Next Generation Higher National Unit Specification

Instrumentation and Control: Practical Skills (SCQF level 7)

Unit code: J6DB 47

SCQF level: 7 (24 SCQF credit points)

Valid from: session 2023–24

Prototype unit specification for use in pilot delivery only (version 1.0) August 2023

This unit specification provides detailed information about the unit to ensure consistent and transparent assessment year on year.

This unit specification is for teachers and lecturers and contains all the mandatory information required to deliver and assess the unit.

This edition: August 2023 (version 1.0)

Unit purpose

Learners develop knowledge and experience of some of the practical skills relevant to instrumentation and control.

They learn how to select, use and calibrate a range of equipment and instruments that are common within the process chemical, oil and gas industries, food and beverage productions, renewables, and other automation industries. Learners set up simple control loops and install instrumentation.

The target group for this unit is learners who want to develop their practical skills in instrumentation and control to support a career in various engineering industries.

Entry to this unit is at your centre's discretion. However, we recommend that learners have a broad knowledge and understanding of electrical, electronic, mechanical and mathematical concepts and principles. For example, learners may have achieved passes at SCQF level 6 in subjects related to electrical, electronics, mechanical and engineering systems.

This unit provides learners with suitable knowledge and skills to progress to employment in a range of engineering industry roles, or further study.

Unit outcomes

Learners who complete this unit can:

1 perform maintenance on a range of instrumentation sensing devices
2 perform maintenance on a range of control valves and positioners
3 commission a process control system

Evidence requirements

Assess this unit holistically mainly using practical activities and assignments in all outcomes. For the practical activities:

- learners generate written and/or oral recorded evidence to support the practical activity under unsupervised, open-book conditions
- you must provide learners with details of the required format for written and/or oral evidence
- you must allow learners to use software packages
- you must allow learners to have access to relevant notes and manufacturers' data sheets for the instruments and equipment they use

Outcome 1

You must assess all knowledge and skills with practical activities and learners must produce a written and/or oral report for each activity.

They can perform the practical exercises using either:

- a traditional pressure, level, temperature and flow instrument (4-20 mA output)
  or
- a smart pressure, level, temperature and flow measuring instrument

They must perform one practical exercise for each of the process variable types (pressure, level, temperature and flow).

Learners must:

- select the correct process variable measuring instrument from a process control system
- remove the process variable measuring instrument from the process control system
- set up and calibrate the process variable measuring instrument to the required range, adjusting the zero and span correctly
- reinstall the process variable measuring instrument into the process control system

They must perform all practical work in a safe manner that is in line with industry health and safety and operation standards.

Learners must produce a written and/or oral recorded report for each of the exercises. Each report must include the following:

- a sketch of the equipment used to perform the calibration
- a description of the procedure
- a table of the calibration results
- a graph of the input/output response of the calibrated system
- a discussion and conclusion on the results of the calibration

You should provide learners with details of the required report format. You should allow learners to use software packages to produce documentation for their reports.

Outcome 2

You must assess all knowledge and skills with practical activities.

Learners must present their evidence by a calibration sheet for the control valve, and a calibration sheet for each of the two chosen types of positioners.

They must complete an observation check sheet for each practical activity and:

- identify and explain the function of a control valve
- strip down and rebuild a control valve to the required specification
- calibrate valve positioners of various types (analogue and smart)

You must provide learners with details of the required calibration form format and allow them to use software packages to produce documentation for their calibration form.

Outcome 3

You must assess all knowledge and skills with practical activities and a written and/or oral report.

