Unit 36: Fluids – Static and Dynamic in Building Services Engineering

Unit code: L/600/0371

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit develops learner knowledge and understanding of the properties and behaviour of fluids, both at rest and when flowing in pipe and ductwork systems, and the design of fluid flow systems.

Unit introduction

Although modern society relies heavily on the transport and use of fluids, putting fluids to use is not a modern phenomenon. In 300 BC the Chinese were using waterwheels to operate smelting bellows, and by the 9th Century air was being used in windmills in Persia to grind corn.

To make appropriate and efficient use of fluids it is crucial that we understand the properties of fluids and can describe, at least approximately, their behaviour under varying conditions. It is also necessary to control the flow of fluids under these varying conditions and be able to specify equipment capable of providing that control. This is true for many industries but it is especially true for the building services engineering industry. An understanding of the properties and behaviour of fluids is fundamental to the successful design of services installations.

Learners will understand that fluids can be usefully characterised by their state of motion, their state of compression and by their internal temperature. To understand how a static or moving fluid interacts with its immediate surroundings, such as a pipe, duct or vessel requires an understanding of the changes in energy, velocity, pressure, mass, volume and temperature within the fluid.

The two fluids most commonly transported and used today are water and air. This unit is predominantly concerned with the characteristics and behaviour of these two fluids, both when static and when in motion. The unit begins by exploring the fundamental properties of fluids, progresses to an analysis of the principles of fluids when flowing in pipes and ducts, and ends by relating these principles to commonly used design practices for building services installations.

Learning outcomes

On completion of this unit a learner should:

1 Know the properties and behaviour of fluids

2 Understand the theory and applications of static fluid systems

3 Be able to use the principles of dynamic fluid flow in pipes and ducts to solve problems

4 Understand the applications of basic principles to the design of fluid flow systems.

Unit content

1 Know the properties and behaviour of fluids

Physical properties: general definitions; associated units and notation; ideal fluids; real fluids; viscosity; flow (uniform, non-uniform, steady, unsteady, laminar, turbulent); boundary layers; variation of density with temperature; pressure; units of pressure; measurement of pressure (absolute, atmospheric, gauge)

Behaviour: static; flowing; fluid flow behaviour; use of Reynolds number to predict flow type

Fluids: compressible eg air; incompressible eg water

2 Understand the theory and applications of static fluid systems

Principles: pressure at any point in a liquid is equal in all directions; pressure at any two points at the same depth in a liquid is equal; liquids 'find their own level'; Pascal's principle; pressure expressed as 'metres head'; $P = \rho gh = wh$; depth of centre of pressure

Pressure recording devices: construction, operating principles and application of compound pressure gauges; barometers; simple piezometers; manometers (U-tube; differential pressure and inclined limb); fluids used in manometers; calculation of pressures in manometers containing different fluids and combinations of fluids

3 Be able to use the principles of dynamic fluid flow in pipes and ducts to solve problems

Principles: continuity of flow equation; forms of energy; principle of conservation of energy; steady flow energy equation; Bernoulli's equation; units and notation for potential energy, pressure energy and kinetic (velocity) energy; velocity of flow; volume flow rate; mass flow rate; viscosity and its effect on flow

Problems associated with pipes and ductwork: use of continuity flow equation to solve duct and pipe flow problems; use of steady flow equation to solve simple flow problems; use of Bernoulli's equation to solve problems relating to continuous flow systems; determination of flow arrangements through orifice contractions, pipe contractions and ductwork branches; application of Bernoulli's equation in orifice plate meter and venturi meter

4 Understand the applications of basic principles to the design of fluid flow systems

Factors contributing to energy losses: eg friction in straight pipes and ducts, turbulence caused by fittings and changes in direction and/or size of pipes and ducts

Energy losses in pipe and ductwork systems: energy loss in systems with laminar flow; solution of problems involving Poiseuille's equation (Hagen-Poiseuille's Law); energy loss in systems with turbulent flow; solution of problems involving use of D'Arcy and Chezy formula; use of friction coefficients; energy losses due to fittings; pressure loss factors for pipe and ductwork fittings; expressing fittings as equivalent lengths of pipe; solution of problems involving pressure loss due to fittings and changes in flow conditions

