



Higher National Unit Specification

General information for centres

Unit title: Water Operations: Water Treatment Processes

Unit code: F53T 34

Unit purpose: This Unit is designed to enable the candidate to develop the skills and knowledge associated with the principles and processes of the major processes used to produce drinking water.

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

- 1 Explain why water needs to be treated to make it potable.
- 2 Explain the processes used in effective water treatment.
- 3 Explain the principles and processes involved in the use of slow sand filtration
- 4 Explain the principles and processes involved in the effective chemical treatment of water.
- 5 Explain recent and future developments within water treatment.

Credit points and level: 1.5 HN credits at SCQF level 7: (12 SCQF credit points at SCQF level 7*)

**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 is recommended that candidates should have completed Unit F53R 34 *Water Operations: Water Quality Management* prior to undertaking this Unit. It would also be beneficial though not essential if candidates had some work experience of water treatment.

Core Skills: There are opportunities to develop written component of the Core Skill *Communication* at SCQF level 6 and the Core Skills of *Information and Communication Technology* and *Problem Solving* at SCQF level 6 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: It is possible to assess candidates on an individual Outcome basis, by combinations of Outcomes, or by a single holistic assessment encompassing all Outcomes. Assessment should be conducted under supervised conditions. The assessment(s) could consist of an appropriate balance of restricted response and structured questions. If a single assessment covering all Outcomes is used, it is recommended that it should not exceed three hours in duration.

Higher National Unit specification: statement of standards

Unit title: Water Operations: Water Treatment Processes

Unit code: F53T 34

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 why water needs to be treated to make it potable

Knowledge and/or Skills

- ◆ Water treatment processes
- ◆ Historical Developmental
- ◆ Waterborne diseases
- ◆ Water sources
- ◆ Water quality parameters

Evidence Requirements

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

- ◆ describe the historical development of water treatment processes and the incidence of waterborne diseases. The description must include the relationship between the development of processes and the incidence of waterborne diseases, key events and developments.
- ◆ explain at least three water treatment processes and the appropriateness of each for different water sources. The explanation must include appropriateness in terms of cost, efficiency and efficacy.
- ◆ explain how the key quality parameters influence the method, operation and choice of water treatment processes to make water potable. The explanation must include at least three key parameters of raw waters and how these may vary for different water resources.

Assessment for this Outcome must be conducted under closed-book conditions.

Assessment Guidelines

Assessment for this Outcome is a closed-book assessment and questions used to elicit candidate response could take the form of an appropriate balance of multiple choice and restricted response in order to meet Evidence Requirements.

Higher National Unit specification: statement of standards (cont)

Unit title: Water Operations: Water Treatment Processes

Outcome 2

Explain the processes used in effective water treatment

Knowledge and/or Skills

- ◆ Methods of storage and sedimentation of water
- ◆ Construction, Maintenance and operation of screens, strainers and rapid gravity sand filters
- ◆ Purification and Treatment of Water

Evidence Requirements

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

- ◆ describe at least three advantages and at least three disadvantages that can be gained by both the natural and engineered storage and sedimentation of water.
- ◆ explain how the main types of screens and strainers used in water treatment work. The explanation must include the construction, operation and maintenance of common types of screens and strainers used in water treatment.
- ◆ explain how the purification and treatment of the water is effected by rapid gravity sand filters. The explanation must include the principles of operation and maintenance of rapid gravity sand filters.

Assessment Guidelines

For this Outcome, it is suggested that the assessment could consist of a report and the assessment could be combined with that of Outcomes 3 and 4.

The evidence for the report could be drawn from a suitable employer's current or historical water treatment plant or facilities.

However if for practical reasons the candidate cannot access employer sites and data, evidence could be provided by means of a desk top study and/or literature search and review of appropriate material which might include, employers future or proposed developments in water treatment, or the investigation and resolution of relevant current or historical water treatment process problems pertaining to the employer.

Higher National Unit specification: statement of standards (cont)

Unit title: Water Operations: Water Treatment Processes

Outcome 3

Explain the principles and processes involved in the use of slow sand filtration

Knowledge and/or Skills

- ◆ Construction, maintenance and operation of Slow Sand Filter
- ◆ Biological purification mechanisms of Slow Sand Filtration
- ◆ Advantages and disadvantages of Slow Sand Filtration

Evidence Requirements

Candidates will need to provide evidence to demonstrate their Knowledge and/or Skills by submitting a report which should:

- ◆ describe the Engineering construction of a Slow Sand Filter. The description must refer to the media used, the inlet and outlet arrangements and how control is effected
- ◆ explain at least three key principles of operation and maintenance of a Slow Sand Filter
- ◆ explain at least three key principles of the biological purification mechanisms involved in Slow Sand Filtration
- ◆ explain at least three advantages and at least three disadvantages of Slow Sand Filtration

Assessment Guidelines

For this Outcome, it is suggested that the assessment could consist of a report and the assessment for this Outcome could be combined with that of Outcomes 2, and 4 of this Unit.

