Unit 4: Land-based Engineering Operations – Service and Repair Engines and Components

Unit code: H/600/3437

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to provide the learner with the knowledge, understanding and skills required to perform service and repair procedures on engines within land based engineering. This unit aims to introduce learners to skills and understanding of engines and their components 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

The skills needed to service and repair engines and their components are fundamental for the qualified land-based engineer. These skills need to become more diverse with the technological developments of engines and engine management systems.

The land-based engineer now has to carry out complex test procedures using sophisticated diagnostic equipment to identify if a fault is being caused by electronic, hydraulic or mechanical components of the system.

This unit gives learners the knowledge, skills and understanding needed to carry out appropriate test procedures using diagnostic equipment, which will enable them to identify and repair engine and component faults correctly. An understanding of how different types of engines work is also required.

Initially, learners will study how to perform service and repair procedures on engines and their components. Learners will need to identify faults and understand the need to prioritise items in an investigation and work in a systematic manner. Learners should understand the need for a base reference point and settings and the use of manufacturers' information and technical data sheets. This builds into developing the knowledge to analyse and interpret findings from engine inspections. Finally, learners will develop the skills to take and understand engine measurements.

Learning outcomes

On completion of this unit a learner should:

1 Be able to perform service and repair procedures on engines and their components

2 Be able to identify engine faults

3 Understand how to analyse and interpret findings from engine inspections and rectify

4 Understand how to take engine measurements.

Unit content

1 Be able to perform service and repair procedures on engines and their components

Engine types: two stroke; four stroke; spark ignition; compression ignition

Engine components: carburettors; spark plugs; injection pumps; fuel delivery pumps; injectors; governors; cold start aids; air filtration systems; exhaust systems; turbo; superchargers

Sub-assemblies: recondition cylinder heads and valve train assemblies; pistons; rings and liner assemblies; engine timing components including camshaft; balancer; crankshaft; spark ignition systems

Serving and repair: piston and connecting rod; piston ring gapping; cylinder/liner taper; ovality and protrusion; crankshaft journal ovality and end float; piston/head clearances; valve, guide, seat, train, operating system; cylinder head/block distortion; engine oil pump; methods of sealing combustion chambers,fuel and ignition systems; recording results and comparing with specifications and making recommendations

2 Be able to identify engine faults

Reasons for inspection and testing: compliance (manufacturers'/technical/legislation); verification of repair; accident or incident occurrence; diagnosis

Machinery information: service history; technical reference data

Inspection and testing: criteria for inspection and testing (equipment must be serviceable, calibrated, certification in date); recognised methods and procedures; safe working practices; risk assessment

Testing: compression; engine power; fuel consumption; fuel pressure

3 Understand how to analyse and interpret findings from engine inspections and rectify

Data analysis: elimination of any influence of external factors affecting the performance; approved methods and procedures eg dynamometer tests, oil sampling; failure cause and effect; importance of accurate data collection

Data interpretation: comparison of analysis against the product specification and identify any deviations; determination of implications of the findings; presentation of findings

Reporting: analysis; interpretation; presentation; methods of reporting; appropriate reporting channels

Identification and rectification: engine performance; misfire; backfire; engine oil pressure; overheating; seizure; abnormal noise; non starting; excessive crank case breathing; oil consumption, fuel delivery and system pressures; air intake charge pressures; abnormal fuel usage injection, cam shaft and ignition timing; emissions including blue, white or black smoke engine performance not in accordance with manufacturers' specification; weak and rich fuel mixtures; restricted intake and exhaust air flow; verifying governor operation; operation of cold starts

4 Understand how to take engine measurements

Methods used: logical elimination; simulation; comparison; isolation of components; comparing results against manufacturer's specification

Equipment: specialist equipment; internal/external callipers; microgauges; micrometers; gas analysis; multi-meter; hydrometer, heavy discharge meter

Measurement: piston ring gapping; cylinder, liner, taper, ovality, and protrusion; crank shaft journal ovality and end float; piston/head clearance; valve, guide, seat, train, operating system; cylinder head and ancillary components

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	prepare, inspect and record the condition of engines and their components	**M1**	justify the procedures carried out, explaining the thought processes involved	**D1**	develop a safe method and system of work for servicing and repairing engines and their components
P2	use correct measuring equipment to verify compliance of engine components				
P3	investigate failed and/or worn parts and record and report findings [SM]				
P4	carry out tests to determine the cause of different engine problems	**M2**	justify the testing carried out, explaining the thought processes involved		
P5	set and adjust engine performance within specified limits				
P6	identify and rectify engine system faults [IE]				

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	describe how to identify and rectify the cause of engine problems	**M3**	develop a planned work sequence to identify and solve engine faults of varying and increasing complexity	**D2**	justify the planned sequence of work for identifying and rectifying engine faults of varying and increasing complexity.
P8	explain the methods of sealing combustion chambers, fuel and ignition systems				
P9	describe the effects of moisture and contaminates in fuel and ignition systems				
P10	explain the procedure to verify correct engine timing covering both static and dynamic timing				
P11	describe the methods and techniques of taking engine specific measurements.	**M4**	evaluate methods and techniques for taking engine specific measurements.		

