National Unit Specification: general information

UNIT Land-based Engineering: Electronic Control and Monitoring Systems (SCQF level 6)

CODE F91V 12

SUMMARY

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

This Unit is designed to allow candidates to develop the basic knowledge, understanding and skills required for servicing, fault finding and repair of electronic control systems found on land-based machinery. During delivery of the Unit candidates will learn to identify the component parts and describe the operation of a range of electronic control and monitoring systems found on land-based machinery. Candidates will also develop the knowledge and skills required to assess the serviceability of the component parts and carry out basic fault finding. They will also learn how to adjust and make any necessary routine or service adjustments to the systems to ensure electronic systems function safely and correctly.

OUTCOMES

1 Outline the function, advantages and disadvantages of selected electronic systems fitted to land-based machinery.
2 Identify components, sub-systems and describe the operation of a range of open and closed loop electronic systems fitted on land-based machinery.
3 Use test equipment and recommended procedures to determine and record control and monitoring systems operation.

RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained some knowledge and experience of working in a practical engineering environment where forestry or arboriculture machinery has been used.

Administrative Information

Superclass: SK

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National Unit Specification: general information (cont)

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CREDIT VALUE

1 credit at SCQF 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:

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

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

National Unit Specification: statement of standards

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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

Outline the function, advantages and disadvantages of selected electronic systems fitted to land-based machinery.

Performance Criteria

(a) Correctly identify the function of selected electronic systems fitted to land-based machinery.
(b) Correctly state the advantages and disadvantages of the selected electronic systems.

OUTCOME 2

Identify components, sub-systems and describe the operation of a range of open and closed loop electronic systems fitted on land-based machinery.

Performance Criteria

(a) Identify correctly and describe the operation of electronic control and monitoring system components fitted to land-based machinery.
(b) Identify correctly sub-systems and describe the operation of named open loop electronic systems fitted to land-based machinery.
(c) Identify correctly sub-systems and describe the operation of named closed loop electronic systems fitted to land-based machinery.

OUTCOME 3

Use test equipment and recommended procedures to determine and record control and monitoring systems operation.

Performance Criteria

(a) Correctly complete scheduled routine or periodic recalibration of electronic systems used in the land-based sector.
(b) Using manufacturers' portable diagnostic equipment or in-built onboard electronic diagnostic mode and after market test equipment, correctly assess, determine and record the correct operation of electronic systems.
(c) Using manufacturers' portable diagnostic equipment or in-built onboard diagnostic mode and after market test equipment, correctly locate electronic system faults.
(d) Replace in accordance with the manufacturer's manual/procedures faulty electronic components or monitoring equipment.

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 Outcomes and Performance Criteria. Candidate evidence must be in the form of a written assessment and could take the form of a project. Where a project is used to ensure fairness of assessment the size complexity of the task should be the same for all learners. Achievement can be decided by the use of a cut-off score.

With regard to Outcome 1

- candidates must correctly identify and state the function of six electronic control and monitoring systems found on an agreed land-based vehicle. The advantages and disadvantages of the electronic systems over their mechanical equivalent must be stated. (Project vehicle systems should be agreed with the assessor from the following list and should relate to the candidate's branch of land-based engineering):
  - Engine management, transmission control, headland management, performance monitoring, closed circuit television monitoring, vehicle instrumentation, driver information, suspension control, hydraulic control, pilot steering, automatic guidance systems, GPS/GIS systems. Fork lift truck steering mode control, load monitor, combine grain loss monitoring. Forager harvester metal detectors, shear bar setting system, automatic knife sharpening systems, feed wagon weighing systems, etc

Outcome 2

Outcome 2 must be assessed by a series of assessments designed to ensure that candidates can generate sufficient evidence to satisfy the Outcomes and Performance Criteria. Candidate evidence must be in the form of written and/or recorded oral evidence and could be combined with the project if used for assessment in Outcome 1.

With regard to Outcome 2

- Candidates must describe the function and operation of the following electronic system components:
  - transistors, capacitors, regulators, resistors, transformers, thermisters and transducers.
- candidates must describe the operation of two named open loop electronic systems fitted to land-based vehicles.
- candidates must describe the operation of two named closed loop electronic systems fitted to land-based vehicles.

