



## Higher National Unit Specification

### General information for centres

**Unit title:** Process Water and Steam Services

**Unit code:** F3XH 34

**Unit purpose:** This Unit is designed to provide candidates with knowledge of the provision and use of water and steam services in the oil refining and chemicals manufacturing industries.

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

- 1 Explain the principal methods of steam production used in the oil refining and chemicals manufacturing industries.
- 2 Explain the principal methods of water treatment used in the oil refining and chemicals manufacturing industries.
- 3 Perform practical procedures in which energy balances are used to estimate the efficiency of steam utilisation and water cooling processes.

**Credit points and level:** 1 HN credit at SCQF level 7: (8 SCQF credit points at SCQF level 7\*)

**Recommended prior knowledge and skills:** Access to this Unit will be at the discretion of the centre. However, it is recommended that the candidate should have completed NC Units EC1E 11 *Plant Services* and EC1D 04 *Heat Transfer*.

**Core Skills:** There are opportunities to develop the Core Skill of *Numeracy* and the components Critical Thinking and Written Communication all at SCQF level 6 in this Unit. Additionally, *Working with Others* may be developed at SCQF level 5.

Achievement of this unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Using Number at SCQF level 6

**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:** Outcomes 1 and 2 could be assessed by a single, supervised assessment in which questions are set requiring descriptions and explanations relevant to specific types of equipment. Outcome 3 could be an assessment of practical skills supported by a report of the procedures followed and results obtained.

## Higher National Unit specification: statement of standards

**Unit title:** Process Water and Steam Services

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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

Explain the design and principal methods of steam production used in the oil refining and chemicals manufacturing industries

#### Knowledge and/or Skills

- ◆ Fire-tube boilers
- ◆ Water-tube boilers
- ◆ Steam distribution equipment
- ◆ Heat Exchange equipment for steam utilisation

#### Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the four Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can provide explanations of the design and method of operation of:

- ◆ Fire-tube boilers. The explanation must include at least one single pass and one multiple pass configuration and the operating characteristics including boiler water condition monitoring and blow-down procedures.
- ◆ Water-tube boilers. The explanation must include combined heat and power installations and the operating characteristics including tube surface condition monitoring and blow-down procedures.
- ◆ Equipment which contributes to the safe and effective distribution of steam. The explanation must include pressure reduction valves, pressure relief valves, steam traps and expansion loops as well as corrosion problems in condensate return lines and their solutions.
- ◆ Heat exchange equipment for steam utilisation including shell and tube heat exchangers and plate heat exchangers.

Candidates must contextualise all Evidence Requirements for the oil refining and chemicals manufacturing industries.

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

**Unit title:** Process Water and Steam Services

### Assessment Guidelines

Outcomes 1 and 2 could be assessed by a combined, supervised assessment in which questions are set requiring descriptions and explanations relevant to specific types of equipment.

The questions could, for example, require descriptions and explanations of representative steam raising equipment and methods of operation followed by descriptions and explanations of appropriate water treatment procedures.

### Outcome 2

Explain the design and the principal methods of water treatment and use in the oil refining and chemicals manufacturing industries

#### Knowledge and/or Skills

- ◆ Feed water conditioning for fire-tube boilers.
- ◆ Feed water conditioning for water-tube boilers.
- ◆ Treatment of cooling water.
- ◆ Treatment of waste water

#### Evidence Requirements

Evidence for this Outcome will be provided on a sample basis with candidates being required to provide evidence for three of the four Knowledge and/or Skills items. Assessment must be carried out under supervised conditions.

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can provide explanations of the design and method of operation of:

- ◆ processes for the safe conditioning of feed water to fire-tube boilers. The explanation must include at least two processes from scale formation by calcium and magnesium, ion-exchange water softening equipment and processes, chemical control of calcium and magnesium, oxygen corrosion, chemical removal of oxygen, alkaline passivation of steel, metering pumps for additive delivery, conductivity measurements and total dissolved solids and the blow-down cycle.
- ◆ processes for the safe conditioning of feed water to water-tube boilers. The explanation must include deaeration and demineralisation.
- ◆ cooling towers and cooling cycles.
- ◆ at least two processes for the treatment of waste water. The explanation must include at least two processes from removal of oils, flocculation and sedimentation and biological treatment methods. The explanation must also include indicators of water quality.

### Assessment Guidelines

Outcomes 1 and 2 could be assessed by a combined, supervised assessment in which questions are set requiring descriptions and explanations relevant to specific types of equipment.

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

### Unit title: Process Water and Steam Services

The questions could, for example, require descriptions and explanations of representative steam raising equipment and methods of operation followed by descriptions and explanations of appropriate water treatment procedures.