You must give learners a practical assignment that asks them to:

- build a simple control loop
- tune the control loop to optimum settings
- record the effect of PID (proportional, integral and derivative) control when tuned

Learners must:

- investigate different types of controllers and how they operate
- investigate the effects of PID adjustments on three term controllers
- build and tune a simple control loop
- explain the operation of a Zener or Galvanic barrier
- carry out a suitable test on a Zener of Galvanic barrier to check its operation
- install and setup a Zener or Galvanic barrier into a simple instrument loop

- test installed barrier in simple instrument loop
- demonstrate correct procedure for glanding of various cables within an EX-environment

They must also produce a written and/or oral report on the practical exercise that includes:

- a sketch of the equipment they used to build the loop
- a description of the control loop built
- a description of the method they used to tune the control loop
- a table of measurement to show input/output response
- a graph trend of the input/output response of the tuned system
- a conclusion on their results of the tuning

Knowledge and skills

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Outcome 1 Learners should understand how to: ♦ describe routine maintenance tasks involving pressure, level, temperature and flow instruments	**Outcome 1** Learners can: ♦ maintain various types of instrument sensing devices by: — conducting instrument identification — removing devices from the live plant — conducting maintenance activities including calibrations and reports installation from pressure, level, temperature and flow types of measurement device — reinstalling back to the live plant
Outcome 2 Learners should understand how to: ♦ describe routine maintenance tasks for control valves and positioners	**Outcome 2** Learners can: ♦ maintain a control valve, by: — stripping down a control valve — rebuilding a control valve — calibrating and setting up a control valve — calibrating various types of positioners

Knowledge	Skills
Outcome 3 Learners should understand how to: ♦ describe the commissioning of process control systems and equipment including installation for equipment	**Outcome 3** Learners can: ♦ outline the effect of using different controllers when operating a simple loop including the effects of PID control by: — building and tuning a simple control loop — testing the Zener or Galvanic barrier — installing and setting up a Zener or Galvanic barrier into a simple system — testing the installed barrier in a simple system — glanding various cables within an EX-environment

Meta-skills

Throughout the unit, learners develop meta-skills to enhance their employability in the engineering sector.

Self-management

Learners develop their skills in:

- integrity (self-awareness, ethics, self-control) through working on their portfolio or investigation reports
- adapting (critical reflection, self-learning) through working on their portfolio or investigation reports
- initiative (decision making, self-motivation and responsibility) when carrying out their learning activities, responsibility (project work) when you follow through on commitments, are proactive and take responsibility for your work, and decision making (project work) when you make considered choices after appropriately using intuition and careful thought

Social intelligence

Learners develop their skills in:

- communicating (receiving information, listening, giving information) when accessing the unit material through the virtual learning environment, keeping an e-portfolio and producing technical reports
- collaborating (teamworking and collaboration) when engaging with fellow learners or lecturers

Innovation

Learners develop their skills in:

- curiosity (questioning, observation, information sourcing) when carrying out their learning activities
- sense-making (holistic thinking, analysis) when carrying out their learning activities either individually or in groups
- critical thinking (deconstruction, logical thinking, judgement) when carrying out their learning activities either individually or in groups

Literacies

Learners develop core skills in the following literacies:

Numeracy

Learners develop their numeracy skills by performing calculations when working out tolerances and expected values in their calibration work.

Communication

Learners develop their communication skills by engaging with other learners and their teacher or lecturer, while they plan their project build in outcome 3.

Digital

Learners develop digital literacy by using a broad range of engineering software and digital testing equipment, and when accessing the course material through a virtual learning environment (if applicable at their centre).

Delivery of unit

This unit is part of the Higher National Certificate (HNC) in Engineering. The framework includes mandatory and optional units, and you can tailor the selected combination of units to specific engineering pathway needs.

The notional design length is 120 hours, however, the amount of time you allocate to each outcome is at your discretion (particularly as we recommend a holistic approach).

We suggest the following distribution of time, including assessment:

Outcome 1 — Perform maintenance on a range of instrumentation sensing devices (38 hours)

Outcome 2 — Perform maintenance on a range of control valves and positioners (28 hours)

Outcome 3 — Commission a process control system (54 hours)

Additional guidance

The guidance in this section is not mandatory.

