# Unit 039 Maintaining and testing process instrumentation and control devices

**Level:** 2
**Credit value:** 15
**NDAQ number:** 500/9514/6

**Unit aim**

This unit covers the skills and knowledge needed to prove the competences required to cover a broad range of activities covering the maintenance of process instrumentation and control devices. These competences will prepare the learner for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or they will provide a basis for the development of additional skills and occupational competences in the working environment.

The learner will be expected to prepare for the instrumentation and control maintenance activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how they intend to carry out the required maintenance activities and the sequence of operations they intend to use.

The learner will be required to select the appropriate equipment to use, based on the maintenance operations to be carried out and the type of instrumentation and control equipment being maintained, such as pressure, flow, level and temperature instruments, fiscal monitoring equipment, fire and gas detection and alarm systems, industrial weighing systems, speed measurement and control systems, vibration monitoring equipment, nucleonics and radiation measurement, telemetry systems and emergency shutdown systems.

The learner will be expected to use a variety of maintenance diagnostic techniques and procedures, such as gathering information from fault reports, using recognised fault finding techniques and diagnostic aids, measuring, inspecting and operating the equipment. The learner will also be expected to cover a range of maintenance activities, such as isolating and locking off, disconnecting, removing and reconnecting instruments and faulty peripheral components, setting and adjusting components, and testing the equipment, using appropriate techniques and procedures.

The learner's responsibilities will require them to comply with health and safety requirements and organisational policy and procedures for the instrumentation maintenance activities undertaken. The learner will need to take account of any potential difficulties or problems that may arise with the maintenance activities, and to seek appropriate help and advice in determining and implementing a suitable solution. The learner will work under a high level of supervision, whilst taking responsibility for their own actions and for the quality and accuracy of the work that they carry out.

The learner's knowledge will provide an understanding of their work, and will enable them to apply safely the appropriate maintenance techniques and procedures for process instrumentation and control equipment. The learner will understand the instrumentation maintenance process, and its application, and will know about the instrumentation and systems being maintained, and the tools and consumables used, to the required depth to provide a sound basis for carrying out the activities to the required specification.

The learner will understand the safety precautions required when carrying out the maintenance activities, (especially those for ensuring that the equipment is correctly isolated), and when using maintenance tools and equipment. The learner will be required to demonstrate safe working practices throughout, and will understand their responsibility for taking the necessary safeguards to protect themselves and others in the workplace.

**Learning outcomes**

There are **two** learning outcomes to this unit. The learner will be able to:

1. Maintaining and testing process instrumentation and control devices
2. Know how to maintain and test process instrumentation and control devices

**Guided learning hours**

It is recommended that **68** hours should be allocated for this unit, although patterns of delivery are likely to vary.

**Details of the relationship between the unit and relevant national standards**

This unit has been derived from national occupational standard Performing Engineering Operations Unit No. 39: Maintaining and testing process instrumentation and control devices (Suite 2).

**Support of the unit by a sector or other appropriate body**

This unit is endorsed by Semta.

**Assessment**

This unit must be assessed in a work environment and must be assessed in accordance with the 'Common Requirements for National Vocational Qualifications (NVQ) in the QCF' which can be downloaded from Semta's website:
**http://www.semta.org.uk/training_providers__awarding/national_occupational_standard/qca_assessment_requirements.aspx**

Additional assessment requirements have been published by Semta. These additional assessment requirements are set down in Semta's Performing Engineering Operations Level 2 unit assessment strategy which can be downloaded from Semta's website:
**http://www.semta.org.uk/training_providers__awarding/national_occupational_standard/qca_assessment_requirements.aspx**

**Unit specific additional assessment requirements:**

In order to prove their ability to combine different process instrumentation and control maintenance operations, at least one of the instrumentation maintenance activities carried out must be of a significant nature, and must cover a minimum of eight of the activities listed in assessment criteria 1.10.

# Unit 039 Maintaining and testing process instrumentation and control devices

## Outcome 1 Maintaining and testing process instrumentation and control devices

**Assessment criteria**

**Practical skills**
The learner will be able to:

1. work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
2. carry out all of the following during the instrumentation maintenance activities:
   - adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment and other relevant safety regulations
   - where appropriate, ensure the safe isolation of instruments (such as electrical, pneumatic, process)
   - follow job instructions, maintenance drawings and procedures
   - check that the tools and test instruments are within calibration date and are in a safe and usable condition
   - ensure that the equipment/system is kept free from foreign objects, dirt or other contamination
   - return all tools and equipment to the correct location on completion of the maintenance activities
3. carry out maintenance activities on **two** of the following types of instrumentation and control systems:
   - pressure
   - fluid level
   - fluid flow
   - temperature measurement
   - fire detection
   - gas detection
   - emergency shutdown
   - speed measurement
   - noise
   - vibration monitoring
   - nucleonic and radiation measurement
   - telemetry systems
   - weight measurement
   - alarm systems
4. plan the maintenance activities before they start them
5. obtain all the information they need for the safe removal and replacement of the instruments and/or sensors
6. obtain and prepare the appropriate tools and equipment
7. apply appropriate maintenance diagnostic techniques and procedures

8. use **four** of the following maintenance diagnostic techniques, tools and aids:
   - fault finding techniques (such as input/output, half-split, unit substitution)
   - diagnostic aids (such as manuals, flow charts, troubleshooting guides, maintenance records)
   - information gathered from the person who reported the fault
   - visual checks (such as signs of damage, leaks, missing parts, wear/deterioration)
   - movement checks (such as loose fittings and connections)
   - monitoring equipment or gauges
   - test instrumentation measurement (such as voltage, resistance, current)

9. use the appropriate methods and techniques to remove and replace the required instruments/sensors