The evidence for the report could be drawn from a suitable employer's current or historical water treatment plant or facilities.

However if for practical reasons the candidate cannot access employer sites and data, evidence could be provided by means of a desk top study and/or literature search and review of appropriate material which might include, employers future or proposed developments in water treatment, or the investigation and resolution of relevant current or historical water treatment process problems pertaining to the employer.

Higher National Unit specification: statement of standards (cont)

Unit title: Water Operations: Water Treatment Processes

Outcome 4

Explain the principles and processes involved in the effective chemical treatment of water

Knowledge and/or Skills

- ◆ Coagulation
- ◆ Flocculation
- ◆ Iron and Aluminium Coagulants
- ◆ Chemical dosing
- ◆ Control systems
- ◆ Disinfection systems
- ◆ Sludge treatment and disposal

Evidence Requirements

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

- ◆ explain the chemical reactions that take place when Iron and Aluminium coagulants are used to clarify natural raw waters. The explanation must include the importance of pH.
- ◆ explain the key parameters and values which have to be optimised in the coagulation process. The explanation must include any other agents which may be used to affect the coagulation process.
- ◆ explain the physical processes of flocculation that take place when Iron or Aluminium coagulants are used to clarify natural raw waters. The explanation must include charge neutralisation and the role of polyelectrolytes in influencing particle size.
- ◆ explain how flocculation is optimised. The explanation must include any other agents which may be used to affect the process.
- ◆ describe at least three typical chemical dosing systems used in water treatment in terms of the type of pumps and control systems used.
- ◆ explain the principles of operation of disinfection systems using Chlorine, Chlorine compounds, and Ozone. The explanation must include at least two advantages and at least two disadvantages of the two substances when used to disinfect drinking water.
- ◆ describe the common processes involved in the treatment and disposal of water treatment sludges. The description must include digestion, mechanical dewatering, incineration, land fill, drying beds and thermal treatment.

Assessment Guidelines

For this Outcome, it is suggested that the assessment could consist of a report and the assessment could be combined with that of Outcomes 2, and 3 of this Unit.

The evidence for the report could be drawn from a suitable employer's current or historical water treatment plant or facilities.

Higher National Unit specification: statement of standards (cont)

Unit title: Water Operations: Water Treatment Processes

Outcome 5

Explain recent and future developments within water treatment

Knowledge and/or Skills

- ◆ Manganese removal systems
- ◆ Membrane filtration systems
- ◆ Ozone clarification systems
- ◆ Magnetite
- ◆ Ultra Violet disinfection systems
- ◆ Current Developments

Evidence Requirements

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

- ◆ explain why Manganese has to be removed from drinking water. The explanation must include the methods which can be used to remove Manganese.
- ◆ explain the principles of operation of Membrane filtration systems. The explanation must include the principles of operation and maintenance of membrane filters, and outline at least two advantages and two disadvantages of membrane filtration systems.
- ◆ explain the principles of how Ozone is produced and its role in the Clarification of water. The explanation must include at least two advantages and at least two disadvantages of using Ozone.
- ◆ explain how Magnetite can be used to clarify water. The explanation must include at least two advantages and at least two disadvantages of using Magnetite.
- ◆ explain how Ultra Violet light can be used to disinfect water. The explanation must include at least two advantages and at least two disadvantages of using Ultra Violet light.
- ◆ describe at least one current development in water treatment processes not included in the previous Evidence Requirements. The description must include the stage of development, the processes involved and the advantages that the development may offer.

Assessment for this Outcome must be conducted under closed-book conditions.

Assessment Guidelines

Assessment for this Outcome is in the form a closed-book assessment and questions used to elicit candidate response could take the form of an appropriate balance of multiple choice and restricted response type

Administrative Information

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Unit title: Water Operations: Water Treatment Processes
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Higher National Unit specification: support notes

Unit title: Water Operations: Water Treatment Processes

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 60 hours.

