SQA Advanced Unit Specification

General information for centres

Unit title: Performing Magnetic Particle Inspection

Unit code: HV3E 46

Unit purpose: This unit is designed to enable candidates to develop knowledge and understanding of the concepts of magnetic particle inspection and allow them to apply and develop this knowledge by inspecting components with natural and artificial defects. It has also been designed to provide a vehicle by which successful candidates can further their career into industrial non-destructive testing.

On completion of the Unit the candidate should be able to:

1 Demonstrate an understanding of the basic concepts of magnetic particle inspection.
2 Demonstrate an understanding of the specific facts of magnetic particle inspection.
3 Demonstrate an understanding of the basic production processes used in the manufacture of components tested by magnetic particle inspection.
4 Perform and report on tests on components using a magnetic particle inspection method.

Credit points and level: 1 SQA Credit at SCQF level 6: (8 SCQF credit points at SCQF level 6).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: It would be beneficial if the candidate has a knowledge of basic Non-Destructive Testing methods. This may be evidenced by possession of relevant qualifications or experience.

Core skills: There may be opportunities to gather evidence towards the Core Skills of Communication, Numeracy and Problem Solving in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Context for delivery: If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Assessment: The assessment for Outcome 1 should be composed of a suitable balance of multi-choice questions and narrative questions covering the topics in the Outcome.

The assessment for Outcome 2 should be composed of a suitable balance of multi-choice questions and narrative questions covering the topics in the Outcome.

The assessment for Outcome 3 should be composed of a suitable balance of narrative questions covering the topics in the Outcome.

The assessment for Outcome 4 should take the form of a practical assignment which will include written practical reports and a written procedure.

All the assessments should be conducted under controlled, supervised conditions.

Both the written and practical assignments should be carried out at the end of the delivery of the Unit.

It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

SQA Advanced Unit specification: statement of standards

Unit title: Performing Magnetic Particle Inspection

Unit code: HV3E 46

The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Demonstrate an understanding of the basic concepts of magnetic particle testing

Knowledge and/or skills

- principles of magnetic particle inspection
- methods of magnetisation
- inspection and detection of indications
- checks and calibrations
- equipment

Evidence requirements

Evidence for the knowledge and/or skills in Outcome 1 will be provided on a sample basis. The evidence will be provided in response to specific questions, using a 10 question multi-choice paper and three narrative type questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample paper is required each time the Outcome is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements showing that the candidate is able to achieve a minimum of 50% correct.

Outcome 2

Demonstrate an understanding of the specific facts of magnetic particle inspection

Knowledge and/or skills

- test procedures
- detectability of defects
- standards and specifications
- interpretation and reporting
- post test procedures

Evidence requirements

Evidence for the knowledge and/or skills in Outcome 2 will be provided on a sample basis. The evidence will be provided in response to specific questions, using a 10 question multi-choice paper and three narrative type questions. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample paper is required each time the Outcome is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements showing that the candidate is able to achieve a minimum of 50% correct.

Outcome 3

Demonstrate an understanding of the basic production processes used in the manufacture of components tested by magnetic particle inspection

Knowledge and/or skills

- crude and finished products
- basic casting methods — finished products
- wrought products — forming processes
- basic welding processes

Evidence requirements

Evidence for the knowledge and/or skills in Outcome 3 will be provided on a sample basis. The evidence will be provided in response to specific questions, using three out of five narrative type questions, covering the topics of casting, forging, rolling, welding and stress relief/heat treatment. Each candidate will need to demonstrate that they can answer questions based on a sample of the items shown above.

In order to ensure that candidates will not be able to foresee what items they will be questioned on, a different sample paper is required each time the Outcome is assessed.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements showing that the candidate is able to achieve a minimum of 50% correct.

Outcome 4

Perform and report on tests on components using a magnetic particle inspection method

Knowledge and/or skills

- testing in accordance with NDT procedure
- inspection reports

Evidence requirements

Evidence for the knowledge/or skills in Outcome 4 will be provided on a sample basis.

Evidence of the candidate's ability to test components safely and accurately, should be generated by their undertaking a series of practical inspections — two samples should be tested from the three categories of welds, forgings and castings. Centres may utilise checklists to score assessments, however the candidate must also produce a report of approximately 500 words which confirms their knowledge of correct technique and understanding of the process. (**which will be the written procedure**). Defect assessment will be assessed from the practical pro-forma report sheet.
This assessment will be judged to be satisfactory where the evidence provided is sufficient to meet the requirements showing the candidate has achieved a minimum 50% pass mark for this Outcome.

