Unit 28: Working with Land-based Diesel Fuel Injection Systems

Unit code: D/601/4288

QCF Level 3: BTEC Nationals

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to the skills and knowledge in diesel fuel injection systems to enable service, diagnostics and repair 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 need to reduce pollution and improve the efficiency and productivity of land-based vehicles has become more important as land-based businesses analyse their machinery costs and the environmental impact of these machines.

Manufacturers have developed fuel systems that are complex in design but reliable and effective in operation. Those employed in the maintenance, fault diagnosis and repair of vehicles must have the knowledge and skills to undertake complex repair activities on diesel fuel systems.

This unit gives learners the opportunity to study diesel fuel systems, giving them the opportunity to gain the knowledge and skills needed to understand the function and operation of different types of diesel fuel injection systems commonly used in land-based vehicles. Throughout the unit health and safety and environmental protection will be stressed.

Learning outcomes

On completion of this unit a learner should:

1 Understand diesel fuel types, systems and components used in land-based vehicles

2 Know the components that are employed in land-based vehicle diesel fuel injection systems

3 Be able to carry out routine service, testing and repairs to diesel fuel injection systems

4 Understand methods by which engine management systems control engine performance and emissions.

Unit content

1 Understand diesel fuel types, systems and components used in land-based vehicles

Components: fuel tanks; primary and secondary filtration systems; in-line fuel injection pumps; rotary injection pumps; Verteiler type (VE) injection pumps; electronic high-pressure systems; cold starting aids

2 Know the components that are employed in land-based vehicle diesel fuel injection systems

Components: conventional diesel fuel injection systems; pressure/timed fuel injection systems; combined pump/injector fuel injection systems; electronically controlled systems; pump drive and timing arrangements; injectors eg injectors, single hole, multi-hole, pintle, pintaux, single stage, two stage and electronic-type

3 Be able to carry out routine service, testing and repairs to diesel fuel injection systems

Maintenance: service schedules; venting and checking the condition of the complete fuel injection system; removal and refitting of fuel injection system components; methods of checking and adjusting fuel injection pump/engine timing; use of manufacturers' service manuals and data; relevant, current legislation eg Environment Act 1995

Fault diagnosis: symptoms and common causes of excessive smoke emissions, poor starting, poor engine performance, fuel leaks and air ingress; methods and equipment used in fault diagnosis; methods used to analyse test data

Health and safety: personal protective equipment (PPE); risk assessments; relevant current legislation eg Health and Safety at Work etc Act 1974, Control of Substances Hazardous to Health Regulations 2002 (COSHH); Provision and Use of Work Equipment Regulations 1998 (PUWER)

4 Understand methods by which engine management systems control engine performance and emissions

Governors and engine management systems: governors eg mechanical, hydraulic pneumatic, electronic; electronic engine management systems; injectors eg injectors, single hole, multi-hole, pintle, pintaux, single stage, two stage and electronic-type; uses; costs; advantages; disadvantages; reliability relevant current emissions 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 layout of diesel fuel injection systems used in land-based vehicles [IE, CT, SM]	**M1** compare cold starting aids commonly used in modern diesel fuel injection systems	**D1** evaluate rotary pump diesel fuel injection systems, common rail diesel fuel injection systems and combined pump/injector fuel injection systems
P2 explain how commonly used cold starting aids function [IE, CT, SM]		
P3 explain the importance of filtration of diesel fuel and air [IE, CT, SM]		
P4 describe the working principles of components used in diesel fuel injection systems [IE, CT, SM, RL]	**M2** discuss the use of mechanical and electronic diesel fuel injection pump components commonly used in land-based vehicles	
P5 describe the working principle of a mechanical fuel injector [IE, CT, SM, RL]		
P6 describe the working principles of selected mechanical fuel injection pumps [IE, CT, SM, RL]		
P7 carry out routine service and testing of diesel fuel injection systems [EP, TW]	**M3** remove, replace and 'time' selected fuel injection pumps to manufacturers' specifications	**D2** diagnose faults in selected diesel fuel injection systems by analysing symptoms and data and make appropriate recommendations to rectify them.
P8 produce a report to outline the serviceability of a given diesel fuel injection system [IE, CT, SM]		
P9 carry out non-scheduled repairs and maintenance to a diesel fuel injection system [EP, TW, 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:**
P10 explain what factors ensure diesel fuel is used efficiently to comply with current emissions regulations [IE, CT, SM]	**M4** compare, in terms of performance, fuel efficiency and emissions, selected diesel engines that use mechanical governing fuel systems and electronic fuel management systems.	
P11 compare different types of diesel fuel injectors and the effect they have on fuel combustion [IE, CT, SM, RL]		
P12 justify the development of electronic control of injection systems and how they are integrated into electronic engine management systems. [IE, CT, SM, RL]		

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 workshop activities, practicals, internet and/or library-based research 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 fuel injection system maintenance procedures and fault-finding 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. Whichever delivery methods are used, it is essential that tutors stress the importance of sound environmental management and the need to manage equipment using legal methods.