Pumps, fans and compressors: propeller, centrifugal and axial fans; liquid pumping devices; reciprocating compression devices and rotary compression devices; fan and pump performance curves; simple fan and pump laws; ways of changing performance; matching pumps and fans to pipe and ductwork systems; determining the duty point; connecting in series and parallel

Assessment and grading criteria

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

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify the physical properties of fluids [IE1, IE2, IE4, IE6]	**M1** use appropriate data and formulae to determine the physical properties of fluids	**D1** evaluate how the various factors, fundamentals and laws of fluid flow influence the design of building services systems and components
P2 describe the factors that affect the physical properties of fluids [IE1, IE2, IE4, IE6]		
P3 explain the principles that underpin the behaviour of static fluids [IE1, IE2, IE4, IE6, CT2, CT5, RL6]	**M2** determine the thrust acting in a liquid on a plane surface and locate the position of the depth of centre of pressure	
P4 explain the use of pressure recording devices [IE1, IE2, IE4, IE6, CT2, CT5, RL6]		
P5 apply basic principles to determine pressure in static fluid systems [IE1, IE2, IE4, IE6, CT2, CT5, RL6]		
P6 explain the principle of continuity of flow for fluids as applied to pipe and duct networks and components [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, RL6]	**M3** apply Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices	
P7 explain how the conservation of energy principle applies to flowing fluids [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, RL6]		
P8 apply Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, RL6]		

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P9 explain the factors contributing to energy loss in pipe and ductwork systems and how good design practice can minimise such losses [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, RL6]	**M4** determine the operational characteristics of fans and pumps.	**D2** justify the selection of fans, pumps and compressors.
P10 discuss energy losses in pipe and ductwork systems under turbulent and laminar flow conditions [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, SM2, SM3]		
P11 explain the operating principles of pumps, fans and compressors and how their performance can be altered. [IE1, IE2, IE4, IE6, CT2, CT5, RL2, RL3, SM2, SM3]		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills which are embedded in the assessment of this unit. By achieving the criteria, learners will have demonstrated effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add to the relevance of the subject.

The learning outcomes are related to the behaviour of fluids in systems. Although the main theme is fluid mechanics, learning outcome 1 provides an initial overview and general definitions, and learning outcomes 2, 3 and 4 deal with different aspects which develop in a logical sequence.

The focus of this unit is on linking scientific principles with the practical applications detailed in other units. The delivery and assessment of this unit should either be integrated or coordinated with the delivery of the appropriate sections of the practical units. The sequence of delivery for this unit and the design of the assessment instruments are likely to be influenced by the delivery and assessment of these related units.

Teaching and learning strategies designed to support delivery of the learning outcomes should take an integrated, learner-centred, investigative and supervised, hands-on, experiential learning approach. Practical activities should be used whenever possible. This would involve learners taking measurements, making observations, consulting standards, making decisions and suggesting alternatives. Calculations are part of all learning outcomes but the unit should not be seen as a mathematical exercise. Delivery should balance calculations, knowledge and understanding. Calculations used to support the delivery process should always reflect real-life and standard practice.

Group activities are permissible, but tutors will need to ensure that individual learners have equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken before practical activities are taken. Centres are advised to read the *Delivery approach* section in the specification, and *Annexe H: Provision and Use of Work Equipment Regulations 1998 (PUWER).*

