Title	**Demonstrate knowledge of process theory for industrial measurement and control processes and applications**		
Level	**5**	**Credits**	**15**

Purpose	This unit standard is intended for use in the training and assessment of industrial measurement and control. People credited with this unit standard are able to demonstrate knowledge of: – thermodynamic processes and their practical applications; – boiler turbine processes; – modes and applications of heat transfer; – the properties of steam under varying conditions and applications; – gas characteristics; – resistance to fluid flow as applied to a process application; and – process chemistry.

Classification	Industrial Measurement and Control > Industrial Measurement and Control - Theory

Available grade	Achieved

Guidance Information

1 This unit standard has been designed for learning and assessment off-job.

2 Definition
Industry practice – those practices that competent practitioners within the industry recognise as current industry best practice.

3 References
Kinsky, Roger. (1996) *Thermodynamics and fluid mechanics: an introduction.* Sydney: McGraw-Hill;
Kinsky, Roger. (1994) *Applied Fluid Mechanics*. Sydney; McGraw-Hill.

4 It is recommended that trainees have a minimum of NCEA Level 1 Mathematics or equivalent skills and knowledge.

5 These elements are intended to give trainees a broad knowledge base of the various processes that they may encounter.

6 Range
- a For purposes of assessment, all calculations must use Système International (SI) units.
- b Formulas for calculations are to be supplied for the assessments.
- c Use of calculators is permitted during assessments.
- d All activities and evidence presented for all outcomes and performance criteria in this unit standard must be in accordance with legislation, policies, procedures, ethical codes and standards, and industry practice; and where appropriate, manufacturers' instructions, specifications, and data sheets.

Outcomes and performance criteria

Outcome 1

Demonstrate knowledge of thermodynamic processes and their practical applications.

Performance criteria

1.1 Constant-volume and constant-pressure thermodynamics are described and the differences explained.

Range specific heat at constant pressure, specific pressure.

1.2 Ideal thermodynamic processes are explained in terms of pressure, volume, and temperature relationships for expansion and compression of gases.

Range isentropic, adiabatic, isothermal, polytropic.

1.3 Practical applications of processes are explained.

Range air conditioning, compression gas pressure reduction.

Outcome 2

Demonstrate knowledge of boiler turbine processes.

Performance criteria

2.1 Ideal thermodynamic cycles are described.

Range isothermal heating and cooling, adiabatic expansion and cooling, Carnot cycle power developed.

2.2 The difference between actual cycles and ideal cycles are compared and the differences explained.

Range boiler cycle, reheat, feed-heating, internal combustion engine, turbo charging.

2.3 Terms used in connection with combustion and fuels are defined.

Range ignition, self ignition, flame front, continuous combustion, detonation, knocking or pinging.

2.4 Concepts associated with air fuel ratio are described.

Range theoretical (stoichiometric) and actual air fuel ratio, lean mixture, rich mixture, primary air, secondary air, risk of explosion.

Outcome 3

Demonstrate knowledge of modes and applications of heat transfer.

Performance criteria

3.1 Modes of heat transfer are described in terms of the type of material and application.

Range modes of heat transfer – conduction, convection, radiation.

3.2 The overall heat transfer coefficient for conduction is explained with reference to thickness and thermal conductivity.

Range U = thermal conductivity/material thickness;
units – watts/metre^2 Kelvin.

3.3 Heat transfer by convection is described.

Range film coefficient, effect of fluid properties, fluid flow characteristics, forced and natural convection.

3.4 Types of heat exchangers and their configuration in industrial applications are described in terms of their characteristics.

Ranges types may include but are not limited to – plate, plate fin, shell and tube, phase change, direct contact, regenerative;
evidence of four is required.
configuration – counter flow, parallel flow.

3.5 Heat transfer effects in process elements are stated and explained.

Range boiler, condensing heat exchanger, spray drier.

3.6 Variation of energy radiated with reference to wavelength is outlined with regard to the change of emissive power.

Outcome 4

Demonstrate knowledge of the properties of steam under varying conditions and applications.

Performance criteria

4.1 Information given in steam tables is described and interpreted.

Range specific enthalpy, saturation temperature and pressure, enthalpy of vaporisation, specific volume.

4.2 Steam tables are used to estimate control requirements for process applications.

Range attemporating water flow for steam desuperheating, maximum steam flow required for condensing heat exchanger, fuel flow to meet boiler nominal full load.

Outcome 5

Demonstrate knowledge of gas characteristics.

Performance criteria

5.1 The meaning of compressibility of gases is explained.

5.2 Correction factors are applied to gas flow measurements.

Range pressure, temperature.

5.3 Capacities of air compressors and receivers are estimated on given compressed air usages.

5.4 The characteristics of two-phase fluid flow involving vapour in liquid, liquid in vapour, and slug flow are outlined and applications identified.

Outcome 6

Demonstrate knowledge of resistance to fluid flow as applied to a process application.

Performance criteria

6.1 Characteristics of fluid flow and the changes that occur with changing viscosity, conduit diameter, and fluid velocity are described.

6.2 Reynolds numbers are calculated to establish flow conditions.

Range turbulent, transitional, laminar.

6.3 The fluid properties of Newtonian and non-Newtonian fluids are compared and at least two examples of each are given.

6.4 Fluid flow pressure drop in pipework systems is estimated.

Range pipework – fittings, vessel inlet and outlet transitions;
estimated – calculations, charts, tables, nomograms.

6.5 Factors affecting fluid flow head loss are applied to practical fluid flow examples.

Range estimation of available head for control valve sizing, approximations used.

Outcome 7

Demonstrate knowledge of process chemistry.

Performance criteria

7.1 The effects of temperature, pressure, catalysts, and negative catalysts, on chemical reactions are outlined and implications explained.

7.2 The process of neutralisation is described.

Range titration curve, pH.

7.3 Basic principles of oxidation and reduction are outlined in terms of electron and chemical changes, with one example of each.

7.4 Properties of common process chemicals are described, and safety precautions required when working with these chemicals are stated.

Range H_2SO_4, HCl, HNO_3, NaOH, $Ca(OH)_2$.

Planned review date	31 December 2021

Status information and last date for assessment for superseded versions

Process	**Version**	**Date**	**Last Date for Assessment**
Registration	1	21 August 2009	N/A
Rollover and Revision	2	28 June 2018	N/A

Consent and Moderation Requirements (CMR) reference	0003

This CMR can be accessed at http://www.nzqa.govt.nz/framework/search/index.do.

Comments on this unit standard

Please contact The Skills Organisation reviewcomments@skills.org.nz if you wish to suggest changes to the content of this unit standard.