National Unit Specification: statement of standards (cont)

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Outcome 3

Outcome 3 must be assessed by a series of practical assessments designed to generate evidence of candidates' abilities to use test equipment and recommended procedures to determine and record control and monitoring systems operation.

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 scheduled routine or periodic calibration of electronic systems used in the land-based sector and complete record sheets in order to verify system performance. Any two different systems from the following list that should relate to the candidate's branch of land-based engineering:
  - Engine management upgrade, transmission calibration/upgrade, headland management, performance monitoring, driver information, suspension control, hydraulic control, pilot steering, automatic guidance systems, GPS/GIS systems. Forklift truck steering mode control, load monitor, combine grain loss monitoring. Forager harvester metal detectors, shear bar setting system, automatic knife sharpening systems, feed wagon weighing systems, harvester head recalibration, machine crane parameter adjustment, machine control system calibration/upgrade.
- candidates must use manufacturers' portable diagnostic equipment or in-built onboard electronic diagnostic mode and after market test equipment to correctly assess, determine and record the satisfactory operation of two electronic systems from the following list that should relate to the candidate's branch of land-based engineering:
  - Engine management upgrade, transmission calibration/upgrade, headland management, performance monitoring, driver information, suspension control, hydraulic control, pilot steering, automatic guidance systems, GPS/GIS systems. Forklift truck steering mode control, load monitor, combine grain loss monitoring. Forager harvester metal detectors, shear bar setting system, automatic knife sharpening systems, feed wagon weighing systems, harvester head recalibration, machine crane parameter adjustment, machine control system calibration/upgrade.
- candidates must use manufacturers' portable diagnostic equipment or in-built onboard diagnostic mode and after market test equipment to correctly locate two electronic system faults from the following list that should relate to the candidate's branch of land-based engineering:
  - Engine management upgrade, transmission calibration/upgrade, headland management, performance monitoring, driver information, suspension control, hydraulic control, pilot steering, automatic guidance systems, GPS/GIS systems. Forklift truck steering mode control, load monitor, combine grain loss monitoring. Forager harvester metal detectors, shear bar setting system, automatic knife sharpening systems, feed wagon weighing systems, harvester head recalibration, machine crane parameter adjustment, machine control system calibration/upgrade.
- Candidates must replace in accordance with the manufacturer's manual/procedures a minimum of two faulty electronic components or monitoring equipment.

National Unit Specification: support notes

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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 electronic control and monitoring systems used in land-based machinery. Candidates will also develop the technical skills required to carry out the routine operator adjustments, scheduled upgrading, diagnose and rectify system faults to ensure the selected machinery operates within manufacturers' specifications. Candidates will also complete service records to industry standards, comply with manufacturers' recommendations, current legislation and safety regulations relating to working on electronic systems found in land-based engineering.

In Outcome 1 candidates should be introduced to the main constructional features and function(s) of a range of electronic systems used in the land-based sector. Candidates should be able to state the advantages and disadvantages of systems found on a given machine that relates to their branch of land-based engineering. Candidates could also be given an awareness of how electronic signals are generated, used and communicated eg sensor types and signal formats, CAN bus, GPS, radar, multiplexing, pulse width modulation, onboard data storage and telemetry.

In Outcome 2 candidates should be introduced to electronic components and their basic operation. To stimulate candidate interest further candidates could be introduced to the various methods of testing individual electronic components and the economic approaches that could be considered to determine the replacement of units or refurbishment of individual component parts. Candidates should have an awareness of the main operational features of open and closed loop systems and their applications on equipment used in the land-based sector.

Candidates should have an awareness of the advantages and disadvantages of open and closed loop systems, be able to describe the function and state the operation of sub-system elements in the major electronic systems found on a given machine that relates to their branch of land-based engineering. To stimulate candidate interest further, various machines and their workshop manual could be introduced in a workshop situation and the candidate given the task of identifying the systems fitted, their component location on the machine, the system's function, how communication, calibration and diagnostic procedures are carried out on the subject vehicle systems.

These vehicle exercises could form the basis of a project used to assess candidate competency for Outcomes 1 and 2.

