

## Higher National Unit Specification

### General information for centres

**Unit title:** Performing Liquid Penetrant Inspection

**Unit code:** DR27 33

**Unit purpose:** This Unit is designed to enable candidates to develop knowledge and understanding of the concepts of liquid penetrant 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 if the training and assessment is carried out by an accredited trainer.

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

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

**Credit points and level:** 1 HN 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 Access 1 to Doctorates.*

**Recommended prior knowledge and skills:** It would be beneficial if the candidate had a knowledge of basic NDT methods. This may be evidenced by possession of NC Modules (EE20 12) Inspection: Principles of Non-Destructive Testing (EE9D 12) Inspection: Non-Destructive Testing Skills and/or similar 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.

## **General information for centres (cont)**

**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 assignment 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.

## **Higher National Unit specification: statement of standards**

**Unit title:** Performing Liquid Penetrant Inspection

**Unit code:** DR27 33

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**

State the basic concepts of liquid penetrant inspection

#### **Knowledge and/or skills**

- ◆ principles of penetrant inspection
- ◆ equipment and materials
- ◆ methods of assessing sensitivity and control testing

#### **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 liquid penetrant inspection

#### **Knowledge and/or skills**

- ◆ preparation for testing
- ◆ testing techniques
- ◆ post test procedures
- ◆ safety
- ◆ standards, codes and specification

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Performing Liquid Penetrant Inspection

### **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 3 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 liquid penetrant 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 liquid penetrant inspection method

#### **Knowledge and/or skills**

- ◆ testing in accordance with NDT procedure
- ◆ inspection reports

## Higher National Unit specification: statement of standards (cont)

**Unit title:** Performing Liquid Penetrant Inspection

### Evidence Requirements

Evidence for the knowledge and/or skills in Outcome 4 will be provided on a sample basis. Evidence of candidates' abilities 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.

The 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 in 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 one hour for the detailed written procedure, 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 practical 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.

*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.*

## **Administrative Information**

<b>Unit code:</b>	DR27 33
<b>Unit title:</b>	Performing Liquid Penetrant Inspection
<b>Superclass category:</b>	WD
<b>Date of publication:</b>	August 2005
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## Higher National Unit specification: support notes

### Unit title: Performing Liquid Penetrant 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 liquid penetrant inspection.

- 1 Basic concepts of liquid penetrant inspection.
- 2 Specific facts of liquid penetrant inspection.
- 3 Production processes associated with liquid penetrant inspection.
- 4 Practical applications of liquid penetrant inspection.

The Unit has been developed to complement the Units in the Principles/Technology section of the HNC Fabrication, Welding and Inspection framework.

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 penetrant systems.

Recommendations have been given as to how much time should be spent on each Outcome. This has been done to help lecturers 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 same requirements as the British Institute of Non-Destructive Testing PCN scheme, so 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 liquid penetrant inspection (8hours)

##### 1.1 Principles of liquid penetrant inspection:

- ◆ Surface tension
- ◆ Viscosity
- ◆ Capillary action

##### 1.2 Properties and requirements of:

- ◆ Emulsifiers
- ◆ Spirit removers
- ◆ Developers

## Higher National Unit specification: support notes (cont)

### Unit title: Performing Liquid Penetrant Inspection

1.3 Terminology associated with liquid penetrant inspection

1.4 Equipment and materials:

- ◆ Colour contrast
- ◆ Fluorescent
- ◆ Combined colour contrast and fluorescent

1.5 Penetrant removers:

- ◆ Solvents
- ◆ Water only
- ◆ Water soluble
- ◆ Oil soluble

1.6 Developers:

- ◆ Dry powder
- ◆ Aqueous suspension
- ◆ Aqueous solution
- ◆ Non aqueous

1.7 Equipment:

- ◆ Fixed installations
- ◆ Portable inspection kits
- ◆ Auxiliary equipment

1.8 Methods of assessing sensitivity and control testing

- ◆ Aluminium test block
- ◆ Chromium plated test block
- ◆ Defective components
- ◆ Colour intensity
- ◆ Fluorescent intensity
- ◆ Comparator checks
- ◆ Efficiency of penetrant removers
- ◆ Fluorescence of developers
- ◆ Coverage and concentration of developers

### Outcome 2: Specific facts of penetrant inspection (8 hours)

2.1 Preparation for testing:

- ◆ Surface preparation
- ◆ Cleaning methods
- ◆ Effect of surface finish
- ◆ Effect of contaminants
- ◆ Compatibility of materials
- ◆ Ambient light levels

## Higher National Unit specification: support notes (cont)



## **Unit title:** Performing Liquid Penetrant Inspection

- 2.2 Testing techniques:
  - ◆ Selection of appropriate technique
  - ◆ Method of application
  - ◆ Temperature
  - ◆ Drainage and drying
  - ◆ Removal of excess penetrant
  - ◆ Contact time
  