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to unit content and grading criteria
Overview of fluids and fluid flow: Learner exercise to identify fluids used in building services engineering, conduits through which fluids flow, devices that influence fluid flow
Explanation, definitions and consequences of incompressible and compressible fluids
Explanation of the significance of density (and specific volume) of fluids and their variation with temperature. Units and notation
Learners practise determining variations in density and volume with changes in temperature, conversions from mass flow rate to volumetric flow rates at constant pressure
Explanation, definitions and units used for fluid pressure, (multiples and submultiples) Atmospheric pressure: what is it and why it varies, standard values for atmospheric pressure. Expressing pressures (gauge and absolute)
Learners practise determining pressures, converting units and expressing same in various multiples and submultiples
Explanation and illustrations of viscosity, definition of units and notation for dynamic and kinematic viscosity. Ideal and real fluids as related to inviscid and viscous flow
Types of flow: explanations, examples and illustrations of uniform and non-uniform, steady and unsteady flow. Explanations, illustrations and significance of laminar and turbulent flow, boundary layers and their effect on the flow of fluids in pipes and ducts
Use of Reynolds number as a mechanism for predicting laminar and turbulent flow
Learners practise calculating Reynolds number from given data
Explanation and illustration of Pascal's principle. Calculation of pressure in static fluid columns subjected to gravity. Use and application of 'metres head' as an expression of pressure, converting between metres head and other SI pressure units
Pressure measuring devices as an application of Pascal's principle. Construction and operating principles of piezometers, U-tube manometers and their variants (single tube, inclined limb, differential manometers/piezometers etc). Calculation of pressure from manometer readings with different liquids and combinations of liquid
Practical applications of different types of manometers
Types of barometers to measure atmospheric pressure. Calculation of atmospheric pressure from Torricelli, Fortin or similar barometers
Learners practise calculating pressures due to static fluid for a variety of fluids

Topic and suggested assignments/activities and/assessment
Assignment 1: Physical Properties and Behaviour of Fluids
Introduction to the continuity of flow principle. Continuity of flow equation expressed for virtually incompressible and compressible fluids (continuity of mass)
Learners practise calculating flow rates (volumetric and mass) and velocities for given pipe and/or duct configurations
Identification of energy forms in a flowing fluid, use of steady flow energy equation to identify total energy at a given point. Importance of expressing energy forms in the same units. Conservation of energy theory for friction free flow
Explanation and application of Bernoulli's equation in building services engineering applications. Use of Bernoulli's equation for solving simple problems
Applications which combine continuity of flow with Bernoulli's principle eg venturimeter, orifice plates, static regain at duct branches. Developing basic formula for such devices
Learners practise problem solving using Bernoulli's equation for various applications
Assignment 2: Static Fluid Systems
Importance of being able to predict total energy loss in building services pipe and ductwork systems. Identification of causes of pressure loss across pipework circuits and ductwork systems.
Pressure loss in straight pipe and ducts, identification of factors which contribute to energy losses in systems with turbulent flow. Use of D'Arcy equation to predict pressure and/or head loss in pipes and ducts. The significance of the friction factor in D'Arcy's formula, identifying factors which affect it and recognition of different methods for obtaining it
Identification of factors which contribute to energy losses in systems with laminar flow
Use of Poiseuille's equation to determine friction factor and to predict pressure loss for pipes or ducts with laminar flow
Learners practise determining predicted pressure loss for pipework and ducts under laminar and turbulent flow conditions with different flow rates, pipe sizes and materials
Introduction to open channel gravitational flow and their applications within building services engineering. Use of Chezy formula for determining velocity in channels
Pressure loss from pipe and ductwork fittings, components and changes in flow conditions Identification of turbulence as the cause of additional pressure energy loss in pipe and duct systems. Techniques for minimising turbulence in pipe and duct systems
Calculation of loss in total pressure loss due to fittings, using basic formula. Significance of pressure loss factors (ζ) for different fittings. Difficulties in obtaining reliable values for pressure loss factors. Equivalent length of pipe concept to allow for the effect of fittings
Learners practise determining the predicted pressure loss due to fittings and components for various fittings, fluids and flow rates

Topic and suggested assignments/activities and/assessment
Assignment 3: Dynamic Fluid Flow
Operational characteristics, principles, features and laws for simple propeller, centrifugal and axial flow fans used in building services applications
Operational characteristics, principles, features and laws for simple centrifugal pumps used in building services applications. Understanding and interpreting manufacturers' pump and fan performance curves
Operational characteristics, principles, features and laws for simple reciprocating and rotary compressors used in building services applications
Study of the simple relationships between rotational speed, diameter, pressure, flow rate and power via the basic fan and pump laws. Plotting system curves and determining the duty or operating point. Effect of different pump/fan connection arrangements
Learners practise plotting system curves, obtaining data from manufacturers charts and solving problems using pump and fan laws
Assignment 4: Design of Fluid Flow Systems
Review of unit and assignment feedback

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments. There are many suitable forms of assessment that could be used, and tutors are encouraged to consider and adopt these where appropriate. Some example assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used then suitable evidence would be observation records or witness statements.

