

Unit 2: Understanding and Working with Land-based Vehicle Engine Technology

Unit code:	J/601/4267
QCF Level 3:	BTEC National
Credit value:	10
Guided learning hours:	60

● Aim and purpose

This unit aims to introduce learners to the skills and knowledge in vehicle engine technology and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

● Unit introduction

Recent developments in engine design have led to improvements in efficiency, performance and exhaust emissions. Manufacturers are developing engines to meet the new emission tiers, whilst improving performance for a given size of engine further. This has mainly been as a result of developments in the combustion process, the introduction of the common rail fuel system and monitoring the engine performance using a variety of electronic control units.

In this unit learners will develop the knowledge and skills needed to understand the construction, function and operation of compression ignition (CI) and spark ignition (SI) engines commonly used in land-based machinery and to support the need for accurate fault diagnosis and repair of land-based engines.

Learners will also develop an understanding of engine systems and their relationship to improvements in efficiency, performance and exhaust emissions.

● Learning outcomes

On completion of this unit a learner should:

- 1 Understand the construction and operation of commonly used land-based vehicle compression ignition and spark ignition engines
- 2 Understand the construction and operation of associated land-based vehicle engine ancillary systems
- 3 Be able to test and diagnose faults in land-based vehicle engines and their ancillary systems
- 4 Be able to maintain and repair land-based vehicle engines and their ancillary systems.

Unit content

1 Understand the construction and operation of commonly used land-based vehicle compression ignition and spark ignition engines

Cycles of operation: two-stroke spark ignition; four-stroke compression and spark ignition

Internal combustion engines: compression ignition (CI); spark ignition (SI); naturally aspirated; turbo-charged

Engine terminology: valve timing diagrams; compression ratio; compression pressure; combustion pressure; volumetric efficiency; swept volume; engine capacity

Engine characteristics: speed; power; torque; noise levels; economy; exhaust emissions

Engine components: cylinder block components (engine block, crankshaft, con-rods, pistons, piston rings); cylinder liners eg wet, dry; timing drives, flywheel, balancer units; cylinder head components eg cylinder head, head gasket, valve guides, inlet and exhaust manifolds; valve train eg camshaft, cam followers; pushrods; rocker shaft, rocker arms; valves, valve springs

2 Understand the construction and operation of associated land-based vehicle engine ancillary systems

Lubrication system: function; sump; pump; pressure relief valve; filter; oil cooler; oil flow diagram; lubricant properties; advantages and disadvantages of different systems; common causes of system failure

Cooling system: function; air cooling systems eg fans, ducting, fins; liquid cooling systems eg radiator, expansion tank, pressure cap, water pump, fan and belt, electric fan, viscous fan; thermostat, hoses, coolant circulation, anti-freeze; cab heater; advantages and disadvantages of different systems; common causes of system failure

Fuel systems: function; diesel fuel eg fuel tank, sedimenters, agglomerators, water stops, lift pumps, priming pumps, in-line fuel injection pumps, rotary fuel injection pumps, pressure/time fuel systems, common rail fuel systems, fuel injectors, cold start aids, air filtration, air filter restriction indicators; petrol fuel eg fuel tank, sedimenter, lift pump, fuel filter, carburettor, petrol fuel injection systems, air filtration; advantages and disadvantages of different systems; common causes of system failure

Ignition systems: function; magneto ignition system eg flywheel, coil, contact breakers, condenser, primary circuit, secondary circuit, sparking plug; coil ignition system eg battery, coil, ignition switch, contact breakers, condenser, electronic ignition module, primary circuit, secondary circuit, distributor cap, rotor arm, sparking plug; advantages and disadvantages of different systems; common causes of system failure

3 Be able to test and diagnose faults in land-based vehicle engines and their ancillary systems

Fault testing and diagnosis: methods used to test systems and/or identify faulty components eg visual, road test, electronic; use of appropriate equipment eg dynamometer, compression cylinder leakage tester, fuel injection testing equipment, engine oil pressure and temperature gauges, coolant system leakage testers, exhaust gas analysis; use of 'on-board' and remote ICT test equipment; methods used to analyse test data; use of manufacturers' service manuals and data; health and safety; risk assessment; relevant, current legislation

4 Be able to maintain and repair land-based vehicle engines and their ancillary systems

Maintain and repair engines and ancillary systems: reasons for maintenance, servicing and repair; use of manufacturers' service manuals and data; methods used to maintain, service and repair or replace engines and ancillary systems as per manufacturers' instructions; methods used to check the integrity of maintenance, service and repair activities; health and safety; risk assessment; relevant current legislation

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 explain the construction and operation of a compression ignition engine [CT, IE, SM]	M1 explain valid reasons for the likely failure of components identified in selected engines and ancillary systems	D1 compare selected compression ignition engines and selected spark ignition engines in terms of their characteristics
P2 explain the construction and operation of a spark ignition engine; both two and four stroke [CT, IE, SM]		
P3 explain the construction and operation of the lubrication system [CT, IE, SM]	M2 compare the construction and operation of selected ancillary systems	
P4 explain the construction and operation of the cooling system; both air and liquid [CT, IE, SM]		
P5 explain the construction and operation of the fuel system; both diesel and petrol [CT, IE, SM]		
P6 explain the construction and operation of the electrical system [CT, IE, SM]		

