National Unit Specification: general information

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

CODE F918 12

SUMMARY

This Unit may form part of a National Qualification Group Award or may be offered on a free standing basis.

This largely theoretical Unit with some practical input is designed to allow candidates to develop knowledge and understanding of the construction and operating principles of engines used in the land-based sector. Candidates will also develop the techniques used in the servicing of engines used in agricultural/forestry machinery and ground care equipment.

During delivery of the Unit candidates will learn to identify the component parts and describe the construction and operating principles of two and four stroke spark ignition (S.I) and compression ignition engines (C.I.) and their configurations. Candidates will also develop the knowledge and skills to service commonly used land-based vehicle engines. Candidates will also learn to comply with current legislation, safety regulations and safe working procedures and practices while working on engines usually used in the land-based sector.

OUTCOMES

1 Identify the construction and describe the sequence of operation of commonly used land-based vehicle engines.
2 Identify the construction and describe the operation of commonly used land-based vehicle engine ancillary systems.
3 Maintain and service engines and ancillary systems.

RECOMMENDED ENTRY

While entry is at the discretion of the centre some knowledge and experience of working in a practical engineering environment where land-based machinery has been used would be an advantage.

Administrative Information

Superclass: SK

Publication date: August 2010

Source: Scottish Qualifications Authority

Version: 01

National Unit Specification: general information (cont)

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CREDIT VALUE

1 credit at SQA level 6 (6 SCQF credit points at SCQF level 6).

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

CORE SKILLS

There may be opportunities to develop the following Core Skills:

- Problem Solving (SCQF level 5)
- Working with Others (SCQF level 5)
- Communication (SCQF level 5)
- Numeracy (SCQF level 4)
- ICT (SCQF level 5)

These opportunities are highlighted in the Support Notes of this Unit Specification.

National Unit Specification: statement of standards

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit Specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

OUTCOME 1

Identify the construction and describe the sequence of operation of commonly used land-based vehicle engines.

Performance Criteria

(a) Identify correctly the name and function of main power unit components.
(b) Describe correctly the sequence of operation of a two stroke S.I. engine.
(c) Describe correctly the sequence of operation of a four stroke C.I. engine.
(d) Determine the appropriate firing order for a multi-cylinder four stroke engine.

OUTCOME 2

Identify the construction and describe the operation of commonly used land-based vehicle engine ancillary systems.

Performance Criteria

(a) Correctly describe the operation of engine cooling systems and their components.
(b) Correctly describe the operation of an engine pressure lubrication system and its components.
(c) Correctly describe the operation of engine air intake systems and their components.
(d) Correctly describe the operation of engine fuel systems and their components.

OUTCOME 3

Maintain and service engines and ancillary systems.

Performance Criteria

(a) Correctly complete routine/periodic maintenance on vehicle engines usually used in the land-based sector.
(b) Correctly complete manufacturer's maintenance schedules/checklists for engine maintenance tasks.
(c) Correctly dispose of waste materials in line with current legislation.

National Unit Specification: statement of standards (cont)

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EVIDENCE REQUIREMENTS FOR THIS UNIT

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written and/or recorded oral, product and performance evidence supplemented with an assessor observation checklist(s) should be produced to demonstrate that a candidate has achieved all Outcomes and Performance Criteria.

Outcome 1

Outcome 1 must be assessed by a series of assessments designed to ensure that candidates can generate sufficient evidence to satisfy the Outcome and Performance Criteria. Candidate evidence must be in the form of written and/or recorded oral evidence. Assessments must be conducted under supervised, closed-book conditions in which candidates are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment.

With regard to Outcome 1

- candidates must identify and state the function of twelve main component parts of a land-based four stroke vehicle engine
  - cylinder block components (engine block, crankshaft, connecting rods, pistons, piston rings)
  - camshaft
  - cylinder liners (wet/dry)
  - timing drives
  - flywheel
  - engine balancer unit
  - cylinder head components (cylinder head; head gasket; valve guides, inlet and exhaust valves, valve train).
- candidates must identify and state the function of four main component parts of a land-based two stroke vehicle engine
  - crankcase
  - ports/reed valves
  - piston
  - crankshaft
- candidates must describe the operation of two stroke spark ignition and four stroke compression ignition engines and identify common configurations.
- candidates must determine the appropriate firing order for a four cylinder four stroke engine.

Outcome 2

Outcome 2 must be assessed by a series of assessments designed to ensure that candidates can generate sufficient evidence to satisfy the Outcome and Performance Criteria. Candidate evidence must be in the form of written and/or recorded oral evidence. Assessments must be conducted under supervised, closed-book conditions in which candidates are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment.