The structure of the unit suggests that the grading criteria could be addressed fully by using four assignments. The first of these would cover P1, P2 and M1, the second would cover P3, P4, P5 and M2, the third would cover P6, P7, P8, M3 and D2, and the fourth P9, P10, P11, M4 and D2.

To achieve a pass grade learners must meet the 11 pass criteria listed in the grading grid.

For P1, learners must identify the physical properties of fluids. There is no requirement for a description of the properties, or any explanation of the importance of each, but the range of properties identified should be satisfactory to support the treatment of fluids that follows.

For P2, learners must describe the factors that affect the physical properties of fluids. The description should include the distinction between ideal and real fluids, a definition of viscosity and its effect, units of viscosity, the distinction between steady, unsteady, laminar and turbulent flow, the implications of these types of flow, the formation of boundary layers, and pressure in fluids, units of pressure, measurement of pressure. Evidence could be in the form of a presentation or report.

For P3, learners must explain the principles that underpin the behaviour of static fluids. This must refer to the laws that govern their behaviour and which determine pressure due to static fluids. They must explain Pascal's principle and illustrate the principle via building services-related applications.

For P4, learners must explain the use of pressure recording devices. They should be able to explain how each device works in terms of the physical properties identified in P1, described in P2 and explained in P3.

For P5, learners must apply basic principles to determine pressures at given points in a static fluid system and calculate pressures indicated on various types of manometers, using various manometer liquids. Answers to the calculations should be substantially correct but small errors in calculation are acceptable if they are corrected after feedback from the tutor. Evidence for P5 could be in the form of a presentation or report supported by appropriate calculations and practical notes.

For P6, learners must explain the principle of continuity of flow for fluids as applied to pipe and duct networks and components. This should include an explanation of the continuity of flow principle as it applies to both compressible and incompressible fluids.

For P7, learners must explain how the conservation of energy principle applies to flowing fluids. This should include an explanation of the different forms of energy in a flowing fluid and the continuity of energy principle as provided in Bernoulli's equation. Although at this stage learners are not required to use the continuity of flow equation or the Bernoulli equation to solve problems, they are expected to give more than mechanistic definitions or reproduced equations. Learners should show that they understand the concepts that are contained within these equations and principles, and how and where they can be applied to provide solutions in various flowing fluid systems.

For P8, learners must apply Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices. This should include the application of Bernoulli's theorem to determine flow arrangements through orifice contractions, pipe contractions and ductwork branches, and the use of orifice plate meters and venturi meters to determine flow rates in fluids.

For P9, learners must explain the factors contributing to the energy loss in pipe and ductwork systems and how good design practice can minimise such losses. This should include recognition of why losses in straight pipes and ducts are different to those caused by fittings, changes of direction and components.

For P10, learners must discuss energy losses in pipe and ductwork systems under turbulent and laminar flow conditions. They should include why energy losses associated with laminar flow are different from those associated with turbulent flow in the same pipe or duct. An explanation of the different factors, constants and variables that contribute to energy losses in a pipe or ductwork system is also required. Although at this stage learners are not required to use energy loss equations to solve problems, they are expected to give more than mechanistic definitions or reproduced equations. Learners should show that they understand the concepts contained within these equations and principles, and how and where they can be applied to provide solutions in various flowing fluid systems. Evidence could be in the form of a written report.