Health and safety issues relating to workshop situations must be stressed and reinforced regularly, and risk assessments must be undertaken before practical activities. 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.

Learning outcomes 1, 2 and 4 cover the theoretical aspects of diesel fuel systems. They are likely to be delivered through formal lectures, discussion, possible site visits, demonstration and supervised practical sessions and independent learner research.

Learning outcomes 3 looks at the maintenance, repair and fault diagnosis of diesel fuel systems. This can be delivered as individual practical sessions as well as through formal lectures and discussions. Health and safety within the workshop must be paramount at all times.

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.
Assignment 1: Understand Diesel Fuel Systems and Components used in Land-based Vehicles (P1, P2, P3, M1) Introduction to the assignment and learner-centred research.
The function and specification of diesel fuel system components – comparing types.

Topic and suggested assignments/activities and/assessment
Assignment 2: Components Employed in Land-based Vehicle Diesel Fuel Injection Systems (P4, P5, P6, M2, D1) Introduction to the assignment and learner-centred research.
The principle of operation of diesel fuel systems components – comparing modern and old technology.
Assignment 3: Carry out Routine Service, Testing and Repairs to Diesel Fuel Injection Systems (P7, P8, P9, M3, D2) Introduction to the assignment and learner-centred practical.
Carry out maintenance activities on diesel fuel systems.
Assignment 4:Methods by which engine management systems control engine performance and emissions (P10, P11, P12, M4) Introduction to the assignment and learner-centred practical.
Analysing performance, fuel efficiency and emissions on engines that use mechanical governing fuel systems and electronic fuel management systems.
Unit review.

Assessment

For P1, learners need to explain the layout of diesel fuel injection systems. Tutors should identify the systems 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. Learners are expected to provide evidence covering two different types of fuel systems.

For P2, learners need to explain the function of commonly used cold starting aids found in diesel fuel injection systems. Tutors should identify the systems 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. Learners are expected to give evidence covering two types of cold starting aids.

For P3 learners need to explain the importance of filtration in diesel fuel injection systems. Tutors should identify the systems 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.

For P4, learners need to describe the working principles of diesel fuel injection system components. Tutors should identify the systems 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. Learners are expected to provide evidence covering the components of two different types of diesel fuel injection system listed in the unit content.

For P5 and P11, learners need to describe the working principles of diesel fuel injectors and compare different types. Tutors should identify the systems 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. Learners are expected to provide evidence covering two different types of injector listed in the unit content.

For P6, learners need to describe the working principles of diesel fuel injection pumps. Tutors should identify the systems 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. Learners are expected to provide evidence covering one type of injection pump listed in the unit content.

For P7 and P8, learners must carry out routine service and testing on diesel fuel injection systems and report their findings. Tutors should identify the systems and the fault diagnosis scenarios. The systems 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 tasks should be the same for all learners. Learners are expected to give evidence for the servicing of one type of diesel fuel injection systems and for the testing of one component.

For P9, learners must carry out non-scheduled repairs to a diesel fuel injection system. Tutors should identify the systems and the fault diagnosis scenarios. The systems 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 tasks should be the same for all learners. Learners are expected to change one minor component in a breakdown situation on one type of fuel system.

P10 and P12 require learners to explain the factors that ensure diesel fuel is used efficiently to comply with current emissions regulations and justify the development of electronic control of injection systems and how they are integrated into electronic engine management systems commonly used in land-based vehicles. Tutors should identify the engine management systems 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. Learners are expected to give evidence covering one type of electronic engine management system commonly used in land-based vehicles.

For M1, learners must compare cold starting aids commonly used in diesel fuel systems. Tutors should identify the systems or agree them through discussion with learners. The systems may be the same as those used to provide evidence for P2. Where possible, to ensure the fairness of assessment the size and complexity of the task should be the same for all learners. Learners are expected to give evidence covering two types of cold starting aids.

For M2 and M4 learners must discuss the use of mechanical and electronic diesel fuel injection pump governors commonly used in land-based vehicles, evidence should include performance, cost, reliability and maintenance requirements. Tutors should identify the governors 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. Learners are expected to give evidence covering one mechanical and one electronic governor system commonly used in diesel fuel systems.

