Employer's Unit of Competence – **Eddy current testing of materials, products and plant**

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Overview

This unit identifies the competencies required to carry out eddy current testing (ET) inspection activities, using manual, semi-automatic or fully automatic equipment, on engineering materials, products and plant, in accordance with approved procedures. The use of both contact and non-contact eddy current flaw detector equipment is covered in this unit.

The apprentice will be required to check that the ET inspection equipment complies with the specification requirements, is safe to use, fit for purpose and has been correctly calibrated. They will prepare the products for inspection, identifying the test area for future reference and checking the environmental conditions, material properties and surface conditions to which eddy current testing is sensitive. They will set up and adjust the equipment, carry out the specified inspection using the correct procedures/techniques, according to the ET testing instructions and requirements, and observe and record the test indications.

The apprentice will be expected to interpret ET equipment displays, recognise changes in the equipment response and draw conclusions about the probable cause of these changes. They will complete the inspection by preparing/completing an ET test report containing the required test information and the values assigned to key inspection parameters and accurately map the position, type, severity and distribution of flaws where these are detected. If appropriate and safe to do so, they may be expected to mark up the products, objects or structures to identify areas of interest and incorporate a chart or digital image of the signals produced from either static or moving probes or test coils. The completed inspection report will be passed to the appropriate people, in accordance with procedures.

The apprentice's responsibilities will require them to comply with organisational policy and procedures for the ET inspection activities undertaken. Any problems with the activities or equipment in use that they cannot personally resolve, or are outside their permitted authority, will be reported to the relevant people. They will be expected to work with minimal supervision, taking personal responsibility for their actions and for the quality and accuracy of the work they carry out.

The apprentice's underpinning knowledge will demonstrate a good understanding of their work and will provide an informed approach to the ET inspection of engineering materials, products and plant, of engineering products, plant, materials or structures and the process or product technology associated with each.

They will have a working knowledge of the principles of ET, common techniques and a variety of equipment configurations, incorporating surface probes, encircling coils and phased arrays.

They will have detailed knowledge of good inspection practice, including equipment calibration requirements, the selection of appropriate calibration pieces, test-blocks and reference discontinuities befitting the specific ET inspection task.

They will become aware of the factors that determine effective coupling of the test article to the sensing probe or test coil, such as lift-off and fill factor, respectively, as well as the consequence of inadequate or unstable coupling relating to test sensitivity, signal-to-noise ratio and/or probability of detection and the appropriate corrective or compensating measures required to negate their effects.

They will develop an in-depth understanding of the main material characteristics affecting ET inspection, such as conductivity, relative permeability, thickness, dimension and mass.

They will apply electromagnetic theory and principles to a host of potential applications, including the sorting and segregation of metals and alloys, surface flaw detection, measurement of the thickness of foils and surface coating thickness, across a range of products, such as hot or cold wire, rod, pipes and tubes. They will also have a detailed knowledge of equipment performance checks and routine care of the equipment.

Their knowledge will include an appreciation of hazards and safe working practices and they will understand the risks posed by materials at high temperature during manufacture, temperature increase due to cold working, working with electrical equipment, active plant and associated material, equipment or vehicular movements.

They will, by virtue of the training and supervised experience that they receive, become keenly aware of the potential consequences of component failure. The importance of compiling accurate and legible reports will also be a key issue in completing this unit.

They will understand the safety precautions required when carrying out the ET inspection activities and when using the associated tools and equipment. They will be required to demonstrate safe working practices throughout and will understand the responsibility they owe to themselves and others in the workplace.

Performance Criteria

The apprentice must be able to:

P1 Work safely at all times, complying with health & safety and other relevant regulations, directives and guidelines

P2 Follow the correct specification/technique for the product or equipment being inspected and the anticipated locations and orientation of flaws

P3 Use the appropriate equipment configuration to achieve specific inspection requirements

P4 Identify and, where possible, control potential sources of electronic and structural noise

P5 Carry out all required ET inspections as specified

P6 Identify any regions with a distinct change in sensor behaviour, likely to be attributed to some definite material change, anomaly or flaw, requiring further investigation, which may include the application of complementary NDT method(s)

P7 Undertake analysis and interpretation of signal displays or inspection charts

P8 Record the results of the ET inspections in an appropriate format

P9 Deal promptly and effectively with problems within their control and report those that cannot be solved.

Knowledge and Understanding

The apprentice must know and understand:

K1 The specific safety precautions to be taken when carrying out ET activities on engineering materials, products and plant

K2 The hazards associated with carrying out the ET activities (such as electrical contact, moving mechanical parts and high temperatures) and how the risks associated with these hazards can be minimised

K3 The type(s) of personal protective equipment (PPE) to be used and how to obtain it

K4 How to obtain the necessary job instructions/techniques, ET testing specifications and how to interpret this information

K5 The benefits of using eddy current testing and the range of materials and products to which it is usefully applied

K6 Why products may need to be inspected by a range of different non-destructive testing methods (such as magnetic particle inspection, penetrant flaw detection, ultrasonics and radiography)

K7 Electricity and magnetism and the fundamentals of electromagnetism

K8 The basic components of the eddy current flaw detection equipment (such as the use of oscillators, test coils, filters, bridge circuits, amplifiers and various signal display formats to include polar, chart, motional and rotational synchronous displays with rectified and/or unrectified signals)