Assessment guidelines for the Unit

The assessments must be undertaken in controlled, supervised conditions. Candidates should have access to calculators if required. The assessments for Outcome 1 and Outcome 2 should be given 45 minutes for each assessment paper. Total 1 hour 30 minutes. (15 mins multi-choice, 10 mins each narrative question)

The assessment for Outcome 3, should be taken at a single event lasting 30 minutes.

The assessment for Outcome 4 should be taken at a single event giving a time of 1 hour for the detailed written instruction, which should be attempted first as it is required to be used to test one of the components. The inspection of the practical components should be given a time of 1 hour for each component, which will include completing the pro-forma report sheet.

Faults in components should not be visible. The types of components used should represent those used in an industrial situation, and centres should have a variety sufficient to minimise the risk of collusion between candidates.

Administrative Information

Unit code: HV3E 46

Unit title: Performing Magnetic Particle Inspection

Superclass category: WD

Date of publication: November 2017

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

SQA Advanced Unit specification: support notes

Unit title: Performing Magnetic Particle Inspection

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this Unit

This unit has been written to allow candidates to develop knowledge, understanding and skills in the following areas of magnetic particle inspection.

1 Basic concepts of magnetic particle inspection.
2 Specific facts of magnetic particle inspection.
3 Production processes associated with magnetic particle inspection.
4 Practical applications of magnetic particle inspection.

The content reflects the need for the candidate to be able to choose and use the correct technique without risk to themselves or the equipment, both while studying and when in employment. Safe and efficient use requires knowledge and understanding of all the magnetic systems.

Recommendations have been given as to how much time should be spent on each Outcome. This has been done to help lecturers to decide what depth of treatment should be given to the topics attached to each of the Outcomes.

Note:
It may also be prudent to use the guidance list for the Outcomes, if the candidate is intending to use this Unit to further their career in Non Destructive Testing. The Unit has been written in such a way that it can be aligned with the requirements of the British Institute of Non-Destructive Testing PCN scheme. As a result, if the candidate achieves the Unit and is assessed by an accredited trainer they can be awarded a PCN training certificate, which is part of the requirements to attain PCN certification. If this certification is required the pass mark for ALL Outcomes should be 70%.

Outcome 1 Basic concepts of magnetic inspection (8 hours)

Principles of magnetic particle inspection
- magnetisation
- leakage field
- attraction of ferromagnetic particles
- production of indication

Terms and definitions
- field
- flux
- field strength
- flux density
- poles

Magnetic fields
- bar magnet
- horseshoe magnet
- fields produced by straight conductor and coil

Magnetic materials
- recognise terms
- permeability
- soft and hard
- brief description of hysteresis

Magnetising currents — description of
- AC
- DC
- HWR
- FWR

General methods of magnetisation
- description of methods showing directions of current
- field and flaw
- calculation of magnetising current
- contact current flow
- rigid coil (flexible cables)
- threading bar
- prods
- magnets and electromagnets
- magnetic flow

Inspection and detection of indications
- detecting media — types and standard requirements
- illumination — white light
  UV(A)
  viewing conditions

Checks and calibrations
- general — reasons for checks, frequency and recording
- sensitivity — portable flux indicators, field strength meter, brief descriptions
- functional tests — CF and flux flow test pieces
- equipment checks — ammeter, illumination, detecting media, electromagnet

Types of equipment

- description and correct use of portable and fixed units
  - — prods
  - — electromagnets
  - — coils
  - — contact heads

Outcome 2 Specific facts of magnetic inspection (8 hours)

Test procedure

- safety — electrical, fire, toxicity and UV(A) hazards and their minimisation
- surface preparation — pre-cleaning, contrast aid paint
- selection of current or flux values
- methods of assessing sensitivity of technique
- correct application of field and detecting media
- demagnetisation — reasons for, when, and methods
- indications — preservation and reporting

Detectability of defects

- advantages and limitations of the test method with regard to defect detection
- characteristics of indications
- factors affecting indications — surface preparation, detecting medium, application, magnetising current

Standards, codes and specifications

- current BSEN issues

Interpretation and reporting

- types of discontinuity and their identification (surface and sub-surface)
- false indications and their cause
- preservation of indications eg transparent tape transfer
  magnetic silicone rubber
  photographic (fluorescent and non-fluorescent)

Post test procedures

- post test cleaning
- restoration of preservation coatings

Outcome 3 Basic production processes (9 hours)

Crude and finished products

- ingot types — narrow end up, wide end up
- continuous casting
- definitions
- difference between ingot and concast process
- ingot casting for further processing — rolling, forging, extrusion