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:
P7 safely carry out testing procedures using manufacturers' service data [SM, EP, TW]	M3 inspect and measure selected individual engine components for wear and determine their serviceability using manufacturers' data	D2 analyse engine fault diagnosis test results and explain why the symptoms displayed would cause the results found during testing.
P8 report on status of engine and ancillary equipment [SM, CT, IE, RL]		
P9 safely carry out (using manufacturers' service data) routine maintenance of engines and associated ancillary equipment [SM, EP, TW]	M4 explain the importance of regular maintenance and the possible results of not following manufacturer's service schedules.	
P10 safely service and repair selected land-based engines and ancillary equipment. [SM, EP, TW]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate 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

For P1 and P2, learners must provide information on the construction and operation of land-based vehicle engines. Tutors should identify the engines or agree them through discussion with learners. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence could be in the form of a project, report or presentation.

For P3, P4, P5 and P6, learners must provide information on the construction and operation of selected land-based vehicle engine ancillary systems. Tutors should identify the systems or agree them through discussion with learners. The systems may be associated with an engine used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

For P9 and P10 learners are required to carry out maintenance as per the 10, 50, 250, 500 and 1000 hour service schedules as appropriate. Learners must consider the disposal of waste oils and used components in line with current environmental guidelines and legislation.

P7, P8, P9 and P10 could be assessed directly by the tutor during practical activities. If this format is used then suitable evidence from guided activities would be observation records completed by learners and the tutor, and accompanied by appropriate worklogs or other relevant learner notes. If assessed during a placement, witness statements should be provided by a suitable representative and verified by the tutor. Alternatively, evidence for this could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated poster or written assignment.

For M1, learners must provide information on reasons for failure of engines. The engines may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence may be in the same form as for P1.

For M2, learners must compare the construction and operation of selected compression ignition engines with that of selected spark ancillary systems. Tutors should identify the engines and the tests required, or agree them through discussion with learners. The engines may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence may be in the same form as for P1.

M3 requires learners to inspect and measure selected individual engine components for wear and determine their serviceability using manufacturers' data. Ancillary systems can be included in learners' evidence. It is expected that, as a minimum, learners will provide evidence for three components. Tutors should identify the components or agree them through discussion with learners. The components may be the same as those used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners. Evidence could be in the same form as for P1.

M4 requires learners to explain the importance of regular maintenance and the possible results of not following manufacturer's service schedules. Learners are expected to cover at least three scenarios. Evidence could be in the same form as for P1.

For D1, learners must compare selected compression ignition engines and selected spark ignition engines in terms of their power and torque characteristics, exhaust emissions, fuel consumption and operational speeds. Evidence could take the form of a pictorial presentation with notes (possibly using appropriate software or an overhead projector), an annotated or a written assignment.

For D2, learners must analyse engine fault diagnosis test results and explain why the symptoms displayed would cause the results found during testing. Learners are expected to provide evidence covering each type

of ancillary system, ie a lubrication system, a cooling system, a fuel system and an ignition system, listed in the unit content. Evidence could be in the same form as for D1.

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 gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction to the unit including safety induction to workshop practices.
Dismantle engines and ancillary systems.
Assignment 1: Engine Construction Characteristics (P1, P2, P3, P4, P5, P6, M1, M2, D1) introduction to assignment Practical investigation of engines/ancillary systems. Learner-centred research.
Assignment 2: Engine Service Test and Repair (P7, P8, P9, P10, M3, M4, D2) Introduction to assignment Practical testing and repair. Learner-centred research and analysis.
Unit review.

Assessment

For P1 and P2, learners are required to explain the construction and operation of the two and four stroke cycles for spark ignition engines and the four stroke cycle for a compression ignition engine.

For P3, P4, P5 and P6, learners should be assessed verbally during practical investigations of the constructional differences of engines and their ancillary systems. Evidence could be in the form of a written assignment based on their findings, for example the oil flow through a particular engine could be investigated and a block and line diagram produced with a description, or this could directly assessed during the practical activity. The same format could be used for fuel, cooling and electrical systems. The size and complexity of the task should be the same for all learners.

For M1, learners need to investigate an engine and its ancillary systems and produce a list of components most likely to fail and explain possible reasons for this. This could be evidenced through a written assignment task. The size and complexity of the task should be the same for all learners.

For M2 and D1, learners need to research the engine ancillary systems used by two manufacturers and compare their construction and operation. This could be evidenced through a written assignment or through evidence collected during a practical activity. The size and complexity of the task should be the same for all learners.

For P7 and P8, learners are required to carry out testing procedures on engines and ancillary systems and report on the status of the engine. This could link with M1 and D2. The evidence for this should be gathered during practical activities. The size and complexity of the task should be the same for all learners.

