

## **SQA Advanced Unit specification**

### **General information**

**Unit title:** Marine Engineering: Process Control (SCQF level 7)

**Unit code:** HW5T 47

**Superclass:** VE

**Publication date:** November 2017

**Source:** Scottish Qualifications Authority

**Version:** 01

### **Unit purpose**

This Unit is designed to enable learners to gain knowledge and understanding of process control systems by being able to read pipe and instrument diagrams, choose a control valve to suit a particular system and be able to classify controllers. The Unit also provides the learner with the opportunity to develop practical tuning skills and enable them to tune a control system to its optimum performance with relation to the marine industry.

### **Outcomes**

On successful completion of the Unit the learner will be able to:

- 1 Read a pipe and instrument diagram.
- 2 Select a control valve and be able to size the valve to a particular operation.
- 3 Explain and classify controllers.
- 4 Set-up or simulate a process control system and tune the system for optimum safe operation.

### **Credit points and level**

1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

### Recommended entry to the Unit

Access to this Unit will be at the discretion of the centre and the following recommendations are for guidance only. Learners should have a basic knowledge of process measurement and control engineering. This may be evidenced by the possession of *Higher Process Measurement and Control: An Introduction* (F6X8 12) or *Engineering: Process Control* (F5KK 12) or *Engineering: Fault Finding in Measurement and Control* (F5KN 12) or *Process Measurement and Control: An Introduction* or unit HT1R 47 *Fundamentals of Controls and Transducers*.

### Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

### 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.

### 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](http://www.sqa.org.uk/assessmentarrangements).

## **SQA Advanced Unit specification: Statement of standards**

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

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. Learners 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**

Read a pipe and instrument diagram.

#### **Knowledge and/or Skills**

- ◆ Identify and explain symbols to BS1553 and BS1646

### **Outcome 2**

Select a control valve and be able to size the valve to a particular operation.

#### **Knowledge and/or Skills**

- ◆ Select the appropriate trim for a given application
- ◆ Select the appropriate size of valve for a given application
- ◆ Select the appropriate valve body material for a given application
- ◆ Select the appropriate fail safe condition for the valve

### **Outcome 3**

Explain and classify controllers.

#### **Knowledge and/or Skills**

- ◆ Gain/Proportional band, integral action time, derivative action time
- ◆ Analogue controllers, time constant, generation of control modes/actions

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### Outcome 4

Set-up or stimulate a process control system and tune the system for optimum safe operation.

#### Knowledge and/or skills

- ◆ Feedback control systems, response to set point/load changes, offset/steady state a paper composed of an appropriate balance of short answer, restricted response and structured questions, errors, overshoot, initial rate of change, setting time
- ◆ Effects of P, I and D variables and their constants on system response
- ◆ Tuning of closed loop systems using open/closed loop methods
- ◆ Use of process analysers for tuning
- ◆ Process Characteristics: distance velocity lags, transfer lags, time constant, process interactions

#### Evidence Requirements for this Unit

Written and/or oral evidence is required for Outcomes 1–4. Outcomes 1–3 should be conducted under closed-book conditions and as such learners should not be allowed to bring any textbooks or handouts to the assessment. Outcomes 1–3 can be combined for assessment with assessment lasting 2 hours 10 minutes.

Outcomes 1–3 may be assessed separately with the duration of Outcome 1 lasting 30 minutes, Outcome 2 lasting 40 minutes and Outcome 3 lasting 1 hour.

Outcome 4 should be conducted under open-book conditions and learners will be allowed to use any relevant course notes, textbooks and reference material for the control system or simulator. Length of assessment is at the centre's discretion for Outcome 4.

#### Outcome 1

In order to ensure learners will not be able to foresee the symbols on which they are assessed a different set of symbols will be required each time the Outcome is assessed.

Written and/or oral evidence is required to demonstrate Knowledge and/or Skills in this Outcome.

A Learner's response will be judged satisfactory where the evidence shows they can:

- ◆ Identify ten from fifteen symbols highlighted on a typical Pipe and Instrument Diagram that they have been given.

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### Outcome 2

Written and/or oral evidence is required to demonstrate Knowledge and/or Skills in this Outcome. A learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the learner is able to:

- ◆ Select the correct type of valve.
- ◆ Carry out a sizing exercise correctly.
- ◆ Select an appropriate valve body material for the given application.
- ◆ State the fail-safe condition required for the application.

### Outcome 3

Written and/or oral evidence is required to demonstrate Knowledge and/or Skills in this Outcome. A learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the learner is able to:

- ◆ Explain gain/proportional band, integral action time, and derivative action time.
- ◆ Explain and classify, analogue controllers, time constant, generation of control modes/actions.