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

Delivery of this unit will involve practical assessments, written assessment, visits to suitable collections and will link to industrial experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, discussions, seminar presentations, site visits, supervised land- based vehicle and engine practicals, research using the internet and/or library resources and the use of personal and/or industrial experience would all be suitable.

Delivery should stimulate, motivate, educate and enthuse learners.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities, so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to carry out complex fault diagnosis and rectification activities, and they should be encouraged to ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Visiting expert speakers could add to the relevance of the subject for learners. For example, land-based vehicle technicians or workshop managers could talk about their work, the situations they face and the methods they use.

Whichever delivery methods are used, it is essential that tutors stress the impact that correct fault diagnosis and rectification can have on the overall performance of the land-based vehicle and the environment.

Health and safety issues relating to the servicing and repair of engines in the workshop and onsite must be stressed and reinforced regularly. Risk assessments must be undertaken before practical activities and before learners visit any workshop. Adequate PPE must be provided and used following the production of suitable risk assessments.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

The unit begins with a review of engine types, including two and four stroke and spark and compression ignition engines. Engine components and sub-assemblies are then investigated, leading to the servicing and repair of engines and their components. Learners should service and repair a range of engines and components. Emphasis should be on work methods, good housekeeping and health and safety at all times. The need to use manufacturers' specifications and to reference recorded results to these is also emphasised.

The ability to diagnose faults is an important part of engine servicing and repair. Learners will be required to develop this skill in relation to the use of machinery information including service history, service intervals, and record keeping. The possible requirement for legal compliance, such as exhaust fumes or noise limits, will be introduced here. Emphasis should be on work methods, good housekeeping and health and safety at all times. Learners will be required to test engine performance.

Learners need to be aware of the methods and associated activities commonly used in complex fault diagnosis and rectification strategies. They will need to analyse data and the results of testing, including the elimination of external factors affecting performance. They should compare data collected against product specifications and identify findings and their implications.

Core to servicing and repair is the ability to take engine measurements and the equipment needed to do this. The tutor should introduce learners to a range of tools and equipment and allow learners to practice using them.

Learners should be made aware of the importance of simple observation and checking for the more obvious faults before beginning complex operations and engine and component dismantling.

Most of this unit should be delivered in a practical context with the emphasis being on safe working practice, correct use of equipment, work techniques and good housekeeping, and working from the simple to the complex.

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 and review of unit; testing of previous knowledge.
Recap of engine types, need for servicing and maintenance, record keeping, service intervals.
Workshop session on recap.
Assignment 1: **Engine Servicing and Repair** (P1, P2, P3, M1, D1). Tutor introduces the assignment brief.
Theory session: engine components and repair/servicing techniques.
Workshop session: engine components and repair/servicing techniques.
Assignment 2: Fault Diagnosis (P4, P5, P6, P7, P8, P9, P10, M2, M3, D2). Tutor introduces the assignment brief.
Workshop session: work techniques and approaches to fault diagnosis.
Workshop session: fault finding.
Theory session: data recording, analysis and interpretation.
Workshop session: data collection, rectification and reporting.
Assignment 3: Engine Measurement (P11, M4). Tutor introduces the assignment brief.
Theory session: equipment for and taking engine measurements.
Practical session: equipment for and taking engine measurements.
Assignment and self-study.
Unit review.

Assessment

For P1, learners must prepare, inspect and record the conditions of engines and their components. P1 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 work logs or other relevant learner notes. If assessed during a work placement, witness statements should be provided by a suitable representative and verified by the tutor.

For P2, learners must use correct measuring equipment to verify compliance of engine components against manufacturers' specifications and given tolerances. Learners should use a range of equipment on a range of different engines. Emphasis should be on safe and accurate use, recording of results, and identification of the relevant manufacturers' data. Assessment could be in a similar format to P1.

P3 requires learners to investigate failed and/or worn parts and to record their findings. Where possible, to ensure fairness of assessment the size and complexity of the tasks should be the same for all learners. Learners must report their findings in both verbal and written form. Assessment could be in a similar format to P1.

For P4, learners are required to carry out tests to determine the cause of a range of engine problems. Learners are expected to make realistic links between symptoms and faults in engines. They should, where necessary, to identify that the source of the fault could lie in a system other than that of the symptom. Where possible, to ensure fairness of assessment the size and complexity of the tasks should be the same for all learners. Assessment could be in a similar format to P1.

P5 requires learners to set and adjust engine performance within specified limits. Learners must make use of manufacturers' leaflets and technical data which could be computer based. Learners are required to both adjust and then test by running a range of engines to be agreed with the tutor. Assessment could be in a similar format to P1.

For P6, learners must identify and rectify selected system faults on a range of engines. Tutors should identify the faults or agree them through discussion with learners. The faults may be associated with engines used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the tasks should be the same for all learners. The selected faults should enable learners to have a number of possible rectification options to choose from. Evidence could be in the same form as for P1.