National Unit Specification: statement of standards (cont)

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With regard to Outcome 2

- candidates must identify and describe the operation of land-based vehicle engine cooling systems
  - air cooling systems (fans, ducting, fins)
  - liquid cooling system (radiator, expansion tank, pressure cap, water pump, fan and belt, electric fan, thermostat, hoses, coolant circulation, anti-freeze, cab heater)
- candidates must identify and describe the operation of land-based vehicle engine lubrication systems
  - pressure lubrication system (sump, pump, pressure relief valve, filter, oil cooler, engine oil flow path)
- candidates must identify and describe the operation of land-based vehicle engine air intake systems
  - air intake systems (naturally aspirated and pressure charged)
  - air filtration (air filter types, air filter restriction indicators)
- candidates must identify and describe the operation of land-based vehicle engine fuel systems
  - C.I. fuel system (fuel tank, sedimenters, water traps, lift pumps, priming pumps, in-line fuel injection pump, rotary fuel injection pump high pressure fuel injection systems)
  - S.I. fuel system (fuel tank, sedimenter, lift pump, fuel filter, carburettor)

The assessment exercises will be conducted under closed-book, supervised conditions within a time limit of one hour. Achievement can be decided by the use of a cut-off score.

Outcome 3

Outcome 3 must be assessed by a series of practical assessments designed to generate evidence of candidates' abilities to maintain and service land-based vehicle engines and ancillary systems.

Candidate evidence must be in the form of performance, written and/or recorded oral evidence. Candidates must undertake assessment on their own. Assessment must be conducted under supervised conditions. An observation checklist must be used to record performance evidence of whether candidates have satisfied all the Performance Criteria in the Outcome or not.

With regard to Outcome 3

- candidates must complete routine/periodic maintenance on vehicle engines usually used in the land-based sector, as per manufacturers' service manuals and data to ensure compliance with maintenance schedules for engine maintenance tasks.
- candidates must complete manufacturer's record sheets in order to confirm compliance with required service and repair activities.
- candidates must comply with relevant current health and safety legislation and current legislation relating to the disposal of waste materials.

National Unit Specification: support notes

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

This part of the Unit Specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

GUIDANCE ON THE CONTENT AND CONTEXT FOR THIS UNIT

The aim of this Unit is to allow candidates to develop knowledge and understanding of the construction and operating principles of engines and their ancillary systems used in the land-based sector. Candidates will also develop the technical skills required to service engines, complete service records to industry standards and comply with current legislation, safety regulations and current legislation relating to the disposal of waste materials used in the servicing of engines commonly used in agricultural/forestry machinery and ground care equipment.

In Outcome 1 candidates should be introduced to the main constructional features and sequence of operation of a range of engines used in the land-based sector. Candidates should be able to state the cycles of two and four stroke engines and determine the appropriate firing order for a four cylinder four stroke engine. To stimulate candidate interest further, the firing order for six cylinder engines could be introduced and the different fuel types that can be burned in Internal Combustion (I.C.) engines may also be included.

In Outcome 2 candidates should be introduced to the operation and main constructional features of engine ancillary systems used in the land-based sector.

Candidates should be able to state the advantages and disadvantages of air and liquid cooling systems, describe the operation of air and liquid cooling system components and the need for antifreeze and corrosion inhibitor in a liquid cooling system.

Candidates, for a four stroke engine, should be able to identify the lubrication system components, their function and describe the flow of oil through the lubrication system. The types and use of oils (SAE classification) that can be used in Internal Combustion (I.C.) engines, including two stroke oil, may also be included.

Candidates should be able to state the need for air filtration and describe the air intake system components and their function in both normally aspirated and pressure charged systems. The types of pressure charged systems could include turbo-charged, super-charged and the use of inter-cooling. Candidates should be able to identify fuel system components and describe the operation of systems as used on CI and SI engines. Candidates could also be given an awareness of common two stroke oil to petrol ratios, calculation of oil/petrol mixtures and the method of lubrication of two stroke engines.

In Outcome 3 candidates should have the opportunity to underpin the knowledge and understanding they developed in Outcomes 1 and 2 by gaining practical experience completing the routine/periodic maintenance tasks on a range of engines at the recommended service/maintenance intervals prescribed by the manufacturer. The candidates should be encouraged to use manufacturers' data sheets and to record the service/maintenance completed on the recommended service record sheet.

Maintenance operations undertaken should include a 500 hour engine service and could take place either in a workshop environment or on-site.

National Unit Specification: support notes (cont)

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

During the delivery of Outcome 3 candidates should be made aware of current legislation, regulations and safe working procedures and practices when working on engines in a workshop situation or on-site. Candidates must comply with safety regulations, safe working practices and procedures, the wearing of appropriate PPE and with current legislation, safety regulations and current legislation relating to the disposal of waste materials used in the servicing of engines commonly used in agricultural/forestry machinery and ground care equipment.

Health Safety and the Environment

As Outcome 3 requires candidates to practically service and repair equipment either onsite or in a workshop situation, it is strongly recommended that candidates be inducted into current legislation, regulations and safe working procedures and practices before starting practical work.