For P11, learners must explain the operating principles of compression devices, fans and liquid pumping devices. This should include the construction, physical features and operating characteristics of the various devices. Learners should explain the performance characteristics appropriate to the various devices, such as flow/pressure (head) relationship, efficiency, power and net positive suction head (npsh). Learners may use manufacturers' performance curves and data but they must show that they understand the concepts contained within this information and how this data can be applied to match the device to the requirements of the system it is installed in. Drawings should be used to support the explanation.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must use appropriate data and formulae to determine the physical properties of fluids. They should select the data from appropriate sources and include calculation of pressure, density of fluids and Reynolds number. Answers to the calculations should be substantially correct, but small errors in calculations are acceptable if they are corrected after feedback from the tutor. This is a natural extension of the work completed in P1 and P2.

For M2, learners must determine the thrust acting in a liquid on a plane surface and locate the position of the depth of centre of pressure. The plane surface in question may be horizontal, vertical or sloping. All workings should be shown and the correct unit should be used throughout.

For M3, learners must apply Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices. The problems provided should be related to practical building services applications that reflect learners' own fields of building services. The answers to the calculations should be substantially correct, but small errors in calculation are acceptable if they are corrected after feedback from the tutor. This could be a natural extension of the work completed in P6, P7 and P8.

For M4, learners must determine the operational characteristics of fans and pumps. They will need to analyse data and apply formulae in order to achieve this criterion. Problems should reflect real-life situations and standard practices associated with realistic pipe and ductwork installations, as encountered in everyday building services installations. This could include determining the resistances of index circuits to specify fan and pump duties, additional resistances to balance branches and sub-circuits (including energy loss due to fittings and changes in direction). This should not be a mechanistic application of rules and procedures. In producing these solutions learners should show their understanding of the principles of energy loss in pipe and duct systems.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must evaluate how the various factors that affect fluid flow influence the design of building services installations. This evaluation should not only include installations where different fluid flow situations occur, it must also evaluate how fluid flow principles influence design and performance of installations and equipment. Learners might evaluate why specific design criteria are used for a particular pipe or ductwork installation, how design data, which would otherwise have to be calculated, is made readily available to designers, how knowledge and applications of the principles of fluid flow can minimise pump and fan duties, and how commissioning equipment and instruments have evolved to be more effective or how they might be improved. It is strongly recommended that these should be contextualised through realistic practical applications taken from learners' own fields of building services engineering.

For D2, learners must justify the selection of fans, pumps and/or compressors in terms of design data and operating principles. As part of the justification, learners are expected to make links with appropriate underpinning principles. Selections must be supported by appropriate calculations, such as those used to plot system curves and apply fan and pump laws to determine operating performance requirements. Learners must also make appropriate use of manufacturers' data and select a range of plant commensurate to their field of building services engineering. Learners should cover at least two of the three devices ie fans, pumps and compressors.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Physical Properties and Behaviour of Fluids	As a training officer, you have been asked to provide a training manual for trainee engineers. This comes in four parts and should be used to link principles and practical details to real-life installations, wherever possible. Exemplar calculations should be included throughout.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.
P3, P4, P5, M2	Static Fluid Systems	As above.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.
P6, P7, P8, M3, D1	Dynamic Fluid Flow	As above.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.
P9, P10, P11, M4, D2	Design of Fluid Flow Systems	As above.	Manual, report and/or presentation to include text, images, calculations, graphs, tables and charts as appropriate.

Links to other National Occupational Standards, BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Construction and the Built Environment sector suite. This unit has particular links with the following unit titles in the Construction and the Built Environment suite:

Level 1	Level 2	Level 3
		Low Temperature Hot Water Heating in Building Services Engineering
		Ventilation and Air Conditioning Design in Building Services Engineering
		Refrigeration Technology in Building Services Engineering
		Plumbing Technology in Building Services Engineering

The learning outcomes in this unit are closely linked with similar units at Higher National and degree level.

Essential resources

Equipment which gives learners hands-on experience of observing and measuring processes, such as venturi meters, pressure loss in pipe/duct, laminar and turbulent flow, pressure measuring equipment, pump performance, while not essential would be advantageous. Centres are encouraged to use as much practical science as possible. While specialist laboratory hydraulic test benches are very useful, some of these specialist units can be expensive but many items can be improvised at a lower cost. Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for all demonstrations and experiments used in the delivery or assessment of the unit.