### Outcome 3

Perform practical procedures in which energy balances are used to estimate the efficiency of steam utilisation and water cooling processes

#### Knowledge and/or Skills

- ◆ Steam heating equipment
- ◆ Water cooling equipment.
- ◆ Measurements.
- ◆ Heat balancing and efficiency.
- ◆ Health and safety regulations

#### Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ describe the equipment used for the practical procedure.
- ◆ safely operate equipment for a steam heating procedure and a water cooling procedure.
- ◆ record measurements of appropriate flowrates, temperatures and pressures.
- ◆ estimate heat balance and efficiency.
- ◆ perform at least two experiments and produce at least one laboratory report for one experiment and a pro-forma report for the second experiment. The laboratory report must include the results of the experiment, calculations and conclusions drawn. Sources of experimental and estimate errors must be included.

Where calculations are performed, the candidate must:

- ◆ apply appropriate formulae.
- ◆ apply the principles of the calculation.
- ◆ show all working through a calculation.
- ◆ provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

#### Assessment Guidelines

Outcome 3 could be assessed by the appraisal of practical performance including health and safety factors recorded on a checklist completed by the tutor/supervisor. Candidates should also submit a laboratory report for at least one procedure. It is envisaged that the laboratory reports will include original measurements, calculations and any conclusions and recommendations derived from these.

## Administrative Information

**Unit code:** F3XH 34  
**Unit title:** Process Water and Steam Services  
**Superclass category:** YC  
**Original date of publication:** August 2008  
**Version:** 02

### History of Changes:

Version	Description of change	Date
02	Core Skill component of Numeracy Using Number at SCQF level 6 embedded.	26/02/16

**Source:** SQA

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## Higher National Unit specification: support notes

### Unit title: Process Water and Steam Services

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

Whilst this Unit may be delivered as a stand alone Unit it has been developed as part of the framework of the HNC Chemical Engineering and HNC/HND Chemical Process Technology.

The following areas could be covered in the delivery of the Unit

#### Outcome 1

The principle methods of operation of fire-tube steam raising equipment (shell boilers).

- ◆ Historic origins of the fire-tube boiler
- ◆ Contemporary designs, including single pass and multiple pass configurations
- ◆ Operating characteristics of fire-tube boilers, including boiler water condition monitoring and blow down procedures
- ◆ Pressure Vessel Regulations, insurance requirements and annual inspections
- ◆ Corrosion problems in fire-tube boilers and their solutions
- ◆ Scaling problems in fire-tube boilers and their solutions

The principle methods of operation of water-tube steam raising equipment.

- ◆ Historic origins of the water-tube boiler
- ◆ Contemporary designs, including combined heat and power installations
- ◆ Operating characteristics of water-tube boilers, including tube surface condition monitoring and blow down procedures
- ◆ Corrosion problems in water-tube boilers and their solutions
- ◆ Scaling problems in water-tube boilers and their solutions

The principle methods of operation of equipment which contributes to the safe and effective distribution of steam:

- ◆ Pressure reduction valves, pressure relief valves, steam traps and expansion loops
- ◆ Corrosion problems in condensate return lines and their solutions

The principle methods of operation of heat exchange equipment for steam utilisation in oil refining and chemicals processing:

- ◆ Steam jackets, internal tube bundles, external reboilers
- ◆ Shell and tube heat exchangers, plate heat exchangers

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

### Unit title: Process Water and Steam Services

#### Outcome 2

Feed water conditioning for fire-tube boilers:

- ◆ Scale formation by calcium and magnesium
- ◆ Ion-exchange water softening equipment and processes
- ◆ Chemical control of calcium and magnesium
- ◆ Oxygen corrosion
- ◆ Chemical removal of oxygen
- ◆ Alkaline passivation of steel
- ◆ Metering pumps for additive delivery
- ◆ Conductivity measurements and Total Dissolved Solids
- ◆ The blow-down cycle

Feed water conditioning for water-tube boilers:

- ◆ Deaeration equipment and processes
- ◆ Demineralisation equipment and processes

Cooling water recycling:

- ◆ Open and closed cooling cycles
- ◆ Natural draught cooling towers
- ◆ Forced draught cooling towers
- ◆ Induced draught cooling towers
- ◆ Total Dissolved Solids control in open systems
- ◆ Microbiological control, particularly legionella

Waste water treatment:

- ◆ Removal of oils
- ◆ Flocculation and sedimentation
- ◆ Biological treatment methods
- ◆ Indicators of water quality

#### Outcome 3

The use of plant or laboratory steam heating and water cooling equipment to demonstrate the principles of heat balancing and the estimation of heat transfer rates:

- ◆ Preparation and operation of equipment in accordance with instructions
- ◆ Steam heating equipment could include boilers, heat exchangers or evaporators
- ◆ Water cooling equipment could include condensers, cooling towers, heat exchangers
- ◆ Measurement of appropriate flowrates, temperatures and pressures
- ◆ Recording and presentation of data in tabular form
- ◆ Heat balance and heat transfer calculations
- ◆ Standard formats for the presentation of reports

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

**Unit title:** Process Water and Steam Services

### Guidance on the delivery and assessment of this Unit

This Unit may be delivered as part of the HNC Chemical Engineering and HND Chemical Process Technology, designed to provide candidates with technical knowledge and skills for employment in the oil-refining and chemicals manufacturing industries, however, it can also be delivered on a standalone basis. If the Unit is delivered as part of a Group Award, it is recommended where possible that the Unit is delivered in the later part of the Group Award, so that candidates have some knowledge of fluid mechanics and heat transfer.