A safe system of work should be established in line with the Health, Safety and the Environment Unit guidelines while taking cognisance of the candidate's previous experience and abilities prior to the commencement of practical activities. The storage and handling of materials and methods for disposal of waste materials produced during the servicing of land-based equipment should comply with current legislation and good practice. Health, safety and environmental issues associated with this Unit ***should be taught together with the subject topics and not separately*** in the Land-based Engineering: Health Safety and the Environment Unit.

GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Unit is delivered in the same sequence the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit.
In delivering Outcomes 1 and 2 emphasis should be placed on the terminology, constructional features and principles of operation of a range of engine types and their associated ancillary systems.
As Outcome 3 requires candidates to practically service engines either onsite or in a workshop situation, it is strongly recommended that candidates are inducted into current legislation, regulations and safe working procedures and practices before starting practical servicing work on vehicle engines. It is important that safe systems of working are established in the workshop/site environment and candidates are given a thorough grounding in their responsibilities with regard to safe working practices, the hazards of working with tools and equipment and the methods for disposal of waste materials produced during the servicing of land-based machinery.

The Unit may be delivered by a combination of lectures, investigations, lecturer demonstration, practical activities and industrial site visits. Industrial site visits, especially for candidates with little or no employment experience in the land-based sector, can be helpful in providing candidates with useful insights into onsite health and safety requirements and environmental considerations for the onsite servicing of land-based machinery.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Critical Thinking component of Problem Solving at SCQF level 5 may be developed in Outcome 3 while candidates are practically planning how to complete the servicing and routine maintenance of land-based vehicle engines.

National Unit Specification: support notes (cont)

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

The Planning and Organising component of Problem Solving at SCQF level 5 may be developed in Outcome 3 while candidates are involved with group practical tasks, as they could be tasked with organising how the required resources will be allocated and have to produce a plan as to how to complete the servicing and routine maintenance of land-based vehicle engines using the most cost effective method.

The Reviewing and Evaluating component of Problem Solving at SCQF level 5 may be developed in Outcome 3 after candidates have completed the group practical task, as they could review the effectiveness of the plan developed, draw conclusions and suggest a more effective way(s) of completing the allocated task(s).

The *Working with Others* Core Skill at SCQF level 5 may be developed in Outcome 1 and 3 while candidates complete group investigative tasks and the servicing and routine maintenance of land-based vehicle engines.

The Working Co-operatively with Others and Reviewing the Co-operative Contribution Core Skill components at SCQF level 5 may be developed in Outcome 3 while candidates engage in practical work as they have to interact with their lecturers, support staff and other candidates, for example; while sharing engineering workshop areas, tools and equipment or in developing a plan and completion of the intended servicing and routine maintenance of land-based vehicle engines.

The *Communication* Core Skill at SCQF level 5 may be developed in Outcomes 1, 2 and 3 as candidates will be required to produce and respond to detailed and complex written and oral communications. As they investigate the differing fuel types that can be used, report on how to apply servicing techniques and to communicate detailed written conclusions about the servicing, routine maintenance and overall condition of land-based vehicle engines.

The Using Number Core Skill component at SCQF level 4 may be developed in Outcome 2 and 3 as candidates could use ratios to calculate fuel to oil mixture used in 2 stroke engines or the volume of anti-freeze required in an engine from stated ratios.

The Using Graphical Information Core Skill component at SCQF level 5 may be developed in Outcome 3 as candidates could be given engine valve and fuel pump timing data, complete an engine timing diagram and then using the correct method practically check the accuracy of the diagram using the engine they are servicing.

The Using Information Technology Core Skill component at SCQF level 5 may be developed in Outcome 1 as candidates could research and report on the different fuel types that can be burned in Internal Combustion (I.C.) engines.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

Health Safety and the Environment

Assessment of health, safety and environmental issues within this Unit could be cross-matched and assessed in the associated Land-based Engineering: Health, Safety and the Environment Unit.

National Unit Specification: support notes (cont)

UNIT Land-based Engineering: Engine Technology (SCQF level 6)

Opportunities for the use of e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by information and communications technology (ICT), such as e-testing or the use of e-portfolios or e-checklists. Centres which wish to use e-assessment must ensure that the national standard is applied to all candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005).*

Outcome 1

Assessment may comprise of a series of assessment papers consisting of short answer and structured questions. Partly completed diagrams may be used as part of the assessment. This assessment may be suitable for on-line delivery.

Outcome 2

Assessment may comprise of a series of assessment papers consisting of short answer and structured questions. Partly completed diagrams may be used as part of the assessment. This assessment may be suitable for on-line delivery.

Outcome 3

Assessment should comprise of practical exercises designed to ensure candidates can gather sufficient evidence to satisfy the Outcome and Performance Criteria. Task instruction sheets, manufacturer's product literature and record forms should be made available to candidates.

The need for an established safe system of work must be addressed before the candidates begin practical servicing work on vehicle engines.

DISABLED CANDIDATES AND/OR THOSE WITH ADDITIONAL SUPPORT NEEDS

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**