Title	Demonstrate and apply knowledge of electro, proportional, and servo hydraulic components and systems		
Level	5	Credits	20

Purpose	This unit standard has been developed for engineering maintenance personnel responsible for the servicing and maintenance of hydraulic components and systems components. People credited with this unit standard, are able to, demonstrate and apply knowledge of: hydraulic symbols, devices, components, circuits and terminology; the principles and operation of electro hydraulic components and circuitry; the principles and operation of proportional hydraulic components and circuitry; and the principles and operation of servo hydraulic components and circuitry.

Classification	Mechanical Engineering > Maintenance and Diagnostics in Mechanical Engineering

Available grade	Achieved

Entry information	
Recommended skills and knowledge	Unit 2727 *Service hydraulic power system components under supervision*, and Unit 2731 *Service hydraulic power system components*; or demonstrate equivalent knowledge and skills.

Explanatory notes

1 References
ISO 1219-1:2012, *Fluid power systems and components - Graphical symbols and circuit diagrams - Part 1: Graphical symbols for conventional use and data-processing applications*.
ISO 1219-2:2012, *Fluid power systems and components - Graphic symbols and circuit diagrams - Part 2: Circuit diagrams*.

2 Definitions
Industry practice – safe and sound practices generally accepted by competent trade persons within the hydraulics industry.
Trainers – kits, apparatus, or devices designed specifically to facilitate training.

3 Assessment notes

Relevant hydraulic circuit diagrams should be used to explain the operation of hydraulic systems and components.
Different scenarios and examples will be presented by assessors for assessment purposes.
All relevant formulas will be provided for the assessment purposes.
Use of software packages for calculation purposes is acceptable.
Practical exercises given should reflect the competency level required of a skilled maintenance technician/tradesmen.
All calculations and solutions to given practical applications (ER 1.5, 2.3, 3.12, and 4.8) should be verified by simulations on trainers or by using appropriate software packages (computer simulations).

Outcomes and evidence requirements

Outcome 1

Demonstrate and apply knowledge of hydraulic symbols, devices, components, circuits and terminology.

Evidence requirements

1.1 Hydraulic drawing symbols, devices, components, and circuits are identified from diagrams in accordance with ISO 1219.

Range devices and components include but are not limited to: hydraulic motors and pumps, directional control valves, actuating modes, pressure valves, flow valves, cylinders, energy transfer and pressure medium, measuring devices, electromechanical switch elements, contacts, sensors, solenoids, relay and contactors, solenoids, plug connectors.

1.2 Control circuit terminology is defined in accordance with industry practice.

Range includes but is not limited to – normally open contact, normally closed contact, changeover contact, limit switches, pressure switches, proximity sensors (inductive, capacitive, optical, and through-beam) reed switches, relays, contactors, solenoids (ac, dc, wet, dry), arcing, spark suppression, controllers, amplifiers, set point value cards.

1.3 Control technology terminology is defined in accordance with industry practice.

Range includes but is not limited to – signals – binary, analogue; valve actuation – switching valve, dynamic valve; block diagram – input signal, output signal, step response, transition function; signal flow diagram – series circuit, branch, junction, parallel circuit; test signals – transition function, ramp function; open loop and closed loop control, feedback.

1.4 Open loop and closed loop control circuits are compared.

Range form of signal, designation of signal flow, measurement of output signal, feedback of output signal.

1.5 Knowledge of hydraulic components and circuitry is applied to develop hydraulic circuits for given situations.

Range includes but is not limited to – direct solenoid activation, indirect solenoid activations, hydraulic control, electrical control, servo control.

Outcome 2

Demonstrate and apply knowledge of the principles and operation of electro hydraulic components and circuitry.

Range relevant hydraulic circuit diagram should aid the explanation.

Evidence requirements

2.1 The operation of a hydraulic drive using an electrical control system and switching valve is explained.

Range pressure relief and flow control, change in flow rate and flow direction, automation of pressure and flow control.

2.2 A series of experiments is conducted to demonstrate the operation of a hydraulic drive using an electrical control system and switching valve.

Range pressure relief and flow control, change in flow rate and flow direction, automation of pressure and flow control.

2.3 The principles and operation of electro hydraulic components and circuitry is applied to provide solutions to practical applications.

Range evidence of solutions to a minimum of eight given practical applications is required.

Outcome 3

Demonstrate and apply knowledge of the principles and operation of proportional hydraulic components and circuitry.

Range relevant hydraulic circuit diagram should aid the explanation.

