Title	**Demonstrate knowledge of pumps and pump selection for rural systems**		
Level	**4**	**Credits**	**6**

Purpose	This unit standard is for the people in the milking and pumping trades, and covers knowledge of pump selection for rural systems. People credited with this unit standard are able to demonstrate knowledge of – pump operations; pump shaft seals and materials; calculating total dynamic head of a pump system; pump performance and of pump operating curves and their application for centrifugal pumps; suction heads; pump performance when operating in series and parallel; characteristic curves of systems and variable speed or frequency drives (VFDs); characteristics of motors used to drive pumps; and motor starters and protection devices.

Classification	Mechanical Engineering > Dairy Systems Engineering

Available grade	Achieved

Recommended skills and knowledge	29158, *Demonstrate knowledge of basic hydraulic theory for rural fluid systems* or equivalent knowledge and skills.

Explanatory notes

1 References
Pump Industry Australia Incorporated *Australian Pump Technical Handbook,* 5th edition
Pump Industry Australia Incorporated *Australian Pipe Friction Handbook,* 4th edition
Grundfos Industry Solutions *Pump Handbook*. Available at http://net.grundfos.com/doc/webnet/mining/_downloads/pump-handbook.pdf
AS1477:2006, PVC pipes and fittings for pressure applications.

2 Definitions
BEP – best efficiency point.
Efficiency – effectiveness of the pump to convert motor power into the output of the pump measured hydraulically and is expressed as a percentage.
NPSH – net positive suction head.
NPSHr – net positive suction head required.
NPSHa – net positive suction head available.

3 Formulae

Pump efficiency:	eta = (SG x H x Q) / (102 x P) SG = specific gravity H = head in meters Q = flow in litres/sec P = power in kilowatts 102 = constant
Power:	Power = Voltage (Volts) x Current (Amperes)
NPSH for a static suction lift:	$NPSHa = H_A – H_{SL} – H_{FL} – H_{VP} - H_{SAFETY}$
NPSH for a static suction head:	$NPSHa = H_A + H_{SH} – H_{FL} – H_{VP} - H_{SAFETY}$ H_A = atmospheric pressure (use the figure based on the actual elevation above sea level) H_{SL} = the pump static suction lift H_{SH} = the pump static suction head H_{FL} = the suction pipeline friction losses H_{VP} = the water vapour pressure H_{SAFETY} = safety margin
Affinity Laws:	$Q_2 = Q_1 \times (N_2/N_1)$ $H_2 = H_1 \times (N_2/N_1)^2$ $P_2 = P_1 \times (N_2/N_1)^3$ N_1 = original pump speed N_2 = new pump speed Q_1 flow rate with pump speed N_1 Q_2 = flow rate with new pump speed N_2 H_1 = head with pump speed N_1 H_2= head with new pump speed N_2 P_1 = absorbed power with pump speed N_1 P_2 = absorbed power with new pump speed N_2

4 Assessment
Candidates are encouraged to refer to and use relevant literature and text such as any training manuals, relevant industry codes of practice, pipe flow charts, and standards.

Outcomes and evidence requirements

Outcome 1

Demonstrate knowledge of the principal of operations and applications of pumps.

Range positive displacement pumps – basic types such as reciprocating; rotary pumps such as flexible impeller, peristaltic, external gear, internal gear, progressive cavity;
kinetic pumps – centrifugal pumps such as the radial impeller, axial impeller, mixed flow impeller, double suction, open impeller; peripheral impeller.
Evidence of four pumps – two from each category is required.

Evidence requirements

1.1 The operating characteristics and application of positive displacement and centrifugal pumps are stated and compared.

1.2 Methods used to smooth the pulsating flow from a piston pump are stated.

1.3 The correlation between flowrate and pressure head produced by a centrifugal pump is explained.

Outcome 2

Demonstrate knowledge of pump shaft seals and pump materials.

Evidence requirements

2.1 Packed gland seals and mechanical seals are compared in terms of their application and relative merits.

2.2 O-ring and rubber bellows seals are compared in terms of their application and relative merits.

2.3 The materials for seals used in acidic conditions are stated.

2.4 Leaks or drips from seals are described in terms of volume and control.

2.5 Materials used for the construction of pump components are explained in terms of how the material is suited to the type of pump and the intended application.

