

SQA Advanced Unit specification

General information

Unit title: Process Instrumentation: Practical Skills (SCQF level 7)

Unit code: HV6D 47

Superclass: XH

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Unit purpose

On completion of this Unit learners should be able to select, use and calibrate a range of equipment and instruments that are common within the process, chemical and oil and gas industries. Learners will gain the skills required to enable them to setup simple control loops and install instrumentation into hazardous areas. Learners will be equipped with the practical skills that are required by the process, chemical and oil and gas industries.

Outcomes

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

- 1 Perform different types of maintenance for Pressure, Level, Temperature and Flow instruments.
- 2 Carry out basic calibration, setup and maintenance procedures to a range of control valves and positioners.
- 3 Investigate a range of process control systems and equipment.
- 4 Identify and carry out installation of equipment within hazardous areas.

Credit points and level

2 SQA Credits at SCQF level 7: (16 SCQF credit points at SCQF level 7)

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Recommended entry to the Unit

This Unit is suitable for any learners that need to gain practical skills for a career in the Measurement and Control Industry. It would ideally suit learners on SQA Advanced Certificate and SQA Advanced Diploma programs but can be delivered as a standalone Unit. Learners should have a basic knowledge of process measurement and control engineering. This may be evidenced by the possession of the SQA Advanced Certificate Units in *Measurement Systems 1, Process Control and Instrumentation in Hazardous Areas* or completion of NC Measurement and Control or NC Multidisciplinary Engineering.

Core Skills

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

Complete Core Skill	None
Core Skill component	Critical Thinking at SCQF level 5

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.

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.

Outcome 1

Perform different types of maintenance for Pressure, Level, Temperature and Flow instruments.

Knowledge and/or Skills

- ◆ Pressure, level, temperature and flow instrument identification
- ◆ Pressure, level, temperature and flow instrument removal
- ◆ Pressure, level, temperature and flow instrument calibrations and reports
- ◆ Pressure, level, temperature and flow instrument installation

Outcome 2

Carry out basic calibration, setup and maintenance procedures to a range of control valves and positioners.

Knowledge and/or Skills

- ◆ Functions of a control valve
- ◆ Strip down a control valve
- ◆ Rebuild a control valve
- ◆ Calibrate and setup valves and positioners

Outcome 3

Investigate a range of process control systems and equipment.

Knowledge and/or Skills

- ◆ Types of controllers
- ◆ Effects of proportional, integral and derivative control
- ◆ Build and tune a simple control loop

Outcome 4

Identify and carry out methods of installation of equipment within hazardous areas.

Knowledge and/or Skills

- ◆ Operation of a Zener or Galvanic barrier
- ◆ Testing of a barrier
- ◆ Install and setup a Zener or Galvanic barrier into a simple system

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- ◆ Test installed barrier in a simple system
- ◆ Glanding of various cables within an EX environment

Evidence Requirements for this Unit

Outcome 1

This is a practical based Outcome and all of the Knowledge and/or Skills must be assessed by practical activities and production of a report for each activity.

The practical exercises can be performed using either a traditional pressure, level, temperature and flow instrument (ie 4-20mA output) or a Smart pressure, level, temperature and flow measuring instrument.

One practical exercise must be performed for each of the process variables types, (ie pressure, level, temperature and flow).

The learner must demonstrate that they can:

- ◆ 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. The learner must adjust the zero and span correctly
- ◆ install the process variable measuring instrument back into the process control system

All practical work must be performed in a safe manner that is in line with industry standards.

The learner should produce a report for each of the exercises. The reports should include the following:

- ◆ A sketch of the equipment used to perform the calibration
- ◆ A description of the method used to perform the calibration
- ◆ A table of the calibration results
- ◆ A graph of the input/output response of the calibrated system
- ◆ A conclusion on the results of the calibration

Learners should have access to relevant notes and manufacturers data sheets for the calibration equipment. All practical activities should be fully supervised.

Centres should provide learners with details of the required report format. If they so desire, learners should be permitted to use software packages to produce documentation for their reports. While learners are not required to produce reports under controlled, supervised conditions, centres should make every reasonable effort to ensure that reports are the learner's own work.