Evidence requirements

3.1 The operation of a hydraulic feed drive using an electrical control system and proportional valves is explained.

Range pressure relief and flow control, change in flow rate and flow direction, automation of pressure and flow control, directional control.

3.2 The signal flow in proportional control hydraulics is described by sketching a labelled block schematic diagram showing all components of a typical system.

3.3 The advantages of proportional control valves over switching valves are explained.

Range adjustability of valves, effect on drives, effect on energy consumption, circuit simplification.

3.4 The design and operation of proportional solenoids are explained.

3.5 The mode of operation of a proportional solenoid is described by sketching a typical characteristic curve.

3.6 The operation of proportional pressure control valves and its actuation mechanism is explained.

3.7 The operation of proportional directional control valves together with its actuation mechanism is explained.

3.8 The advantages and disadvantages of pilot actuated proportional valves over directly actuated proportional valves are described.

3.9 The correlation between the overlap of the control signal edges and flow/signal function is described by sketching control signal and the flow/signal functions.

Range positive overlap, zero overlap, negative overlap.

3.10 The terms associated with and the functions of the switching mechanisms/processes using proportional valves are explained.

Range speed control: flow characteristics of proportional restrictors and directional control valve, load-dependent speed control with proportional directional control valves, load-independent speed control with proportional directional control valves and pressure balance, differential circuits, counter pressure;
leakage prevention;
positioning drives: rapid traverse/creep speed circuit;
energy saving measures: fixed displacement pump, variable displacement pump.

3.11 The purpose and advantages of using different types of control edges is described.

Range triangular, rectangular.

3.12 The principles and operation of proportional hydraulics components and circuitry is applied to provide solutions to practical applications.

Range evidence of solutions to a minimum of eight given practical applications is required.

Outcome 4

Demonstrate and apply knowledge of the principles and operation of servo hydraulic components and circuitry.

Range relevant hydraulic circuit diagram should aid the explanation.

Evidence requirements

4.1 The benefits of using servo valves are compared to those of proportional valves.

4.2 The variables in a hydraulic system controlled by means of servo valves are described and the characteristic curves are explained.

4.3 The usefulness of applying a positive overlap control signal to proportional valves is explained.

4.4 The purpose and advantages of using different types/shapes of control edges is described.

Range triangular, rectangular.

4.5 Closed loop control terminology and its function are described in accordance with industry practice.

Range control variable, reference variable, system deviation, correcting variable, final control element, controlled-system component, controlled system, interference variable, measuring system, stability and instability, steady-state behaviour, steady-state system deviation, dynamic behaviour, control quality, response to set point changes, response to interference, fixed-value control system, follow-up control system, timing control system, differentiation of a signal, integration of a signal;
block diagrams, circuits, and input/output/control/correcting signal waveforms may be used to support the explanation.

4.6 Closed loop control terminology is described and an explanation given on how control is achieved in practice using closed loop control circuits.

Range control systems with compensation – zero order controlled system, first order controlled system, second order controlled, controlled system with dead time;
control systems without compensation – zero order controlled system, first order controlled system, second order controlled, third order controlled system; operating point; controlled system gain; control factor; closed-loop gain; interference variable;
block diagrams, circuits, and input/output/control/correcting signal waveforms may be used to support the explanation.

4.7 Controllers and controller structures, their operations, and applications are described.

Range dynamic controllers – P (proportional) controller; I (integral-action) controller, D (derivative) controller;
non-dynamic controllers – three-step action, controller, two-step controller, multi-step controller; PI, PD, and PID controllers;
block diagrams, circuits, and waveforms may be used to support the explanation.

4.8 The principles and operation of servo hydraulics components and circuitry is applied to provide solutions to practical applications.

Range evidence of solutions to a minimum of eight given practical applications is required.

Planned review date	31 December 2018

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	18 July 2013	N/A

Consent and Moderation Requirements (CMR) reference	0013

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

Please note
Providers must be granted consent to assess against standards (accredited) by NZQA, before they can report credits from assessment against unit standards or deliver courses of study leading to that assessment.

Industry Training Organisations must be granted consent to assess against standards by NZQA before they can register credits from assessment against unit standards.

Providers and Industry Training Organisations, which have been granted consent and which are assessing against unit standards must engage with the moderation system that applies to those standards.

Requirements for consent to assess and an outline of the moderation system that applies to this standard are outlined in the Consent and Moderation Requirements (CMRs). The CMR also includes useful information about special requirements for organisations wishing to develop education and training programmes, such as minimum qualifications for tutors and assessors, and special resource requirements.

Comments on this unit standard

Please contact Competenz qualifications@competenz.org.nz if you wish to suggest changes to the content of this unit standard.