Content and context for this unit

This unit allows learners to develop knowledge, understanding and skills in the following areas.

Perform maintenance on a range of instrumentation sensing devices (outcome 1)

Learners must remove, calibrate and reinstall a range of pressure, level, temperature and flow equipment.

Perform maintenance on a range of control valves and positioners (outcome 2)

Learners must carry out a basic calibration and maintenance procedure to control valves and positioners.

Commission a process control system (outcome 3)

Learners must set up and operate a range of process control systems and equipment.

Approaches to delivery

As this unit could provide evidence of some of the process engineering maintenance national occupational standards (NOS) requirements, you may want to refer to these standards when you deliver the unit.

You should have the knowledge and skills to use all listed equipment, however you can use other equipment at your centre’s discretion.

Encourage learners to use the internet to research different types of process variable measurement equipment, and access maintenance and calibration procedures, as well as relevant industry standards.

You must give learners access to a measurement and control engineering laboratory that has a range of process variable measuring equipment. You can use demonstrations and laboratory exercises to improve their understanding. This helps learners to relate theory to practice. Your centre must ensure there is a wide range of typical measuring instruments and calibration equipment available. All instruments and equipment should meet current process industry standards.

The following is a sample list of equipment and instruments for each outcome:

Outcome 1

Typical equipment could include: Bourdon gauges, DP cells, pressure switches, pressure transducers, turbine flowmeters, positive displacement flowmeters, orifice plates, vortex flowmeters, electro-magnetic flowmeters, ultrasonic flowmeters, Coriolis flowmeters,

thermocouples, resistance thermometers, filled system thermometer, ultrasonic level, radar level, capacitance level, Wallace and Tiernan pneumatic calibrators, dead weight tester, pressure calibrator, comparator, AMS/calibration software, handheld communicator for smart devices test instruments, flow test rig, water baths, sand baths, dry block calibrators, infra-red thermometer, and multi-function calibrator.

Outcome 2

Typical equipment could include: control valves (including forward and reverse acting), pneumatic positioners, electrical positioners, smart/wireless positioners, Wallace and Tiernan pneumatic calibrators, pressure calibrator, AMS/calibration software or alternative software, and test instruments.

Outcome 3

Typical equipment could include: three term controllers (PID), signal converters, control valves, process instruments, controllers, test equipment, simulation test rig, DCS/PLC, test rig using analogue and digital elements, IS barriers, Ex glands, Ex junction boxes, and Ex armoured braided cabling.

Approaches to assessment

You should assess knowledge and skills for all outcomes with practical activities.

You can generate evidence using different types of assessment. The following are suggestions, however, there may be other methods that would be more suitable for your learners. If you are devising your own assessments, ensure that they meet the national standard. If learners experience a range of assessment methods, this helps them to develop different skills that can be transferred to the workplace or further and higher education.

We recommend the total assessment time for this unit is no more than 10 hours.

Outcome 1

Learners should produce a report(s) based on the assessment activities or an actual workplace exercise. You can supplement their reports with additional questions or observation checklists, to ensure all aspects of the evidence requirements are covered. Reports can be written or oral. You should develop appropriate checklists that cover the evidence requirements and where learners record their assessment evidence. Learners produce their reports under unsupervised, open-book conditions, so you should make every reasonable effort to ensure that reports are their own work.

Outcome 2

You should develop appropriate observation checklists and calibration sheets, which learners use to record their assessment evidence.

Outcome 3

Learners should produce a report(s) based on the assessment activities or an actual workplace exercise. You can supplement their reports with additional questions or observation checklists, to ensure all aspects of the evidence requirements are covered. Reports can be written or oral. You should develop appropriate checklists that cover the evidence requirements and where learners record their assessment evidence. Learners produce their reports under unsupervised, open-book conditions, so you should make every reasonable effort to ensure that reports are their own work.

Opportunities for e-assessment

Assessment that is supported by information and communication technology (ICT), such as e-testing or the use of e-portfolios or social software, may be appropriate for some assessments in this unit.