K9 The different test coil configurations, to include single and double absolute, differential coils and multi-winding coils with separated transmitting and receiving coils, as applicable to both surface probes and encircling coils

K10 The common signal evaluation techniques, ranging from impedance testing, through modulation testing and finally phase analysis techniques

K11 The effect of test frequency and material properties on the distribution of eddy currents on and below the surface skin of the test item and their relative magnitude and phase at increasing depth within the test material (standard depth of penetration)

K12 Factors that will affect the selection of suitable probes (such as the purpose of the test, material type, accessibility of the inspection surface, area coverage, maximum defect depth and length, potential orientation and location of flaws, proximity to edges or a sharp change in contour)

K13 How the properties of the products to be tested (such as conductivity, relative permeability, hardness, heat-treated condition, magnetic state, size, dimensions and surface condition) will affect the way the equipment performs

K14 How to set up and calibrate the eddy current flaw detection equipment using specified calibration blocks, setting test sensitivity as appropriate to the product being inspected and the maximum permitted depth and length of any

surface flaw and the effect of any differences in material properties between the calibration block and the material of the inspected products

K15 How to carry out the eddy current testing activities by selection of appropriate probes, test coils or test configurations and the use of an appropriate scanning index or inspection pitch to assure the detection of flaws of the specified maximum length

K16 How to interpret the various signals from the equipment, in terms of defect/flaw identification, defect/flaw sizing and the effect of probe manipulation, fill factor and lift-off

K17 The types of defects/flaws that are detectable using eddy current testing methods

K18 The level of defects/flaws that are acceptable in the products and the influence of the defects on the service/performance of the products, materials or structures

K19 Industrial process monitoring applications: furnace and boilers, ducting, process plant systems, welded pipes and heat exchangers

K20 The system of quality control within the company and who is responsible for it

K21 Why it is critical that records of ET inspections on the products are accurate, comprehensive and maintained legibly

K22 The person/s that they need to pass the inspection records to

K23 In the case of digital data, how to facilitate automatic storage and back-up to a more accessible server

K24 Care and control of the equipment (to include checking the condition of insulation and all electrical cables and connections, equipment operating controls and displays)

K25 The extent of their own responsibility and to whom they should report if they have problems that they cannot resolve.

Skills

The apprentice must be able to:

1. Carry out **all** of the following during the ET inspections:

   - Obtain the required equipment, probes and/or test coils and ensure that it is in a safe and usable condition
   - Use appropriate personal protective equipment
   - Comply with job instructions, NDT testing inspection procedures, relevant COSHH sheets and risk assessment documentation
   - Follow the defined testing procedures/techniques and apply safe working practices and procedures at all times
   - Leave the work area in a safe condition on completion of the activities.

2. Obtain the correct configuration of equipment, as required by the ET procedures/techniques or work instructions, to include **all** of the following:

   - Oscillator/generator
   - Cables, shunts, balancing coils and inductances
   - Encircling coils
   - Surface probes
   - Reference pieces or blocks.

3. Prior to undertaking an ET inspection, carry out and record the following equipment parameters (where appropriate) that could influence the outcome from the inspection:

   - Test coil balance
   - Test frequency
   - Filter settings

- Probe frequency
- Magnetic state/properties of the test material
- Scanning speed and pitch.

4. Preparation prior to commencing an inspection, to include carrying out the following as appropriate:

- Identify the inspection areas
- Check that the test areas are correctly prepared for testing
- Check for key reference (datum) markings
- Recognise/compensate for magnetic variations within the material
- Recognise and deal with potential coupling inefficiencies
- Recognise and deal with material condition, coatings, heat-treated condition, corrosion and contamination
- Check, when appropriate, for surface roughness, scuffing, scratching or marking, which may generate unwanted signals
- Recognise and deal with electrical noise and/or poor signal-to-noise ratio.

5. Carry out the specified tests, using **all** of the following:

- The specified type of scan
- The appropriate scanning procedure and technique
- The specified probes (correct type, size and frequency)
- The correct flaw size measurement technique.

6. Carry out ET Inspection on **one** of the following:

- Wrought products
- Welds
- Pure metals and/or alloys
- Tubes or pipe
- Industrial process plant
- Cold-formed products (formed, for example, by bending, pressing or rolling)
- Heat-treated components
- Structures (such as airframes, lifting beams and pressure vessels)
- Other specific products.

7. Complete an ET inspection report, to include recording **all** of the following:

- Test frequency
- Test configuration
- Absolute or differential probes/coils
- Material type, dimensions and condition
- Probe-to-material gap (shimmed)
- Fill factor for encircling coil
- Name of inspector, qualification and signature
- Reference drawings or sketches as appropriate
- Phase setting
- Flaw response thresholds
- dB values per individual test channel

- Defect/flaw type
- Defect/flaw length and depth
- Defect/flaw location
- Test area identification
- Summary of inspection results, including a conclusion.

8. Follow the correct procedure to deal with products that fall into one or more of the following categories:

- Components, materials or structures that meet the specification
- Components, materials or structures with identified defects
- Components, materials or structures requiring further investigation
- Components, materials or structures requiring other inspection methods.

9. Complete the inspection activities, to include carrying out **all** of the following:

- Marking up defective products, plant, materials or structures with all relevant information
- Handing over the inspection report to the appropriate people.