### Outcome 4

This is a practically based Outcome and all Knowledge and/or Skills in this Outcome should be assessed. The evidence should be presented in response to a practical assignment in which the learner is set the task of setting up a single loop process control system and tune the system for optimum safe operation. A learner's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the learner is able to:

- ◆ Set-up a single loop control system ready to be tuned.
- ◆ Choose the appropriate action and/or actions for the controller.
- ◆ Tune the closed loop system to its optimum settings.
- ◆ produce a report that includes the following:
  - a description of the process to be controlled
  - produce a schematic sketch of the system
  - describe how the system was tuned
  - produce before and after results for the systems response
  - include any calculations that required to optimise the system
  - an explanation of the safety and operating futures of the un-tuned and the tuned system

The control problem in this assignment should be based on an industrial process, which can be an actual or simulated process.

Learners should have access to relevant equipment to set-up the control loop on the process, instruction manuals, notes and textbooks. If the learner's system is not fully tuned then the learners should be allowed to correct the fault and retest the system.

Centres should make every reasonable effort to ensure that the tuning parameters found is the learner's own work.

### SQA Advanced Unit Support Notes

**Unit title:** Marine Engineering: Process Control (SCQF level 7)

Unit Support Notes are offered as guidance and 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 in order to allow learners to develop knowledge, understanding and skills in the following areas:

- 1 Be able to read a pipe and instrument diagram.
- 2 Select a control valve and be able to size the valve to a particular operation.
- 3 Explain and classify controllers.
- 4 Set-up or simulate a process control system and tune the system for optimum safe operation.

The Unit is at SCQF level 7 and the Unit has been developed as part of the Marine Engineering SQA Advanced Diploma. However, this does not preclude the use of this Unit in other awards where award designers feel it is appropriate.

In designing this Unit, the writer has identified the range of topics that they would expect to be covered by lecturers. A list of topics for each Outcome is given below.

#### Outcome 1

- ◆ Read a pipe and instrument diagram:
  - identify symbols to BS1553 (Graphical symbols for general engineering)
  - identify symbols to BS1646 (Symbolic representation for process measurement control functions and instrumentation) although you may find many variations in the different Pipe and Instrument diagrams used in industry

#### Outcome 2

- ◆ Select a control valve and be able to size the valve to a particular operation. Given a specific application:
  - select the appropriate trim for a given application
  - select the appropriate size of valve for a given application
  - select the appropriate valve body material for a given application
  - select the appropriate fail safe condition for the valve

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### Outcome 3

- ◆ Explain and classify controllers:
  - gain/proportional band, integral action time, derivative action time
  - analogue controllers, time constant, generation of control modes/actions

### Outcome 4

- ◆ Set-up or simulate a process control system and tune the system for optimum safe operation:
  - feedback control systems, response to set point/load changes, offset/steady state errors, overshoot, initial rate of change, setting time
  - effects of P.I and D variables and their constants on system response
  - tuning of closed loop systems using open/closed loop methods
  - use of process analysers for tuning

Outcome 4 may be assessed by an assignment in which learners are asked to complete a series of tasks to enable them to set-up safely a single loop control system and optimise it for safe operation on the system.

## Guidance on approaches to delivery of this Unit

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

### Outcome 1

Standards are BS1553 (Graphical symbols for general engineering) and BS1646 (Symbolic representation for process measurement control functions and instrumentation) although you may find many variations in the different Pipe and Instrument diagrams used in industry.

Learners should be given a typical Process Instrument Diagram which can be a copy of an actual drawing or a made up drawing of a process on which the symbols to be identified have been highlighted alternatively a list of 'TAG Numbers' is given to the learner along with the drawing which he/she has to identify correctly.

### Outcome 2

Evidence of learner knowledge may take the form of a restricted response question, in which the learner is given details of a typical industrial situation, eg type of liquid, flow rate, pressure and any special conditions (corrosive/non-corrosive, etc) from which they have to select correctly an appropriate valve to control the plant characteristics correctly.

Learners should be supplied with appropriate materials and charts for the correct sizing of valves.

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### **Outcome 3**

This Outcome should be delivered in a classroom setting with appropriate process control training rig or similar set up. Centres may also use appropriate simulation packages and/or software available online. Ideally, this Outcome will be delivered after Outcomes 1 and 2 have been completed.

### **Outcome 4**

The assessment of this Outcome should take the form of an assignment and be carried out at the end of the delivery of the Unit. The time allocated for the assignment, including the writing of the report, is at the centre's discretion. It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and or skills items.

It is essential that centres ensure that evidence generated is the learner's own work. Centres can choose to issue each learner either with a different process or the same process. If each learner is issued with a different process specification then the degree of difficulty for each one should be equal. If the same process specification is assigned to each learner then the specification should be such that each learner is required to interpret it and offer his/her unique solution.