Guidance on the content and context for this Unit

This Unit is designed to give the candidates a sound underpinning knowledge of water treatment principles and processes to facilitate them to function or develop as water treatment operators and technicians, or to enable them to progress to more advanced study. Whilst the Unit may be taken as a stand alone Unit it has been developed as a mandatory Unit within HNC Water Operations.

It is suitable for those who are currently employed in, or who are seeking employment in a water treatment environment or a related role. Delivery of the Unit is best suited to those who have access to water operations.

The following provides an indication of the content and context of each Outcome whilst the recommended time allocations to each Outcome are given as guidance towards the depth of treatment that might be applied to each topic

Outcome 1 Explain why water needs to be treated to make it potable (10 hours)

This Outcome explores the historical relationship between the development of water treatment processes and the incidence of waterborne diseases. Key dates, events and people involved in waterborne disease identification and prevention and major developments in water treatment over the years should be covered.

An outline of the key quality parameters of raw waters and how these vary for different water sources should be provided.

Typical treatment regimes and strategies for different quality waters should be explored and how the associated quality parameters influence the choice of treatment process.

Outcome 2 Explain the processes used in effective water treatment (15 hours)

This Outcome considers the processes used in effective water treatment and should cover the advantages and disadvantages of storing water in raw water reservoirs and the advantages and disadvantages of storing water in service and clear water reservoirs.

An outline of role of sedimentation within water treatment processes and a description of the construction, operation and maintenance of the main types of Sedimentation Tanks in common use should be covered.

The Outcome also includes description of construction, operation and maintenance of common types of screens and strainers used in water treatment

Higher National Unit specification: support notes (cont)

Unit title: Water Operations: Water Treatment Processes

The principles of construction, operation and maintenance of rapid gravity sand filters and an explanation of how filters effect purification should be given.

Outcome 3 Explain the principles and processes involved in the use of slow sand filtration (10 hours)

This Outcome includes the construction and principles of operation and maintenance of slow sand filters. An explanation of the Biological treatment mechanisms involved in slow sand filtration should be given as well as a discussion of the advantages and disadvantages of slow sand filtration.

Outcome 4 Explain the principles and processes involved in the effective chemical treatment of water (15 hours)

This Outcome considers the effective chemical treatment of water and the efficiency and effectiveness of different processes. The Outcome includes:

- ◆ an explanation of the chemistry of coagulation of Iron and Aluminium compounds and the role of pH in the chemical reactions.
- ◆ explanation of the Physical chemistry of flocculation, Charge Neutralisation and the role of Polyelectrolytes in influencing particle size. The relationship between pH, particle size and polyelectrolyte dose on colour and turbidity removal should be considered.
- ◆ description of the principles of operation of common types of chemical dosing pumps and dosing control principles.
- ◆ explanation of the principles of operation of disinfection systems using Chlorine, Chlorine compounds, and Ozone. Advantages and disadvantages of the two substances when used to disinfect drinking water should be included.
- ◆ description of the common processes involved in the treatment and disposal of water treatment sludges.

Outcome 5 Explain recent and future developments within water treatment (10 hours)

This Outcome looks at recent and future developments in effective water treatment and should consider new and potential future developments in the industry. Candidates should be encouraged to explore current thinking within the industry. The Outcome should also include:

- ◆ explanation of why Manganese has to be removed from drinking water and an outline of the methods which can be used
- ◆ principles of construction, operation and maintenance of membrane filters and explanation of how they effect purification
- ◆ production of Ozone and its use in the clarification of water
- ◆ the use of Ultra Violet light as a disinfection agent

Higher National Unit specification: support notes (cont)

Unit title: Water Operations: Water Treatment Processes

Guidance on the delivery and assessment of this Unit

This Unit is likely to form part of a Group Award which is designed to increase the understanding of existing water treatment operators and technicians, or to enable Water Company employees currently involved in other functions, to move into a water treatment or related role.

The emphasis should therefore be on ensuring that candidates comprehend the principles of water treatment and have a thorough understanding of the processes involved.

It is recommended that evidence for learning Outcomes is achieved through well planned course work structured reports and site visit(s) to an operational water treatment works preferably accompanied by a course tutor or someone with knowledge of the content of this Unit, in order that the visit is appropriately structured.

During such a visit the candidates should be encouraged to work in groups to collect relevant information for dissemination amongst them later. This will assist candidates in providing evidence for assessment particularly in relation to any reports.

However, if for practical reasons the candidate cannot access employer sites and data, evidence could be provided by means of a desk top study and/or literature search and review of appropriate material which might include, employer's future or proposed developments in water treatment, or the investigation and resolution of relevant current or historical water treatment process problems.