Employer Engagement and Vocational Contexts

Support to enable centres to initiate and establish links to industry, and to networks arranging visits to industry and from property practitioners is given below:

- Chartered Institution of Building Services Engineering – www.cibse.org
- Heating and Ventilation Contractors Association – www.hvca.org.uk
- Learning and Skills Network – www.vocationallearning.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- The Royal Institution of Chartered Surveyors – www.rics.org
- Summit Skill – www.summitskills.org.uk
- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI University of Warwick) – www.warwick.ac.uk/wie/cei/

Indicative reading for learners

Textbooks

Eastop T and McConkey A – *Applied Thermodynamics for Engineering Technologists, 5th Edition* (Longman, 1993) ISBN 0582091934

Rogers G and Mayhew Y – *Thermodynamics and Transport Properties of Fluids, 5th Edition* (Basil Blackwell, 1994) ISBN 0631197036

Sherwin K and Horsley M – *Thermofluids* (Spon Press, 1995) ISBN 0412598000

Journals

Journal of Fluids Engineering (ASME) – The Johns Hopkins University

Journal of Fluid Mechanics – Cambridge Journals

Physics of Fluids – American Institute of Physics

Websites

www.bmtfm.com	BMT Fluid Mechanics
www.efunda.com/formulae/fluids	Engineering Fundamentals

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS that have been included within the assessment criteria of this unit:

Skill	When learners are …
Independent enquirers	identifying the physical properties of fluids, describing the factors that affect the physical properties of fluids explaining the principles that underpin the behaviour of static fluids explaining the use of pressure recording devices applying basic principles to determine pressure in static fluid systems explaining the principle of continuity of flow for fluids as applied to pipe and duct networks and components explaining how the conservation of energy principle applies to flowing fluids applying Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices explaining the factors contributing to the energy loss in pipe and ductwork systems and how good design practice can minimise such losses analysing energy losses in pipe and ductwork systems under turbulent and laminar flow conditions and explaining the operating principles of pumps, fans and compressors and how their performance can be altered
Creative thinkers	explaining the principles that underpin the behaviour of static fluids explaining the use of pressure recording devices applying basic principles to determine pressure in static fluid systems explaining the principle of continuity of flow for fluids as applied to pipe and duct networks and components explaining how the conservation of energy principle applies to flowing fluids, applying Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices explaining the factors contributing to the energy loss in pipe and ductwork systems and how good design practice can minimise such losses analysing energy losses in pipe and ductwork systems under turbulent and laminar flow conditions and explaining the operating principles of pumps, fans and compressors and how their performance can be altered

Skill	When learners are …
Reflective learners	explaining the principles that underpin the behaviour of static fluids explaining the use of pressure recording devices applying basic principles to determine pressure in static fluid systems explaining the principle of continuity of flow for fluids as applied to pipe and duct networks and components explaining how the conservation of energy principle applies to flowing fluids, applying Bernoulli's equation to solve simple problems associated with pipe and ductwork systems and devices explaining the factors contributing to the energy loss in pipe and ductwork systems and how good design practice can minimise such losses analysing energy losses in pipe and ductwork systems under turbulent and laminar flow conditions and explaining the operating principles of pumps, fans and compressors and how their performance can be altered
Self-managers	analysing energy losses in pipe and ductwork systems under turbulent and laminar flow conditions and explaining the operating principles of pumps, fans and compressors and how their performance can be altered.

Functional Skills – Level 2

Skill	When learners are …
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	researching fluid mechanics and planning their assignment work
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching fluid mechanics and planning their assignment work
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	presenting their reports for assignment work, using text, tables, calculations, charts, graphs and images as appropriate
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	using email to communicate with other learners and the tutor
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	performing calculations on: • physical properties of fluids • pressures and thrusts in static fluids • energy components of fluids in motion • energy losses in pipes and ducts • results of orifice plate and venturi meters • selection of fans, pumps and compressors
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	

Skill	When learners are …
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	gathering information for use in assignments and to support their studies
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	presenting their reports for the assignment work