Unit 24: Industrial Process Measurement

NQF Level 3: BTEC National

Unit abstract

This unit will introduce learners to the principles involved in the operation, selection and calibration of transducers and signal processors used to measure a range of common industrial process variables. The methods of system and device construction and their specifications are investigated along with relevant calibration and documentation processes.

Learning outcome 1 considers the performance, operation and application of industrial transducer systems and the relationship between the physical principles of a transducer to its selection and application.

Learning outcome 2. Often there are requirements for signal processing once a transducer has been selected to ensure that the measurement system output meets specification. This unit provides a thorough background in the operation of signal processors and details the current systems that are available.

In many industrial process plants the process being measured can be some distance from the display systems, for example in a control room. Therefore signal transmission is required over distance. This unit identifies the variety of transmission systems and standards that are used within industrial plant.

For the purposes of this unit, measurement systems are assumed to consist of a transducer, signal processor and transmitter.

Learning outcome 4 of this unit relates to the requirements and techniques of system calibration. Learners will be able to use industrial procedures and standards in order to correctly calibrate such measurement systems.

Learning outcomes.

On completion of this unit a learner should:

1. Know about and select industrial transducer systems
2. Know about the operation and application of signal processing systems
3. Be able to examine a range of signal transmission and recording systems
4. Be able to select and use a range of equipment to test and calibrate instruments on process plant.

Unit content

1. Know about and select industrial transducer systems

System performance: accuracy; error; linearity; reliability; sensitivity; resolution; range; static and dynamic characteristics eg dead time, time constant, hysteresis, steady state.

Transducer types and operation: pressure eg diaphragm capsule, bellows, Bourdon tube, piezo-electric, manometers; level eg pressure gauges, DP cell transmitters, purged dip pipes, capacitive probes, ultrasonic, nucleonic, load cells, level switches; temperature eg thermocouples, metallic resistance thermometers, thermistors; flow eg Venturi, orifice plate, Pitot static tube, DP cell, conventional/smart electronic and pneumatic types, variable area, vortex, ultrasonic; nucleonic analysers eg alpha, beta, gamma, neutron; speed eg tachogenerator, radar; position eg linear/rotary potentiometer, absolute/incremental digital encoder, Linear Variable Differential Transducer (LVDT), resolver

Applications: selection of appropriate transducer in terms of process variable, system performance, environment and constraints

2. Know about the operation and application of signal processing systems

Signal converters: resistance to voltage eg potential divider, Wheatstone bridge; voltage to current; pressure to current; current to pressure; analogue to digital eg counter type, integrator type

Signal conditioners: signal standards eg 4–20 mA, 1–5 V, 3–15 psi, 20–100 Kpa; amplification eg simple op–amp arrangements, difference amplifier; attenuation; lineariser eg square root extractor; filters eg low pass, high pass

Applications: selection of appropriate signal processing system to meet system specification in terms of signal input and signal output

3. Be able to examine a range of signal transmission and recording systems

Transmission requirements: systems eg pressure transmission, analogue electrical transmission, digital transmission; electrical standards eg RS232, RS422; transmission devices eg multiplexers; selection of appropriate medium for transmission

Recording and display devices: analogue meters eg voltmeter, ammeter, pressure gauge; trend indicators eg hand held oscilloscope, chart recorder; computer system eg Supervisory Control and Data Acquisition (SCADA), Distributed Control Systems (DCS); specifications eg acquisition time, update speeds, resolution

4. Be able to select and use a range of equipment to test and calibrate instruments on process plant

Selection and use of equipment: instrumentation specifications to determine the system inputs and outputs (range, zero requirements, span); test and calibration equipment eg multi–meters, oscilloscope, data acquisition system

Test and calibrate: calibration of process transmitters eg pressure, level, temperature, flow, nucleonic, position, speed; calibration parameters (component specification, system requirements); recording and presentation of test and calibration results; calibration process eg standards, accuracy, methods,
documentation

Systems: process measurement eg vessel level, vessel pressure, air–flow supply in a bubbler system, furnace temperature

Grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

To achieve a pass grade the evidence must show that the learner is able to:

P1 define the terms relating to system performance
P2 describe a transducer type and its operation for each of pressure, level, temperature, flow, nucleonic, speed and position process variables
P3 select a transducer to meet a given application
P4 describe the operation and application of five different types of signal converter used in process measurement
P5 describe the operation and application of two common signal conditioning systems that can be found within process measurement
P6 identify and explain the signal transmission requirements for two different types of transducers
P7 select two common recordings and display devices that will meet given specifications
P8 select the equipment required to test and calibrate a given process measurement system
P9 test and calibrate a given process plant instrumentation system

To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:

M1 justify the choice of transducer to meet a given specification
M2 design a signal processing system to meet a given specification
M3 justify the choice of standard equipment for the calibration of given measuring systems.

To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:

D1 evaluate the performance of an industrial transmission and recording system
D2 document calibration results and evaluate the overall error in the measuring systems based on the individual accuracies of each element in the system