Outcome 1 and 2 are designed to assess understanding rather than recall. Therefore any assessment should reflect this, for example through candidates having access to their own material, and any questions set should elicit an understanding of the material and the candidate's problem solving ability. Assessment of Outcomes 1 and 2 should be supervised. There could be one assessment period of approximately two hours or two assessment periods of approximately one hour each and due to the sampling nature of the questions posed the questions must remain unseen prior to the assessment even A suitable format could be six questions covering both Outcomes, each requiring approximately 15 minutes to be completed comfortably.

Supervision of the report writing element of the Outcome 3 assessment is probably not practical and the assessor should be satisfied that the reports presented by each candidate are authentic.

#### A note on the Evidence Requirements

The Evidence Requirements state that candidates 'must provide a satisfactory response' which includes reasonable answers derived 'from the application of the formula and correct application of the principles of the calculation'. This allows for acknowledgement of the correct working and application of formulae, even where candidates' final answer may be inaccurate.

The statement allows for the eventuality where a single error at one stage in an extended calculation sequence has a cumulative effect on the final answer, even though working/formulae are otherwise correctly applied. Acknowledgement of the correct working should be given in such cases.

#### *Opportunities for developing Core Skills*

There are opportunities to develop the Core Skill of *Numeracy* and the components Critical Thinking and Written Communication all at SCQF level 6 in this Unit. Additionally, *Working with Others* may be developed at SCQF level 5.

The Evidence Requirements of Outcome 3 require estimates to be calculated and all components of the Core Skill of *Numeracy* at SCQF level 6 may be developed during the preparation and presentation of these estimates. If reports are presented in written form, the Written Communication component of the Core Skill of *Communication* may be developed, during their preparation and presentation. The laboratory component may provide the opportunity to develop the Core Skill of *Working with Others*, as candidates may be required to work in partnership.

This unit has the Using Number component of Numeracy embedded in it. This means that when learners achieve the Unit, their Core Skills profile will also be updated to show they have achieved Numeracy at SCQF level 6.



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

**Unit title:** Process Water and Steam Services

### **Open learning**

Outcomes 1 and 2 of this Unit would be suitable for delivery by distance learning provided that electronic or telephone consultation is available when required and on-line teaching materials are available.

Outcome 3 may not be suitable for delivery or assessment by distance learning because of the practical activity which requires candidates to safely operate equipment for a steam heating procedure and a water cooling procedure.

### **Candidates with disabilities and/or additional support needs**

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. Further advice can be found in the SQA document *Guidance on Assessment Arrangements for Candidates with Disabilities and/or Additional Support Needs* ([www.sqa.org.uk](http://www.sqa.org.uk)).

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

**Unit title:** Process Water and Steam Services

### General information for candidates

This Unit is intended primarily for those who are working towards the HNC and HND awards in Chemical Engineering and Chemical Process Technology, however, the Unit may be taken on a stand alone basis.

The Unit is designed to provide you with an overview of water and steam services in the oil refining and chemicals processing industries, and an introduction to the equipment in use, and some technical details of its operation. The level of detail should be useful to you if you are employed or seeking employment as process operators in those industries. In addition, if this Unit is taken as part of the aforementioned qualifications, it may contribute towards entry to degree studies in Chemical Engineering at second or third year level.

The Unit has three main areas:

- 1 Types of steam raising equipment (boilers) and principles of operation.
- 2 Types of water treatment equipment and principles of operation.
- 3 Practical procedures using steam heating and water cooling equipment.

To complete the Unit successfully, you must provide satisfactory answers to questions relating to steam equipment and water treatment, these questions will normally be conducted under supervised conditions without conferring.

In addition, candidates must perform at least two practical procedures in the plant or laboratory and prepare reports of these procedures as required. The recording of measurements of flowrate and temperature and the calculations based on these measurements will be an important part of the reports.

The calculations based on measurements provide opportunities to develop the Core Skill of *Numeracy* at SCQF level 6 and the submission of laboratory reports may provide opportunities to develop the Written Communication skills. There may be opportunities to develop the Core Skill of *Working with Others* if working in partnerships during the practical work.

This unit has the Using Number component of Numeracy embedded in it. This means that when you achieve the Unit, your Core Skills profile will also be updated to show you have achieved Numeracy at SCQF level 6.