For M3, learners are required to inspect and measure a minimum of three engine components, compare with manufacturers' service data and determine their serviceability. This could be assessed directly during

practical activity or through a written assignment task. The size and complexity of the task should be the same for all learners.

For P9, P10 and M4, learners are required to carry out and provide information on servicing and repair on selected engines and ancillary systems. This should be assessed directly during the practical activity. The size and complexity of the task should be the same for all learners.

For D2, learners are required to analyse the results of the tests carried out for P7 and P8 and explain why the results of the tests would reflect the symptoms shown by the engine or ancillary system. This could be produced as a written assignment task. The size and complexity of the task should be the same for all learners.

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, P3, P4, P5, P6, M1, M2, D1	Engine Construction Characteristics	Learners will need to research two and four stroke cycles for both SI and CI engines. Learners will carry out a practical investigation of the constructional differences of engines and their ancillary systems. Learners will need to carry out associated research into engine characteristics and produce their results in the form of a written assignment.	Written assignment. Practical assessment. Research/written report.
P7, P8, P9, P10, M3, M4, D2	Engine Service, Test and Repair	Learners are required to carry out engine testing and report on engine status. Learners are required to carry out routine service and repair to land-based vehicle engines. Learners will need to carry out measuring tasks and compare the results with manufacturers' specifications and report their results.	Practical. Written report.

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

This unit forms part of the BTEC land-based sector suite. This unit has particular links with:

Level 2	Level 3
Land-based Engineering Operations – Carry out Servicing and Maintenance on Land-based Equipment	LEO11 Service and Repair Engines on Land-based Equipment
	Understanding and Servicing Mechanical Power Transmission Systems

Essential resources

Learners will need access to a range of vehicles with relevant engines and ancillary systems and simulation equipment to support practical investigation and sufficient test and repair equipment and materials to enable accurate evaluation of engines and ancillary system assemblies and components.

Manufacturers' training videos, service manuals and test data will make a significant contribution to learners achievement.

Staff should be familiar with engine and ancillary systems as used by current equipment manufacturers.

Employer engagement and vocational contexts

Learners could be introduced to a variety of professionals from different companies and organisations such as mechanics and engineers, manufacturers of agricultural machines and manufacturers of engines. This will broaden their knowledge and make the learning experience interesting and contextualised. This could be through guest lecturers or off-site visits to different establishments.

Indicative reading for learners

Textbooks

Bell B – *Farm Machinery, 5th Edition* (Old Pond Publishing, 2005) ISBN 1903366682

Hillier V and Coombes P – *Hillier's Fundamentals of Motor Vehicle Technology, 5th Edition* (Nelson Thornes, 2004) ISBN 0748780823

Whipp J and Brooks R – *Transmission, Chassis and Related Systems (Vehicle Maintenance & Repair Series: Level 3), 3rd Edition* (Thomson Learning, 2001) ISBN 186152806X

Journals

Farmers Guardian

Farmers Weekly

Profi International

Websites

www.bagma.com

British Agricultural and Garden Machinery Association

www.defra.gov.uk

Department for Environment, Food and Rural Affairs

www.hse.gov.uk

Health and Safety Executive

www.iagre.org

Institution of Agricultural Engineers

www.lantra.co.uk

Lantra Sector Skills Council

Delivery of personal, learning and thinking skills [PLTS]

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

Skill	When learners are ...
Independent enquirers	explaining the construction characteristics of engines and ancillary systems
Creative thinkers	explaining the construction characteristics of engines and ancillary systems
Reflective learners	explaining the construction characteristics of engines and ancillary systems
Team workers	servicing and testing engines
Self-managers	explaining the construction characteristics of engines
Effective participators	servicing engines.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	researching sources of reference for assignment tasks
Creative thinkers	reporting alternative repair strategies
Reflective learners	analysing results of practical investigations
Team workers	working as part of a team testing and servicing engines
Self-managers	meeting deadlines for assignments
Effective participators	feeding back results of investigations during workshop practical sessions.

● 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	producing assignments/assessment using ICT using charts/tables when reporting results using proprietary hardware and software to communicate with OEM equipment eg calibration and fault finding modern transmissions
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	producing effective file storage hierarchy for assessment work
Follow and understand the need for safety and security practices	adhering to local ICT codes of practice
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching through a variety of media, eg CDs, internet, data transfer, manufacturer downloads, the information required for assessment completion and gearbox calibration
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching information sources to enhance assessment delivery
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> • text and tables • images • numbers • records 	producing and presenting high quality evidence to meet the criteria required for assessments
Bring together information to suit content and purpose	producing and presenting high quality evidence to meet the criteria required for assessments
Present information in ways that are fit for purpose and audience	producing and presenting high quality evidence to meet the criteria required for assessments
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	adhering to local ICT codes of practice.

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	reporting and analysing test results
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	reporting and analysing test results
Use appropriate checking procedures and evaluate their effectiveness at each stage	measuring engine and ancillary components
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	reporting and analysing test results
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	delivering feedback to peers on practical investigations
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching information for assessment, interpreting information and explaining it in their own words
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	producing information for assignments.