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

## **Guidance on approaches to assessment of this Unit**

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Written and/or oral evidence is required for Outcomes 1–4. Outcomes 1–3 should be conducted under closed-book conditions and as such learners should not be allowed to bring any textbooks or handouts to the assessment. Outcomes 1–3 can be combined for assessment with assessment lasting 2 hours 10 minutes.

Outcomes 1–3 may be assessed separately with the duration of Outcome 1 lasting 30 minutes, Outcome 2 lasting 40 minutes and Outcome 3 lasting 1 hour.

Outcome 4 should be conducted under open-book conditions and learners will be allowed to use any relevant course notes, textbooks and reference material for the control system or simulator. Length of assessment is at the centre's discretion for Outcome 4.



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### **Outcome 1**

The assessment for Outcome 1 in this Unit should consist of a drawing which learners are given from which they must identify items listed on an assessment paper. This assessment should be conducted under controlled, closed-book, supervised conditions. Learners should not be allowed to bring any textbooks, handouts to the assessment.

### **Outcome 2**

The assessment paper should be composed of a suitable balance of short answer, restricted response and structured questions. This assessment should be conducted under controlled, supervised conditions. Learners should not be allowed to bring any textbooks, handouts to the assessment.

### **Outcome 3**

Explain and classify controllers:

- 1 Gain/proportional band, integral action time, derivative action time.
- 2 Analogue controllers, time constant, generation of control modes/actions

Outcome 3 may be made up of a written paper composed of questions to satisfy the knowledge requirements. This assessment should be conducted under controlled, supervised conditions. Learners should not be allowed to bring any textbooks, handouts to the assessment.

### **Outcome 4**

Outcome 4 should be assessed by an assignment in which learners are asked to complete a series of tasks to enable them to set-up safely a single loop control system and optimise it for safe operation on the system. The assignment tasks should involve the setting up of the single loop control system, applying knowledge gained on tuning control systems for optimum performance to that system, verifying the correct operation of the control system after tuning and documentation of the set-up, tuning procedure and final performance of the system. Learners should have access to a single loop control system or a process control simulator and be allowed to use any relevant course notes, textbooks and reference material for the control system or simulator.

Outcome 4 should be conducted under open-book conditions and learners will be allowed to use any relevant course notes, textbooks and reference material for the control system or simulator. Duration of assessment is at the centre's discretion for Outcome 4.

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

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

### **Opportunities for e-assessment**

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at [www.sqa.org.uk/e-assessment](http://www.sqa.org.uk/e-assessment).

### **Opportunities for developing Core and other essential skills**

There are opportunities to develop the Core Skills of Written Communication (Writing), Written Communication (Reading), *Problem Solving* (Critical Thinking) and *Problem Solving* (Planning and Organising) at SCQF level 5 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

## History of changes to Unit

Version	Description of change	Date

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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](#).

### General information for learners

#### **Unit title:** Marine Engineering: Process Control (SCQF level 7)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit has been designed to allow you to develop knowledge and understanding and skills associated with process control in a Marine engineering environment.

The early part of the Unit deals with pipe and instrument diagrams and should provide you with a good grounding in this subject area. Being able to read pipe and instrument diagrams is an essential part of working within the process industries.

The Unit will also enable you to gain an understanding about control valves, which are often forgotten about, but are the final control element in most control systems. Control valves can vary in size from very small to in excess of 1m in diameter, they have different flow/lift characteristics, and they also have to be sized correctly to enable the process to be controlled correctly. You will be able to correctly select and size a control valve to an application by the end of the Unit.

The second half of the Unit deals with controllers, the different types and their uses and finally the Unit will enable you to put a single loop process control system together and then tune it to its optimum safe performance.

The formal assessment for this Unit will consist of both written assessments and a practical assignment. In Outcome 1 you will have to identify ten from fifteen symbols highlighted on a typical pipe and instrument diagram that you have been given. Outcome 2 will consist of a suitable balance of short answer, restricted response and structured questions. Outcome 3 will consist of an appropriate balance of short answer, restricted response and structured questions.

Outcome 4 is a practical assignment and report based on the information from the practical assessment.

Outcome 4 should be assessed by an assignment in which learners are asked to complete a series of tasks to enable them to set-up safely a single loop control system and optimise it for safe operation on the system. The assignment tasks should involve the setting up of the single loop control system, applying knowledge gained on tuning control systems for optimum performance to that system, verifying the correct operation of the control system after tuning and documentation of the set-up. A report should be written, centres may develop checklists to support the assessment requirements for each of the knowledge and or skills items.

All the assessments and practical assignment will be carried out at the end of the delivery of the Unit.