- 2.3 Penetrant removal:
  - ◆ Solvents
  - ◆ Aqueous washes
  - ◆ Post emulsifiers
  - ◆ Contact times
  
- 2.4 Component drying:
  - ◆ Application of developers
  - ◆ Dry powders
  - ◆ Liquid developers (aqueous & non aqueous)
  
- 2.5 Viewing conditions:
  - ◆ White light and illumination
  - ◆ UVA radiation and intensity
  
- 2.6 Defect types:
  - ◆ Identification
  - ◆ Significant, non relevant, spurious
  - ◆ Causes
  - ◆ Advantages and limitations of test method with regard to defect detection
  
- 2.7 Preservation of defects:
  - ◆ Transparent tape
  - ◆ Lacquer coatings
  - ◆ Photographic
  
- 2.8 Post test cleaning procedures
  
- 2.9 Safety:
  - ◆ Fire hazards
  - ◆ Electrical safety
  - ◆ Ventilation
  - ◆ Toxic materials
  - ◆ Safe use of UVA radiation
  
- 2.10 Standards, codes and specifications:
  - ◆ Current BSEN issues

## Higher National Unit specification: support notes (cont)

### Unit title: Performing Liquid Penetrant Inspection

#### Outcome 3: Basic production processes (9 hours)

- 3.1 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
  
- 3.2 Basic casting methods — Finished products:
  - ◆ Sand casting
  - ◆ Die casting
  - ◆ Investment casting
  
- 3.3 Basic defects associated with cast products:
  - ◆ Shrinkage
  - ◆ Sinks
  - ◆ Cold shuts
  - ◆ Porosity
  - ◆ Laps
  - ◆ Hot tears
  - ◆ Cracks
  
- 3.4 Stress relieving:
  - ◆ Purpose of stress relief
  - ◆ Methods
  
- 3.5 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

## Higher National Unit specification: support notes (cont)

### Unit title: Performing Liquid Penetrant Inspection

#### 3.6 Forging:

- ◆ Open die forging
- ◆ Closed die forging
- ◆ Forging defects — appearance and formation:
  - cracks
  - laps
  - bursts
  - excessive flash
  - underfill
  - seams

#### 3.7 Extrusion:

- ◆ Definition
- ◆ Uses
- ◆ Advantages over rolling or forging

#### 3.8 Annealing:

- ◆ Purpose
- ◆ Process
- ◆ Results obtained
- ◆ Full anneal and definition
- ◆ Sub-critical anneal and definition

#### 3.9 Stress relieving:

- ◆ Purpose
- ◆ Process
- ◆ Results obtained

#### 3.10 Basic welding processes:

- ◆ MMA
- ◆ TIG
- ◆ MMA
- ◆ TIG
- ◆ MIG/MAG
- ◆ Sub arc
- ◆ Electro slag

#### 3.11 Basic types of weld:

- ◆ Fillet weld
- ◆ Butt weld in plate, pipe, nozzle, node

## Higher National Unit specification: support notes (cont)

### Unit title: Performing Liquid Penetrant Inspection

#### 3.12 Welding defects:

- ◆ Lack of fusion
- ◆ Porosity, worm holes, gas pores
- ◆ Cracks – centreline, haz etc
- ◆ Visual defects
- ◆ Lack of penetration
- ◆ Slag

#### 3.13 In service defects:

- ◆ Fatigue crack
- ◆ Stress corrosion crack

#### 3.14 Welding terms:

- ◆ Definition of terms
- ◆ Weld parts
- ◆ Adjacent parent plate

#### 3.15 Stress relieving:

- ◆ Purpose
- ◆ Method

#### 3.16 Normalising:

- ◆ Purpose
- ◆ Method
- ◆ Comparison to annealing

### **Outcome 4: Perform and report on tests on components using liquid penetrant inspection (10 hours)**

- 4.1 Test two samples (selected by 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.
- 4.2 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

## Higher National Unit specification: support notes (cont)

### Unit title: Performing Liquid Penetrant Inspection

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

#### Unit Assessment

<b>Outcome 1</b>	45 minutes
<b>Outcome 2</b>	45 minutes
<b>Outcome 3</b>	30 minutes
<b>Outcome 4</b>	3 hours

### 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 liquid penetrant 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.

Details on approaches to assessment are given under Evidence Requirements and assessment guidelines in the Higher National Unit Specification: statement of standards section. It is recommended that these sections be read carefully before proceeding with assessment of candidates.

#### *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.

### Candidates with additional support needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs*, which is available on the SQA website [www.sqa.org.uk](http://www.sqa.org.uk).

## **General information for candidates**

### **Unit title: Performing Liquid Penetrant Inspection**

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

The 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, aluminium, copper 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, the 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 Magnetic Particle Inspection Unit 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 a total of 3 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.