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 calibration tasks and fault finding on a range of electronic control and monitoring systems. The candidates should be encouraged to use data sheets and to record the service/maintenance tasks completed.

Candidates should be introduced to manufacturers' diagnostic methods/equipment and after market equipment used to diagnose faults in electronic systems.

National Unit Specification: support notes

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Candidates should also be introduced to the methods used to retrieve, interpret and reinstate information stored in electronic control units, be able to recognise when systems and component parts are performing within manufacturers' specifications and be able to determine when the data retrieved is outwith system parameters and indicating a fault or system problem. To stimulate candidate interest further, the data from diagnostic testing could be the subject of group discussion where the various data obtained could be considered and a decision as to the correct or faulty operation of various systems and/or sensors could be established.

When replacing faulty components candidates should comply with the relevant safe working practices, dismantling procedures and techniques as specified by manufacturers' workshop manuals and safety regulations.

Maintenance and repair operations undertaken in Outcome 3 could take place either in a workshop environment or on-site.

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 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. The Unit may be delivered largely by a combination of lectures, computer simulation, candidate research/investigation and practical work.

In delivering Outcomes 1 and 2 emphasis should be placed on the terminology, constructional features and principles of operation of a range of open and closed loop electronic monitoring and control systems found in the candidate's branch of land-based engineering.

As Outcome 3 requires candidates to practically maintain electronic control and monitoring equipment to ensure satisfactory performance 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 work on vehicles. 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 of repairing and/or replacing components to ensure satisfactory performance of land-based machinery control and monitoring equipment.

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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 maintenance of land-based machinery.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Critical Thinking component of *Problem Solving* at SCQF level 5 may be developed in Outcomes 2 and 3 while candidates are involved in analysing the diagnostic test results and deciding upon the most economic use of resources in the approach that will be used to practically completing the servicing, and faulty component replacement of land-based vehicle electronic systems.

The Planning and Organisation 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 to practically completing the servicing, diagnostic tests and faulty component replacement on a land-based vehicle electronic systems.

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 task(s).

The *Working with Others* Core Skill at SCQF level 5 may be developed in Outcomes 1 and 2 while candidates complete the group investigative tasks and diagnostic testing of the electronic systems on working machinery.

The Working Co-operatively with Others Core Skill component and Reviewing the Co-operative Contribution 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 testing, diagnosing and replacement of components on electronic systems.

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 operation of electronic systems, research and report on how to apply the advanced diagnostic skills and to communicate detailed written conclusions about the serviceability of electronic control and monitoring systems.

National Unit Specification: support notes

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The practical diagnosis tasks involved with Outcome 3 will give candidates the opportunity to develop both the Using Number and Using Graphical Information components of *Numeracy* Core Skill at SCQF level 5 as detailed numerical information and graphs require to be correctly analysed and interpreted, to enable the candidate to draw the correct conclusions, to practically complete testing/diagnosing and replacement tasks on a range of land-based machinery. The candidate will also further develop the Using Number component as while candidates are involved with group practical tasks, they will organise how the required resources are allocated, by calculating the most economic method and then develop a plan to complete the servicing, diagnostic testing and faulty component replacement on a land-based vehicle electronic systems, using the calculated most economic method.

The Using Information Technology Core Skill component at SCQF level 5 may be developed in Outcomes 1 and 2 as candidates could research and report on the constructional features and communication systems used in electronic systems. This could entail the use of a wide range of remote data sources — eg from manufacturers' CD-ROMs (on which the data will need to be kept secure) to general information evaluated from internet searches.

It will be developed further in Outcome 3 as candidates apply diagnostic procedures using a range of ICT hardware and software, to obtain and combine information from electronic machine control systems and adjust electronic control systems to ensure the machine(s) perform within manufacturer's specifications.

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.

GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

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, or alternatively may be completed as a guided project. To ensure fairness of assessment the size and complexity of the project should be the same for all candidates. This assessment may be suitable for on-line delivery.

National Unit Specification: support notes

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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. Or alternatively may be integrated in the guided project used for the assessment of Outcome 1. 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 work on land-based vehicles.

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**