Basic casting methods — finished products

- sand casting
- die casting
- investment casting

Basic defects associated with cast products

- shrinkage
- sinks
- cold shuts
- porosity
- laps
- hot tears
- cracks

Stress relieving

- purpose of stress relief
- methods

Wrought products —forming processes

- primary rolling — blooms and slabs
- secondary rolling — billets sections and plates
- cold rolling — sheets and strips
- rolling defects— appearance and formation
  cracks
  seams and rokes
  stringers
  slugs
  mechanical marks
  laminations

Forging

- open die forging
- closed die forging
- forging defects — appearance and formation
  cracks
  laps
  bursts
  excessive flash
  underfill
  seams

Extrusion

- definition
- uses
- advantages over rolling or forging

Annealing
- purpose
- process
- results obtained
- full anneal and definition
- sub-critical anneal and definition

Stress relieving
- purpose
- process
- results obtained

Basic welding processes
- MMA
- TIG
- MIG/MAG
- sub arc
- electro slag

Basic types of weld
- fillet weld
- butt weld in plate, pipe, nozzle, node

Welding defects
- lack of fusion
- porosity, worm holes, gas pores
- cracks — centreline, haz etc
- visual defects
- lack of penetration
- slag

In service defects
- fatigue crack
- stress corrosion crack

Welding terms
- definition of terms
- weld parts
- adjacent parent plate

Stress relieving
- purpose
- method

Normalising

- purpose
- method
- comparison to annealing

Outcome 4 Perform and report on tests on components using magnetic particle inspection (10 hours)

- Test two samples (selected by the lecturer) in accordance with the NDT procedure or instructions. (one instruction provided by the lecturer and one to be generated by the candidate) which will state sensitivity levels and reporting thresholds.

- Prepare a detailed written instruction (suitable for another candidate to follow) for testing one of the above samples to a procedure, code, standard or specification, and prove the instruction by application.

  The written instruction should cover the following:

  — foreword, status and authorisation
  — personnel
  — apparatus to be used
  — product/area to be tested
  — test conditions
  — detailed instructions for application of test
  — recording and classifying results
  — reporting the results

- Report the results on the pro-formas provided. Each test report must indicate the location, type and size of any defects found.

If any centre requires further information or an example of a written procedure so that all centres can produce a similar type assessment then contact the INSTITUTE OF APPLIED TECHNOLOGY who will forward example copies.

Guidance on the delivery and assessment of this Unit

This Unit should be delivered using both theoretical and practical exercise sessions, which will allow candidates to develop safe and efficient testing skills using all types of magnetic particle inspection. Candidates should be provided with the opportunity to gain as much hands on experience as possible.

Ideally each candidate should have individual equipment and specimen to test, but if due to resource constraints, this is not possible then, for non assessment purposes, candidates could work in small groups. If candidates are working in small groups it is essential that each candidate participates in the testing exercises and produces a pro-forma report sheet.

Unit Assessment

Outcome 1	45 minutes
Outcome 2	45 minutes
Outcome 3	30 minutes
Outcome 4	3 hours

Opportunities for developing Core Skills

There may be opportunities to gather evidence towards the Core Skills of Communication, Numeracy and Problem Solving in this Unit.

Open learning

Due to the high practical content of this unit, it is unlikely that it will be offered through open learning.

Equality and inclusion

This unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

General information for candidates

Unit title: Performing Magnetic Particle Inspection

This Unit has been designed to allow you to develop knowledge, understanding and skills in magnetic particle inspection.

This Unit will also allow you to develop skills that will enable you to test various component types, such as welds, castings and forgings. You will have the opportunity to gain hands on experience in using the various techniques to detect surface breaking defects in a range of components of different material types, eg steel, alloys etc. By the end of the Unit you should be able to use your skills to detect defects as you would in an industrial situation.

It is good to gain sound theoretical knowledge and understanding but it is also important that you are able to set your theoretical knowledge against the practical aspect of the Unit. Thus it is likely during the Unit that you will be provided with the opportunity to relate the theory to practice by doing practical experiments.

Outcome 3

The requirement for outcome three is to give you a depth of knowledge so that you can understand the various production processes used to make the components that you will test, terms used in these production processes, and the origin and nature of the flaws associated with each of the production processes.

If this Outcome has been achieved previously with the Unit *Performing Liquid Penetrant Inspection* (HV3D 46), a credit transfer can be awarded for this Outcome.

The formal assessment for this Unit will consist of both written and practical parts.

The written assessment will consist of three papers. These assessments will be carried out under closed book conditions in which you will not be allowed to take notes, textbooks etc into the assessment.

The practical assessments will consist of testing two components (which will be from the three groups of welds, castings or forgings) and compiling a written instruction on how to test one of the components. This will last no longer than three hours. You will be required to complete a pro-forma report sheet for each component detailing defect type, size and location.

All assessments will be carried out at the end of the Unit.