Outcome 2

This is a practical based Outcome and all of the Knowledge and/or Skills must be assessed by practical activities.

The evidence should be presented in the form of a calibration sheet for the control valve and a calibration sheet for each of the two chosen types of positioner. An observation check sheet should be completed for each of the practical activities.

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The learners must demonstrate that they can:

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

Learners should have access to relevant notes and manufacturers data sheets for the calibration equipment. All practical activities should be fully supervised.

Centres should provide learners with details of the calibration sheet that they must complete.

Outcome 3

This is a practical based Outcome and all of the Knowledge and/or Skills items should be assessed by practical activity and production of a report.

Evidence should be presented in response to a practical assignment in which the learner is set the task of building a simple control loop, tuning the control loop to optimum settings and recording the effect of PID (proportional, integral and derivative) control when tuned.

The learner must demonstrate proportional, integral and derivative that they can:

- ◆ investigate different types of controllers and how they operate
- ◆ investigate the effects of proportional, integral and derivative adjustments on three term controllers
- ◆ build and tune a simple control loop

All practical work must be performed in a safe manner that is in line with industry standards.

The learner should produce a report on the practical exercise. The report should include the following:

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

Learners should have access to relevant notes and manufacturers data sheets for the calibration equipment. All practical activities should be fully supervised.

Centres should provide learners with details of the required report format. If they so desire, learners should be permitted to use software packages to produce documentation for their reports. While learners are not required to produce reports under controlled, supervised conditions, centres should make every reasonable effort to ensure that reports are the learner's own work.

Outcome 4

This is a practical based Outcome and all of the Knowledge and/or Skills items should be assessed by practical activities.

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Evidence should be presented in response to a practical assignment in which the learner is set the task of selecting an appropriate barrier for a given control loop then installing the barrier into the loop using correct installation procedures using suitable cable and glands for hazardous areas. Once installing the learner should then test that their installation is working correctly and to standard.

The learner must demonstrate that they can:

- ◆ explain the operation of a Zener or Galvanic barrier
- ◆ carry out a suitable test on the 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

Learners should have access to relevant notes and manufacturers data sheets for the instruments and equipment used. All practical activities should be fully supervised.

Unit Support Notes

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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 80 hours.

Guidance on the content and context for this Unit

This Unit allows learners to develop knowledge, understanding and skills in the following areas:

- 1 Removal, calibration and reinstallation of a range of pressure, level, temperature and flow Equipment.
(32 hours class time including 4 hours for assessment)
- 2 Carry out basic calibration and maintenance procedure to control valves and positioners.
(24 hours class time including 3 hours for assessment)
- 3 Setting up and operating a range of process control systems and equipment.
(16 hours class time including 2 hours for assessment)
- 4 Installation of instrument equipment within hazardous areas.
(8 hours class time including 2 hours for assessment)

The Unit is at SCQF level 7 and has been developed as part of the SQA Advanced Certificate/SQA Advanced Diploma in Measurement and Control Engineering. 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. 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.

This Unit could evidence some of the requirements of the Process Engineering Maintenance National Occupational Standards PEM NOS and lecturers may want to refer to these standards when delivering the Unit.

A sample list of equipment and Instruments for each Outcome is given under 'Guidance on approaches to delivery of this Unit'. The Knowledge and/or Skills required to use all listed equipment should be known however other equipment can be used with discretion of the centre.

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Guidance on approaches to delivery of this Unit

The use of ICT (Information and Communication Technology) should be used to support the delivery of this Unit. This could take the form of learners researching different types of process variable measurement equipment on the internet and using ICT to access maintenance and calibration procedures as well as relevant British standards.

This Unit requires access to a measurement and control engineering laboratory with a range of process variable measuring devices/equipment. Demonstrations and laboratory exercises can be used to improve the learner's understanding which will help to relate theory to practice.

During delivery of this Unit the delivering centre must ensure that as wide a range of typical measuring instruments and calibration equipment is available. All instruments and equipment should meet current process industry standards.