Range evidence is required for a minimum of 3 different materials.

Outcome 3

Demonstrate knowledge of calculating total dynamic head of a pump system.

Evidence requirements

3.1 Factors that affect the total head of a pump system and the effect they have on the system are described.

Range factors include - static discharge head, static suction, friction head, residual pressure.

3.2 The factors for determining pipe losses are stated, and the relationship between flowrates and pipe head loss is described.

3.3 Pump heads are calculated.

Range evidence of two calculations for given specifications is required.

3.4 Head loss in pipeline fittings is calculated.

Range may include but not limited to bends, joiners, gate valves, foot valves, non-return valves, tees.
Evidence of calculations for three fittings is required.

Outcome 4

Demonstrate knowledge of pump performance and of pump operating curves and their application for centrifugal pumps.

Range pump operating curves may include - performance curve, efficiency curve, power curve, net positive suction head (NPSH) curve.

Evidence requirements

4.1 The effect altering flowrates has on the head of a centrifugal pump within a system is described.

4.2 The disadvantages of selecting a pump which is too large for the requirements are described.

4.3 Pump operating curves are used to determine efficiency, power, and NPSH.

4.4 Pump power for a given system is calculated using formula.

4.5 The effect on the power of a centrifugal pump when operated with little or no backpressure is described.

Outcome 5

Demonstrate knowledge of suction heads.

Evidence requirements

5.1 The force required to push water into a pump is stated.

5.2 The effects of changing altitudes on the pressure and boiling point of water are described.

5.3 NPSHr is defined and methods of deriving NPSHr and NPSHa are stated.

5.4 Implications of NPSHr greater than NPSHa and three methods of correcting the effect are described.

5.5 Cavitation is explained with examples of possible causes and solutions.

Outcome 6

Demonstrate knowledge of pump performance when operating in series and parallel.

Evidence requirements

6.1 Performance characteristics of pumps connected in series and in parallel are described.

Range performance characteristics - flowrate, discharge head, power.

6.2 The performance of a pump is calculated when changes are made to the pump parameters.

Range performance - flowrate, discharge head, power.

6.3 The characteristics of impeller trimming are described.

Outcome 7

Demonstrate knowledge of system curves and variable speed or frequency drives (VFDs).

Evidence requirements

7.1 A system curve is described.

7.2 A system curve is plotted for a specified system and the effect on the head of reducing the static suction lift for the curve is explained.

7.3 The purpose of a VFD is explained and the disadvantages of using a VFD are stated.

7.4 Factors to be considered when over-speeding a pump are described.

Outcome 8

Demonstrate knowledge of characteristics of motors used to drive pumps.

Evidence requirements

8.1 Power absorbed by the motor (input power to the motor) and the power absorbed by the pump are defined.

8.2 The relationship between voltage, current, and power is expressed mathematically and the units of measurement stated.

8.3 The nominal speeds of motors are matched to the relevant number of poles.

Range number of poles - 2, 4, 6, 8

8.4 The difference between rated current and start current is described.

8.5 The effects of operating a motor above the rated current are described.

8.6 The effects on the winding of a motor of exceeding the maximum temperature rating are stated.

8.7 The information provided by the ingress protection (IP) rating of motors is stated.

Outcome 9

Demonstrate knowledge of motor starters and protection devices.

Evidence requirements

9.1 The suitability of star-delta starting for pumps with low moment of inertia is explained.

9.2 Parameters controlled by autotransformer starters are stated.

9.3 Two advantages of using soft starters are stated.

9.4 Methods of starting motors are identified and their relative current draw stated.

Range – a minimum of three methods of starting motors.

9.5 The maximum ramp time to full speed when using electronic starters with submersible borehole pumps is stated.

9.6 Potential causes of motor failures are identified and described.

Range evidence is required of a minimum of three potential failures.

9.7 Phase failure protection and multi-function devices are explained in terms of how they protect motors.

Planned review date	31 December 2020

Status information and last date for assessment for superseded versions

Process	Version	Date	Last Date for Assessment
Registration	1	15 October 2015	N/A

Consent and Moderation Requirements (CMR) reference	CMR 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 (CMR). 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 the Competenz qualifications@competenz.org.nz if you wish to suggest changes to the content of this unit standard.