10. carry out all of the following instrumentation maintenance activities:
    - removing excessive dirt and grime
    - taking electrostatic discharge (ESD) precautions (where appropriate)
    - disconnecting supply/signal connections
    - removing instruments from the system
    - dismantling equipment to the required level
    - labelling/marking of components
    - checking components for serviceability
    - replacing all 'lifed' items (such as seals, gaskets)
    - replacing instruments in the system
    - setting, aligning and adjusting components
    - tightening fastenings to the required torque
    - re-connecting instrumentation pipework and power supply
    - checking signal transmission is satisfactory
    - functionally testing the maintained equipment
    - replacing or repairing damaged/defective components (such as electrical, mechanical and back-up batteries)

11. use **four** of the following types of instrumentation test and calibration equipment:
    - signal sources
    - standard test gauges
    - analogue and digital meters
    - digital pressure indicators
    - calibrated flow meters
    - special-purpose test equipment
    - pressure sources
    - comparators
    - manometers
    - current injection devices
    - calibrated weights
    - logic probes
    - temperature baths
    - workshop potentiometers
    - dead weight testers
    - insulation testers

12. carry out tests on sensing elements and associated instruments

13. set up and test sensing elements and/or stand alone instruments, to include three of the following:
    - pressure (such as bourdon tube gauge, capsule/diaphragm gauge, pressure transducers)
    - temperature (such as thermocouple, resistance thermometers, liquid in steel thermometer)
    - flow (such as differential pressure systems, balanced flow meters, positive displacement)

- level (such as displacer systems, purged dip leg, capacitance probes, differential pressure systems, ultrasonic probes)
- other instruments/sensing elements (such as fire or gas detection, noise or vibration, speed or weight)

14. maintain instrumentation and control systems, in accordance with one or more of the following:
    - organisational guidelines and codes of practice
    - equipment manufacturer's operation range
    - BS and ISO standards

15. deal promptly and effectively with problems within their control, and seek help and guidance from the relevant people if they have problems that they cannot resolve
16. leave the work area in a safe and tidy condition on completion of the maintenance activities

# Unit 039 Maintaining and testing process instrumentation and control devices

## Outcome 2 Know how to maintain and test process instrumentation and control devices

**Assessment criteria**

**Underpinning knowledge**
The learner will be able to:

1. describe the health and safety requirements, and safe working practices and procedures required for the instrumentation maintenance activities undertaken
2. describe the isolation and lock-off procedure or permit-to-work procedure that applies to the system and instruments being worked on, and how to check that any stored energy in pipework and instruments has been released
3. describe the importance of wearing appropriate protective clothing and equipment, and keeping the work area safe and tidy
4. describe the hazards associated with carrying out instrumentation and control maintenance activities (such as live electrical components, process controller interface, stored pressure/force, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them
5. explain how to recognise and deal with victims of electric shock (to include methods of safely removing the victim from the power source, isolating the power source, and methods of first aid resuscitation)
6. describe the procedures and precautions to be adopted to eliminate electrostatic discharge (ESD)
7. explain how to obtain and interpret information from job instructions and other documents needed for the maintenance activities (such as drawings, circuit and physical layouts, charts, specifications, manufacturers' manuals, history/maintenance reports, symbols and terminology, BS and ISO wiring regulations)
8. describe the basic principles of operation of the instrumentation being maintained (to include pressure, temperature, level and flow instrument sensors)
9. explain how to identify the various instrument sensors (including how to identify their markings, calibration information, component values, operating parameters and working range)
10. describe the various maintenance diagnostic techniques and aids that can be used (such as fault reports, visual checks, measuring, movement and alignment checks, testing)
11. describe the various fault location techniques that can be used, and how they are applied (such as half-split, input-to-output, function testing, unit substitution, and equipment self-diagnostics)
12. explain how to use a range of fault diagnostic equipment to investigate the problem
13. describe the care, handling and application of instrumentation and control measuring instruments
14. describe the reasons for making sure that control systems are isolated or put into manual control, and that appropriate trip locks or keys are inserted, before removing any sensors or instruments from the system, and the consequences of failing to do this

15. describe the techniques used to dismantle/remove the equipment (such as release of pressures/force, proof marking to aid assembly, plugging exposed pipe/component openings, dealing with soldered joints, screwed, clamped and crimped connections)
16. describe the methods of attaching identification marks/labels to removed components or cables, to assist with reassembly
17. describe the methods of checking that components are fit for purpose, and the need to replace batteries, boards and other failed items
18. describe the correct way of re-fitting instruments to avoid faulty readings (such as caused by head correction, poor flow past the sensor, blockages, incorrect wiring, poor insulation or incorrect materials)
19. explain how to carry out visual checks of the instruments (such as security of joints and physical damage)
20. describe the need to carry out tests and calibration checks on the various sensing elements and stand alone instruments, and the use of standard calibration charts and tables
21. describe the types and application of standard test equipment (such as pressure sources, deadweight tester, temperature baths, signal sources and comparators)
22. explain how to check that tools and equipment are free from damage or defects and are in a safe and usable condition
23. describe the approved methods of carrying out the tests on each type of instrument/sensor; setting instrument zero readings; obtaining instrument readings and comparing them with the circuit parameters; making adjustments to instrument/circuit components
24. describe the generation of maintenance documentation and/or reports following the maintenance activity
25. describe the problems that can occur during the maintenance of the instrumentation and control system, and how they can be overcome
26. describe the organisational procedure to be adopted for the safe disposal of waste of all types of materials
27. explain when to act on their own initiative and when to seek help and advice from others
28. describe the importance of leaving the work area in a safe and clean condition on completion of the maintenance activities (such as returning tools and test equipment to is designated location, cleaning the work area, and removing and disposing of waste)