For Outcome 1 typical equipment should include the following:

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, Hand Held Communicator for Smart Devices Test Instruments, Flow Test Rig, Water Baths, Sand Baths, Dry Block Calibrators, Infra-Red Thermometer, Multi-function Calibrator

For Outcome 2 typical equipment should include the following:

Control Valves (to include forward and reverse acting), Pneumatic Positioners, Electrical Positioners, Smart/Wireless Positioners, Wallace and Tiernan Pneumatic Calibrators, Pressure Calibrator, AMS/Calibration software, Test Instruments

For Outcome 3 typical equipment should include the following:

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

For Outcome 4 typical equipment should include the following:

IS Barriers, Ex Glands, Ex Junction Boxes, Ex armoured\braided cabling

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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.

For Learning Outcome 1 Knowledge and Skills should be assessed by practical activities.

In the assessment, learners should produce a report or reports based on the assessment activities or an actual workplace exercise. Reports can be supplemented by additional questions or Observation checklists to ensure all aspects of the Evidence Requirements are covered. The report may be presented in any suitable way. Reports may be written, oral, or signed.

Centres should develop appropriate checklists that cover the Evidence Requirements to record learner assessment evidence.

While learners are not required to produce reports under controlled, supervised conditions, centres should make every reasonable effort to ensure that reports are the learner's own work.

Total assessment time for the Outcome should be no more than 4 hours.

For Learning Outcome 2 Knowledge and Skills should be assessed by practical activities.

All Evidence Requirements can be evidenced by use of Observation checklists and calibration sheets.

Centres should develop appropriate checklists and calibration sheets that cover the Evidence Requirements to record learner assessment evidence.

Total assessment time for the Outcome should be no more than 3 hours.

For Learning Outcome 3 Knowledge and Skills should be assessed by practical activities.

In the assessment, learners should produce a report or reports based on the assessment activities or an actual workplace exercise. Reports can be supplemented by additional questions or Observation checklists to ensure all aspects of the Evidence Requirements are covered. The report may be presented in any suitable way. Reports may be written, oral, or signed.

Centres should develop appropriate checklists that cover the Evidence Requirements to record learner assessment evidence.

While learners are not required to produce reports under controlled, supervised conditions, centres should make every reasonable effort to ensure that reports are the learner's own work.

Total assessment time for the Outcome should be no more than 2 hours.

For Learning Outcome 4 Knowledge and Skills should be assessed by practical activities.

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All Evidence Requirements can be evidenced by use of Observation checklists.

Centres should develop appropriate checklists that cover the Evidence Requirements to record learner assessment evidence.

Total assessment time for the Outcome should be no more than 2 hours.

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.

Opportunities for developing Core and other essential skills

The ability to perform, interpret and record accurate instrument measurements and calibrations would be enhanced by formative opportunities to practise calculations in practical engineering contexts.

All elements of the Core Skill of *Problem Solving*, that is, Planning and Organising, Critical Thinking, and Reviewing and Evaluating, will be naturally developed as learners apply knowledge and understanding to a complex practical task. The influence of installation and environmental factors will be taken into account before calibration data is measured, checked and recorded. Evaluation will be on going although class group discussion and assessor feedback may be useful to learners as they analyse issues in depth at various stages of formative activity.

This Unit has the Critical Thinking component of Problem Solving embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 5.

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: Process Instrumentation: Practical Skills (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 practical knowledge and skills of calibration procedures and maintenance tasks used in a lot of industries, eg Oil and Gas and Manufacturing. In the Unit there is also investigation of simple control loops and how they would be installed into hazardous areas.

The early part of the Unit deals with the methods required to calibrate a range of instrument from pressure, level, flow and temperature used in industry. The next stage of the Unit deals with the control valve element of a control loop and the methods required to maintain these and simple process control loops they are used in and how they can be affected in a system. The final part of the Unit deals with the connection standards required in connecting up all the elements in a real life process control loop and the methods required to install some of the instruments and safety devices into a process control loop.

The assessment will comprise of a number of practical exercises that will test your knowledge and skills that will have been developed throughout the duration of the Unit. Assessments will also be evidenced by observation checklists and your reports.

Due to the highly practical nature of this Unit the learner will develop Core Skills in *Problem Solving* and *Working with Others*. Report writing will also lead to development of communication skills.