Outcomes 1 and 5 are assessed through the use of closed-book assessment that may be presented separately or at a single assessment event. Outcomes 2, 3 and 4 may be combined as a single report. The evidence for the report could be drawn from a suitable employer's current or historical water treatment plant or facilities.

Where the centre has access to laboratories, practical work might be used to illustrate some of the principles of chemical treatment and filtration.

Opportunities for developing Core Skills

There are opportunities to develop Written component of the Core Skill *Communication* at SCQF level 6 and the Core Skills of *Information and Communication Technology* and *Problem Solving* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

Outcomes 2, 3 and 4 require candidates to produce a report that considers the effective treatment of water. If this report is presented as a written report that explores the issues relating to water treatment processes and is presented in an appropriate format this may offer candidates the opportunity to develop the Written component of the Core Skill *Communication* at SCQF level 6.

This Unit may also provide opportunities to develop the Core Skill *Information and Communication Technology* at SCQF level 6 as candidates may utilise *Information and Communication Technology* to research and understand different water treatment processes. They may also use information technology to present information including tables, graphs and diagrammatical representations of treatment processes in their report for Outcomes 2, 3 and 4 of this Unit.

Higher National Unit specification: support notes (cont)

Unit title: Water Operations: Water Treatment Processes

Should the report require candidates to investigate issues relating to water treatment processes with a view to making conclusions and recommendations for the resolution of those issues then there may be opportunities to develop all three components of the Core Skill *Problem Solving* at SCQF level 6.

Open learning

This course may be delivered in a flexible/distance/open learning format. In this case, a considerable amount of independent study will be required and will need to be supported by appropriate materials. The use of a Virtual Learning environment as a means of supporting Open learning delivery would be beneficial.

To relate the knowledge gained to the industrial practice, it is recommended that the candidate should make at least one site visit to an operational water treatment works preferably accompanied by a course tutor or someone with knowledge of the content of this Unit. This would enable the visit to be appropriately structured to Unit requirements.

However with regard to assessment, planning would be required to by the centre concerned to ensure the sufficiency and authenticity of candidate evidence and arrangements put in place to ensure that assessments were conducted under controlled, supervised conditions.

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).

General information for candidates

Unit title: Water Operations: Water Treatment Processes

This is a 1.5 credit SCQF level 7 Unit intended to be delivered as part of the HNC Water Operations Qualification. It is designed to give you a good understanding of the principles and practices involved in water treatment. Ideally, you should be working in the water industry or have access to the industry and had some experience of water treatment. Additionally, it would be beneficial if you had completed the HN Unit F53R 34 *Water Operations: Water Quality Management* prior to undertaking this Unit.

There are five Outcomes in this Unit.

Outcome 1 looks at the historical development of water treatment processes and the relationship with incidence of waterborne diseases. Key dates, events and people involved in waterborne disease identification and prevention and major developments in water treatment are covered. The Outcome also covers key quality parameters of raw waters and how these vary for different water sources. Typical water treatment processes and strategies for different quality waters and how quality influences the choice of treatment process are covered.

In Outcome 2 different water treatment processes are covered which include means of storing waters as well as covering processes of sedimentation, screens and strainers and rapid sand filters. The Outcome considers how these treatment processes are constructed, operated and maintained.

Outcome 3 covers the construction and principles of operation and maintenance of slow sand filters. You will be able to explain the biological treatment mechanisms involved in slow sand filtration and the advantages and disadvantages of slow sand filtration.

Outcome 4 is about the principles and processes used in the chemical treatment of water. It introduces the chemistry of coagulation of Iron and Aluminium compounds and the role of pH as well as explaining the Physical chemistry of flocculation, Charge Neutralisation and the role of Polyelectrolytes in influencing particle size. The Outcome also considers the principles of operation of common types of chemical dosing pumps.

The use of Chlorine and Ozone are also included as is the common processes involved in the treatment and disposal of water treatment sludges.

The final Outcome looks at recent and current developments in the treatment of water. It covers removal of Manganese from drinking water; the use of membrane filtration systems; the production of Ozone and its use in the clarification of water and the use of Ultra Violet light as a disinfection agent. The Unit will also look at current developments in the industry.

Outcome 1 and 5 may be assessed under closed-book conditions whilst Outcomes 2, 3 and 4 may be assessed by a report looking at water treatment processes.

There are opportunities to develop the written component of the Core Skill *Communication* at SCQF level 6; the Core Skill *Information and Communication Technology* and the Core Skill *Problem Solving* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.