M3 requires learners to remove, replace and 'time' diesel fuel injection pumps to manufacturers' specifications. Tutors should identify the pumps or agree them through discussion with learners. The pumps 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. Learners are expected to give evidence covering two types of injection pump listed in the unit content.

For D1, learners must evaluate rotary pump diesel fuel injection systems, common rail diesel fuel injection systems and combined pump/injector diesel fuel injection systems. Learners are required to evaluate three current diesel fuel injection systems, in terms of air pollution control and engine performance. Where possible, to ensure fairness of assessment the size and complexity of the task should be the same for all learners.

D2 requires learners to diagnose faults in diesel fuel injection systems by analysing symptoms and data and make appropriate recommendations to rectify them. Tutors should identify the systems and the fault diagnosis scenarios presented to learners. These 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 tasks should be the same for all learners. Learners are expected to provide evidence for four different fault diagnosis scenarios.

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	Understand Diesel Fuel Systems and Components used in Land-based Vehicles	You are working for a local agricultural dealership that specialises in the repair of diesel fuel systems, in order to assist your work you need to understandi the function of components used in diesel fuel systems.	Assignment/report. Presentation.
P4, P5, P6, M2, D1	Components Employed in Land-based Vehicle Diesel Fuel Injection Systems	You are working for a local agricultural dealership that specialises in the repair of diesel fuel systems, in order to assist your work you need to know how the components operate in diesel fuel systems.	Assignment/report. Presentation.
P7, P8, P9, M3, D2	Carry out Routine Service, Testing and Repairs to Diesel Fuel Injection Systems	You are working for a local agricultural dealership that specialises in the repair of diesel fuel systems and will need to maintain test and repair different types of diesel fuel systems.	Practical. Report/job card/work logs.
P10, P11, P12, M4	Methods by which Engine Management Systems Control Engine Performance and Emissions	You are working for a local agricultural dealership that specialises in the repair of diesel fuel systems, to assist your work you will need to understand the electronic control systems of modern diesel fuel systems in relation to performance, fuel efficiency and emissions.	Assignment/report. Presentation.

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	Land based Engineering Operations – Service and Repair Engines and Components
LEO4 Core Land-based Engineering Principles – Mechanical Principles	
LEO5 Core Land-based Engineering Principles – Tools and Equipment	
LEO8 Core Land-based Engineering Principles – Servicing and Maintenance	

Essential resources

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

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

Tutors delivering this unit should be familiar with diesel fuel injection 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 to broaden their knowledge and make the learning experience interesting and contextualised. This could be through guest lectures, work placements or off site visits to different establishments.

Indicative reading for learners

Textbooks

Hillier V, Coombes P and Rogers D – *Hillier's Fundamentals of Motor Vehicle Technology: Powertrain Electronics, 5th Edition* (Nelson Thornes, 2006) ISBN 0748780998

Nunney M J – *Light and Heavy Vehicle Technology, 4th Edition* (Butterworth-Heinemann, 2006) ISBN 0750680377

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	explaining the function of diesel fuel system components assessing risk explaining principles of operation
Creative thinkers	explaining the function of diesel fuel system components assessing risk explaining principles of operation discussing the correct selection of components
Reflective learners	discussing the correct selection of components describing methods of fault diagnosis
Team workers	planning and carrying out maintenance and repair work diagnosing faults using a variety of sources
Self-managers	planning and carrying out maintenance and repair work diagnosing faults using a variety of sources
Effective participators	diagnosing faults using a variety of sources.

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	planning and carrying out research activities related to the unit evaluating and carrying out extended thinking
Creative thinkers	asking questions to extend their thinking during lectures and practical sessions adapting ideas as circumstances change eg fault diagnosis on a variety of machinery
Reflective learners	identifying opportunities for their own achievements setting goals for themselves eg time management reviewing progress in practical tasks and coursework
Team workers	working with others to carry out repair and maintenance tasks reaching clear agreements regarding who is carrying out which tasks during practical activities working together when diagnosing faults
Self-managers	dealing with pressures in an emergency situation managing time and resources during practical activities
Effective participators	discussing issues of concern relating to time management and resources during practical activities identifying improvements that could be implemented during practical tasks.

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	completing their course work using ICT facilities using interactive materials for teaching and learning researching subjects on the internet
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	
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	
Bring together information to suit content and purpose	
Present information in ways that are fit for purpose and audience	
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	

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	planning an activity and getting relevant information from relevant sources using this information to carry out multi-stage calculations to do with, amounts or sizes, scales or proportion and using formulae interpreting the results of calculations, presenting findings and justifying methods
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	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	reading material on the subject from a variety of sources for their assignment work reading around subjects and producing clear and concise documents using correct engineering terminology presenting information to a group of people ideally in a classroom situation with their peers.
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	