For P7, learners must identify and rectify selected engine problems on a range of engines. Tutors should identify the problems or agree them through discussion with learners. The problems may be associated with engines used to provide evidence for other grading criteria. Where possible, to ensure fairness of assessment the size and complexity of the tasks should be the same for all learners. The selected problems should enable learners to have a number of possible rectification options from which to choose. Evidence could be in the same form as for P1.

For P8, learners are required to explain the methods of sealing combustion chambers, fuel and ignition systems. Evidence for this could be in the form of a written report, presentation, and/or verbal reporting. In the case of verbal reporting this could be achieved in the workplace.

P9 requires learners to explain the effects of moisture and contaminants in fuel and ignition systems. Evidence for this could be in the form of a written report, presentation, and/or verbal reporting. In the case of verbal reporting this could be achieved in the work place.

P10 requires the learner to explain the procedure to verify correct engine timing covering both static and working tests. Emphasis must be on the dangers of carrying out tests on working engines and the need for safe working practices. Evidence could be in the same form as P8 and P9.

In P11 learners are required to describe the methods and techniques of taking engine specific measurements. Evidence could be in the same form as P8 and P9. Evidence could also be generated in the workplace through practical demonstration.

M1 requires learners to justify the procedures carried out to prepare and inspect engines and their components, explaining the thought processes involved. It also requires learners to justify the procedures uses to inspect failed and/or worn parts. This could be a development of P1, P2, and P3. Evidence could be in the same form as for P1.

For M2, learners must justify the choice of testing carried out for selected faults on engines and explain the thought processes involved. Tutors should identify the faults and problems or agree them through discussion

with learners. Where possible, to ensure fairness of assessment the size and complexity of the tasks should be the same for all learners. Evidence could be in the same form as for P1.

M3 requires learners to develop a planned work sequence to identify and solve engine faults of varying and increasing complexity. Evidence should be in the form of a written work sequence (algorithm) with supporting justification for s the steps and sequencing involved. Evidence could also be in the form of a presentation.

M4 requires learners to evaluate methods and techniques for taking engine specific measurements. Evidence could take the form of a written report or presentation.

D1 requires learners to develop a safe method and system of work for servicing and repairing engines and their components. This builds on P1, P2, P3 and M1. Evidence is likely to be in the form of a written report supported by verbal questioning but could also be provided and/or supported by demonstration in the workplace.

For D2, learners are required to justify a planned sequence of work for identifying and rectifying engine faults of varying and increasing complexity. This could be a development of the work carried out for D1 and evidence could be in the same form as in D1.

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, M1, D1	Engine Servicing and Repair	You are working in a workshop and are given an engine requiring service and repair. You must return it to good running order, reporting on servicing and repairs, studies carried out and associated costs.	Practical exercise with written and verbal reporting.
P4, P5, P6, P7, P8, P9, P10, M2, M3, D2	Fault Diagnosis	Develop and justify an algorithm (work sequence) for diagnosing the fault(s) of a given engine and apply it to return an engine to good running order.	Practical exercise with written and verbal reporting.
P11, M4	Engine Measurement	Investigate and report on equipment and methods used to take engine measurements, identifying and prioritising common faults and their causes.	Written report with possible verbal/practical application.

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 – Understand how to Use, Service and Maintain Tools and Equipment	LEO11 Service and Repair Engines on Land-based Equipment
Undertake Work Related Experience in the Land-based Industries	Undertake and Review Work Related Experience in the Land-based Industries

Essential resources

Learners will need access to a range of vehicles, engines, and simulation equipment to support practical investigation and sufficient test and repair equipment and materials to enable accurate diagnosis and measurement. A range of engines for service and repair must be available. Demonstration rigs would greatly aid delivery.

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

Tutors delivering the unit should be familiar with the range of engines available and used by equipment manufacturers, current and dated.

Employer engagement and vocational contexts

It is essential that this unit is delivered in an applied and vocational context. Work- based experience will also be important. The unit will be enhanced by contact with employers. Centres are encouraged to develop links with local businesses, manufacturers and machinery dealers, who can support the breadth and application of the unit. Employers can provide real-work practical exercises and guest speakers and experts to support the learning experience. Employer engagement will ensure the use of technically up-to-date information and processes.

Indicative reading for learners

Textbooks

Bell B – *Farm Machinery (Resource Management), 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

HSE – *Essentials of Health and Safety at Work* (HSE Books, 2006) ISBN 0717661792

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.howstuffworks.com	HowStuffWorks
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	preparing, inspecting and recording the condition of engines and their components investigating failed or worn parts and reporting their findings identifying and rectifying engine system faults describing the methods and techniques of taking engine specific measurements
Self-managers	carrying out tests to determine the cause of different engine problems using correct measuring equipment setting and adjusting engine performance.

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 ...
Reflective learners	analysing their performance whilst participating in a presentation, either individually or as a group, or when giving a verbal report
Team workers	participating in exercises and/or practical tasks as a group.

Functional Skills – Level 2

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	
Identify the situation or problem and the mathematical methods needed to tackle it	developing and justifying an algorithm for fault diagnosis
Select and apply a range of skills to find solutions	analysing and interpreting data
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Draw conclusions and provide mathematical justifications	developing and justifying an algorithm for fault diagnosis.