

SQA Advanced Unit Specification

General information for centres

Unit title: Process Control

Unit code: HT9X 47

Unit purpose: This Unit is designed to enable candidates 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 candidate with the opportunity to develop practical tuning skills and enable them to tune a control system to its optimum performance.

On completion of the Unit the candidate should 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*).

**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: Access to this Unit will be at the discretion of the centre and the following recommendations are for guidance only. Candidates should have a basic knowledge of process measurement and control engineering. This may be evidenced by the possession of Higher Process Measurement or Higher Process Control or NQ units in Measurement and Control or NC Measurement and Control or NC Multidisciplinary Engineering.

Core 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.

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.

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Assessment: The assessment for Outcome 1 in this Unit should consist of a drawing which candidates are given from which they must identify items listed on an assessment paper. This paper should be taken as a separate assessment that lasts approximately one hour. This assessment should be conducted under controlled, supervised conditions.

Outcome 2 and 3 in this Unit should be combined together into one written assessment paper. This paper should be taken by candidates at one single assessment event that should last approximately two hours and thirty minutes. 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.

Outcome 4 should be assessed by an assignment in which candidates 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. Candidates should complete the assignment in eight hours. Candidates 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.

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 the candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

SQA Advanced Unit specification: statement of standards

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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

Read a Pipe and Instrument Design

Knowledge and/or skills

- ◆ Identify and explain symbols to BS1553 and BS1646

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

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

In order to ensure candidates will not be able to foresee the symbols which they will have to identify, a different set of symbols can be required each time the Outcome is assessed.

Evidence should be generated through assessment undertaken in controlled supervised conditions.

Assessment guidelines

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.

The assessment paper should be taken on a single assessment event lasting approximately one hour.

Assessments should be conducted under closed book conditions and consequently candidates should not be allowed to bring any textbooks, handouts or calculators to the assessment.

Candidates 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 No’s” is given to the candidate along with the drawing which he/she has to identify correctly.

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

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ 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

Assessment guidelines

Evidence of candidate knowledge may take the form of a restricted response question, in which the candidate is given details of a typical industrial situation e.g. type of liquid/gas, 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.

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

The assessment paper for Outcome 2 could be combined with Outcome 3 into a single assessment event, details of which can be found in Outcome 3.

Evidence should be generated through an assessment undertaken in controlled supervised conditions. Assessments should be conducted under closed book conditions and consequently candidates should not be allowed to bring any textbooks or handouts to the assessment.

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
- ◆ digital controllers, algorithm type, filters, scaling, bias, generation of control modes/actions
- ◆ fault tolerant controllers, triple modular redundant (TMR) architecture, majority voting, selection of middle value from three, sequence of events capability

Evidence Requirements

Candidates will need evidence to demonstrate their knowledge and/or skills in this Outcome which will be provided on a sample basis. The evidence may be provided in response to specific questions.

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Each candidate will need to demonstrate that they can answer questions based on samples of the items above. In any assessment of this Outcome, three out of four knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all three items.

Where sampling takes place, a candidate's response can be judged to be satisfactory where evidence provided is sufficient to meet the requirements for each item by showing that the candidate 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
- ◆ explain and classify digital controllers, algorithm type, filters, and scaling, bias, generation of control modes/actions
- ◆ explain, fault tolerant controllers, triple modular redundant (TMR) architecture, majority voting, and selection of middle value from three, sequence of events capability

Assessment guidelines

Evidence of candidate knowledge may take the form of a short answer, restricted response, or structured questions. The assessment paper for Outcome 2 and 3 should be taken at a single assessment event lasting approximately two hours and thirty minutes. Such a paper should be composed of an appropriate balance of short answer, restricted response and structured questions.

In order to ensure that candidates will not be able to foresee what type of conditions they will be questioned on, a different sample of knowledge and/or skills is required each time the Outcome is assessed.

Evidence should be generated through assessment undertaken in controlled supervised conditions. Assessments should be conducted under closed book conditions and consequently candidates should not be allowed to bring any textbooks or handouts to the assessment.

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 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

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

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- a description of the process to be controlled
- a schematic sketch of the system
- a description of how the system was tuned
- before and after results for the system's response
- any calculations that are 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.

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

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

Assessment guidelines

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 eight hours in total. 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 candidate's own work. Centres can choose to issue each candidate either with a different process or the same process. If each candidate 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 candidate then the specification should be such that each candidate is required to interpret it and offer his/her unique solution.

Administrative Information

Unit code: HT9X 47
Unit title: Process Control
Superclass category: VG
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History of Changes:

Version	Description of change	Date

Source: SQA

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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: Process Control

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 in order to allow candidates 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 may form part of a group award or be completed as a free-standing Unit.

In designing this Unit, the writer has identified the range of topics that they would expect to be covered by lecturers. The writer has also given recommendations as to how much time should be spent on each Outcome. This is done to help lecturers to decide what depth of treatment should be given to the topics attached to each Outcome.

A list of topics for each Outcome is given below.

Outcome 1(8 hours)

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 (8 hours)

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

Outcome 3 (8 hours)

Explain and classify controllers

- ◆ gain/proportional band, integral action time, derivative action time
- ◆ analogue controllers, time constant, generation of control modes/actions
- ◆ digital controllers, algorithm type, filters, scaling, bias, generation of control modes/actions
- ◆ fault tolerant controllers, triple modular redundant (TMR) architecture, majority voting, selection of middle value from three, sequence of events capability

Outcome 4 (8 hours)

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

Guidance on the delivery and assessment of this Unit

The assessment for Outcome 1 should last approximately one hour. This assessment should be conducted under controlled, supervised conditions.

Outcome 2 and 3 in this Unit should be combined together into one written assessment paper that should last approximately two hours and thirty minutes. This assessment should be conducted under controlled, supervised conditions.

Outcome 4 should be assessed by an assignment in which candidates 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. Candidates should complete the assignment in eight hours.

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 the candidates must achieve all the minimum evidence specified for each Outcome in order to pass the Unit.

Opportunities for developing Core Skills

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

Open learning

The Unit could be delivered by distance learning which may incorporate some degree of online support. With regard to assessment, planning would be required of the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that written assessment was conducted under controlled conditions.

Arrangements would also need to be made to ensure that the candidate could practically demonstrate the operation of his/her solution to the practical assignment required as assessment evidence for

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Outcome 4. This would involve the candidate attending the centre or utilising video conferencing. Alternatively, special arrangements would be made for the candidate to demonstrate the practical work to a designated responsible person local to the candidate.

For information on open learning, please refer to *SQA guide assessment and quality assurance of open and distance learning (A1030, Feb 2001)*.

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: Process Control

This Unit has been designed to allow you to develop knowledge and understanding and skills associated with process control.

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, so 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. Outcome 1 will be assessed on its own, where you have to identify ten from fifteen symbols highlighted on a typical pipe and instrument diagram that you have been given. This will last one hour. Outcomes 2 and 3 will be an integrated assessment paper that will last two hours and thirty minutes. Both these assessments will take place under controlled, supervised conditions in which you will not be allowed to take notes, handouts, textbooks, etc into the assessment.

Your practical skills will be assessed by means of an assignment in which you will be required to satisfactorily complete the task of setting up or simulating a process control system, and tuning the system for optimum safe operation. This assignment should normally be completed within eight hours. Your centre will provide you with access to the process control system or simulation and you should be allowed to use any relevant course notes, textbooks and reference manuals for the system.

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