and magnetic flow.
Prod magnetisation, flux distribution, current selection, hazards.

Test media

Formulation and properties of the various magnetic particle test media types;
Advantages and limitations of dry powders and fluid suspensions.
Relative sensitivities for different defect sizes & depths.
Choice of colour and fluorescent materials.
Particle size.
Viscosity of carrier.
Concentration of suspended media.
Quality control of media, viewing conditions.
Disposal procedures
Environmental care

Testing

Preparation of parts.
Selection of process

	Effect of surface coatings on sensitivity. Effect of surface roughness. Dressing of welds. Continuous and residual methods - sequence of application of current and media. Use of residual method for detection of flaws at sudden change of section and thread roots. Importance of good electrical contact, use of braided copper and lead pads. Metallurgical effects of arcing and overheating. Test sensitivities using various current/media combinations. Demagnetisation by AC, coil reversing, reducing DC coil, AC yoke. Tests for demagnetisation. Problems with circularly magnetised parts. **Interpretation of indications** Lighting conditions. Use of magnification. Factors influencing appearance. Non-relevant indications, false indications. Magnetic writing. Effect of metallurgical and physical effects, grinding burns, weld HAZ, cold work, carburising, induction hardening. Surface and sub-surface indications. Analysing indications, importance of processing history. Preservation of indications. **Recording and reporting** Keeping of worksheets. Reporting of results. NATA requirements **Standards, codes applicable to magnetic particle testing** AS1171 ASTM E1444
6. Assessment strategy	Competency based assessment applies. Assessment should be carried out by gathering evidence using a variety of methods or instruments that have validity according to the learning being assessed.
Assessment method	Multiple choice and short answer questions Written assignments and demonstrated competence through assigned work tasks. Final assessment will be by a written examination as required by AS3998 for Level 2 Certification in one or more NDT method(s). This examination will require, in addition to this module, knowledge of, and competence in, the NDT method(s) for which certification is being sought.
Conditions of assessment	Assessment will be conducted by a suitably qualified assessor, as required by AS3998. Candidate will have access to any equipment, materials and/or documentation required.

7. Learning outcome details

On completion of this module the learner will be able to:

Learning outcome 1

Describe the metallurgical factors that affect the production of quality welds.

Assessment criteria

1.1 Describe the solidification process and how discontinuities such as porosity develop.

1.2 Explain the metallurgical characteristics that occur with thermal cycles.

1.3 Identify the cause of distortion in welding.

1.4 Describe the different ferrous and non-ferrous alloys that are subjected to welding processes, and the effect of welding on these alloys.

Learning outcome 2	Describe the common welding processes and list and describe the common discontinuities found in weldments.
Assessment criteria	2.1 Describe the principle, techniques and applicability of the common fusion and solid phase welding processes. 2.2 Distinguish the type of welds produced by different processes. 2.3 Produce simple welds using oxy-acetylene and electric arc processes. 2.4 Identify factors to be considered in developing welding procedures and explain the effects of variations in procedure.
Learning outcome 3	Explain in simple terms the reason for the formation of each discontinuity type, distinguish different discontinuities, list the methods used for discontinuity prevention, and test welds using suitable NDT methods.
Assessment criteria	3.1 Describe the cause of discontinuities in welds, and distinguish between different types of discontinuities. 3.2 Relate discontinuity types to welding processes. 3.3 Explain the effect of different discontinuity types on structural integrity. 3.4 Discuss the NDT methods available for detection of the various types of weld discontinuities, select the most appropriate test method, and identify the signals or appearance of the discontinuities as revealed by NDT.
Learning Outcome 4	Describe and identify welding terms and symbols.
Assessment criteria	4.1 Describe and identify common welded joint configurations. 4.2 Identify weld symbols and NDT symbols as used on engineering drawings.

Learning Outcome 5	Explain and interpret the NDT aspects of codes and specifications relating to welding.
Assessment criteria	5.1 Explain the purpose of codes and specifications. 5.2 Interpret the NDT requirements of codes and specifications relating to welding. 5.3 Distinguish different acceptance levels of codes and specifications. 5.3 Describe the varying level of visual examination of welds.
Learning Outcome 6	Indicate the NDT aspects in adhesive bonding quality control procedures.
Assessment criteria	6.1 List the types of defects in adhesive bonded joints. 6.2 Summarize NDT applications to bonded joints. 6.3 Interpret NDT codes and specifications relating to adhesive bonding.
8. Delivery of the module	This module may be taught by active participation, illustration, demonstration and description. This module is practical in nature and theoretically integrated to complement the acquisition of practical skills .
Delivery strategy	This module will generally be taught and assessed off-the-job. The module has a high practical content. Theory and practice will be taught concurrently. There will be a range of learning activities including modified lectures, practical work and project work.

Resource requirements

Human Resources

- trainer/mentor

Physical Resources

- legislative and regulatory documentation
- relevant personnel, information and equipment
- appropriately equipped training room

Major texts & references:

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Sandvik welding handbook	Sandvik
Metallurgy of Welding	Lancaster
Introduction to the Physical Metallurgy of Welding	Kenneth Easterling
The Procedure Handbook of Arc Welding	Lincoln Electric
Welding Handbook Vol 1-5	American Welding Society
A.W.S Certification manual for Welding Inspectors	American Welding Society
Welding Metallurgy, Vols 1 & 2	Linnert
Rational Welding Design	Gray, Spence & North
Detection & Measurement of Cracks	Welding Institute,UK

Australian Standards

AS Z5, Parts 1 & 2 Terms
AS 1101, Part 3 Welding & NDT
AS 1210 Unfired Pressure Vessels
AS1228 Watertube Boilers
AS1554 Structural Welding
AS1697 Gas Pipelines
AS1797 Firetube Boilers
AS2812 Terms
AS CB15 Pipe Welding

Occupational health and safety requirements

Learners and/or employees undertaking this module should have demonstrated competencies as defined in the Metal & Engineering Industry Standards Unit No 1.2F - Apply principles of OH&S in work environment. This would apply in the classroom or workplace.