If you want to use e-assessment, you must ensure that you apply the national standard to all evidence and that conditions of assessment (as specified in the evidence requirements) are met, regardless of the mode of gathering evidence.

Equality and inclusion

This unit is designed to be as fair and as accessible as possible with no unnecessary barriers to learning or assessment.

You should take into account the needs of individual learners when planning learning experiences, selecting assessment methods or considering alternative evidence.

Guidance on assessment arrangements for disabled learners and/or those with additional support needs is available on the assessment arrangements web page: www.sqa.org.uk/assessmentarrangements.

Information for learners

Instrumentation and Control: Practical Skills (SCQF level 7)

This information explains:

- what the unit is about
- what you should know or be able to do before you start
- what you need to do during the unit
- opportunities for further learning and employment

Unit information

This unit provides you with knowledge and skills specific to instrumentation and control engineering. It is part of the Higher National Certificate (HNC) in Engineering, which is aimed at those wishing to become engineering technicians.

In this unit, you learn about procedures and methods, and carry out maintenance on equipment used in chemical, oil and gas industries, food and beverage productions, renewables, and other automation industries. You work in areas such as pressure, level temperature and flow measurement systems, analysers and detectors, PID control, industrial actuators, and complex control systems.

Before starting this unit, you should have a broad understanding of electrical, electronic, mechanical and mathematical concepts and principles. For example, you could have SCQF level 6 in subjects related to electrical, electronics, mechanical and engineering systems.

Outcome 1

You work on industry standard equipment, and carry out procedures and methods. You complete required maintenance on the relevant devices within the four main types of pressure, level, temperature and flow. You safely remove the device from a working live plant, carry out the required maintenance to the device, then refit it safely back onto the live plant. You then prove your device is working within the required standard.

Outcome 2

You strip check, repair and rebuild a diaphragm actuator control valve, and then calibrate the control valve to a required setting. You carry out maintenance to at least two types of valve positioner (pneumatic and smart), and fit the positioners to the valve you are working on.

Outcome 3

You design, build and commission a simple PID control loops using industry-type equipment. The loop is based on pressure, level, temperature and flow. You use (where possible) all industry standard equipment and procedures.

You demonstrate evidence of all knowledge and skills in the context of one or more overarching instrumentation and control engineering scenario(s).

You are assessed using a variety of methods, including reports from practical activities, mini projects and observations. You should collate all evidence in your individual portfolio.

On completion of this unit, you can:

- perform maintenance on various instrumentation sensing devices
- perform maintenance on a range control valves and positioners
- commission a process control system

This unit provides you with suitable knowledge and skills to progress to further study, or employment in a wide range of engineering industries.

Meta-skills

Throughout the unit, you can develop meta-skills to enhance your employability in the engineering sector.

Meta-skills include self-management, social intelligence and innovation.

Self-management

You develop the skills of:

- integrity (self-awareness, ethics, self-control) through working on your portfolio or investigation reports
- adapting (critical reflection, self-learning) through working on your portfolio or investigation reports
- initiative (decision making, self-motivation and responsibility) when carrying out your learning activities and projects, responsibility (project work) when you follow through on commitments, are proactive and take responsibility for your work, and decision making (project work) when you make considered choices after appropriately using intuition and careful thought

Social intelligence

You develop the skills of:

- communicating (receiving information, listening, giving information) when accessing the unit material through the virtual learning environment, keeping an e-portfolio and producing technical reports
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Innovation

You develop the skills of:

- curiosity (questioning, observation, information sourcing) when carrying out your learning activities and projects
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- critical thinking (deconstruction, logical thinking, judgement) when carrying out your learning activities and projects, either individually or in groups

Administrative information

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Superclass: VE

History of changes

Version	Description of change	Date

Note: please check SQA's website to ensure you are using the most up-to-date version of this document.