



## National Unit Specification: general information

**UNIT** Land-based Engineering: Mechanical Transmission Systems  
(SCQF level 6)

**CODE** F91R 12

### SUMMARY

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

This is a combined theoretical and practical Unit designed to provide candidates with the knowledge and understanding to enable them to identify the type, construction and operating principles of clutches and mechanical transmission systems used in land-based vehicles and equipment, and to develop the skills to remove, replace, dismantle, condition assess, identify faults and rebuild mechanical transmission systems used in land-based vehicles and equipment.

The Unit is suitable for candidates training to be service engineering technicians working on land-based vehicles and equipment.

### OUTCOME

- 1 Identify the component parts and operating principles of dry single plate, dry dual plate, wet single plate and wet multi plate clutches used in land-based equipment.
- 2 Identify types and operating principles of transmission systems used in land-based equipment.
- 3 Remove and replace a transmission assembly and related components.
- 4 Dismantle, clean and visually inspect a transmission assembly fitted to land-based equipment.
- 5 Rebuild the transmission assembly to manufacturer's specification.

### RECOMMENDED ENTRY

While entry is at the discretion of the centre, candidates would normally be expected to have attained one of the following, or equivalent:

- ◆ Maths at SCQF level 4
- ◆ Physics at SCQF level 5
- ◆ Technological studies at SCQF level 5

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### Administrative Information

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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**

The Unit provides opportunities for the candidate to develop aspects of the following Core Skills:

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

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

## **National Unit Specification: statement of standards**

### **UNIT        Land-based Engineering: Mechanical Transmission Systems (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 component parts and operating principles of dry single plate, dry dual plate, wet single plate and wet multi plate clutches used in land-based equipment.

#### **Performance Criteria**

- (a) The component parts and operating principles of a dry single plate clutch are identified correctly.
- (b) The component parts and operating principles of a dry dual plate clutch are identified correctly.
- (c) The component parts and operating principles of a wet single plate clutch are identified correctly.
- (d) The component parts and operating principles of a wet multi plate clutch are identified correctly.

#### **OUTCOME 2**

Identify types and operating principles of transmission systems used in land-based equipment.

#### **Performance Criteria**

- (a) The types and operating principles of transmission systems are identified correctly.
- (b) The types and operating principles of powered front and rear axles are identified correctly.
- (c) A drive path through one mechanical transmission using manufacturer's schematic drawings is identified correctly.

#### **OUTCOME 3**

Remove and replace a transmission assembly and related components.

#### **Performance Criteria**

- (a) Correctly remove ancillary components to facilitate removal of the main transmission.
- (b) Remove main transmission assembly following manufacturer's recognised procedures.
- (c) Refit transmission assembly following manufacturer's recognised procedures.
- (d) Correctly refit ancillary components to transmission assembly.

## **National Unit Specification: statement of standards**

**UNIT** Land-based Engineering: Mechanical Transmission Systems  
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### **OUTCOME 4**

Dismantle, clean and visually inspect a transmission assembly fitted to landbased equipment.

#### **Performance Criteria**

- (a) Dismantle a transmission assembly following manufacturer's service procedures.
- (b) Clean transmission assembly components in compliance with current legislation.
- (c) Visually inspect and assess transmission components for serviceability in accordance with manufacturer's specification.
- (d) Correctly identify unserviceable components.

### **OUTCOME 5**

Rebuild the transmission assembly to manufacturer's specification.

#### **Performance Criteria**

- (a) Use workshop manual/manufacturer's data correctly.
- (b) Reassemble components ensuring correct fit.
- (c) Rebuild sub assemblies using correct torque settings.
- (d) Check and set clearances accurately during assembly.

## **National Unit Specification: statement of standards (cont)**

### **UNIT Land-based Engineering: Mechanical Transmission Systems (SCQF level 6)**

#### **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.

#### **Outcome1**

Outcome 1 is a written and/or recorded oral assessment which is assessed in four parts: the first part is designed to generate evidence of the candidate's ability to identify the component parts and operating principles of a dry single plate clutch; the second is designed to generate evidence of the candidate's ability to identify the component parts and operating principles of a dry dual plate clutch, the third is designed to generate evidence of the candidate's ability to identify the component parts and operating principles of a wet single plate clutch and the fourth is designed to generate evidence of the candidate's ability to identify the component parts and operating principles of a wet multi plate clutch.

Candidate evidence should take the form of a closed-book written assessment conducted under closely supervised conditions. An alternative may be an on line E-assessment or workshop exercise where the assessor could ask the candidate to identify the component parts.

#### **Outcome 2**

Outcome 2 is a theoretical assessment which is assessed in three parts: the first part is designed to generate evidence of the candidate's ability to identify the type, and operating principles of mechanical gearboxes and transmission assemblies; the second is designed to generate evidence of the candidate's ability to identify the type, and operating principles of powered front and rear axle components; the third provides evidence of the candidate's ability to identify a power drive path for a selected transmission using a manufacturer's schematic diagram as a base for the assessment.

Candidate evidence should take the form of a closed-book written assessment conducted under closely supervised conditions or in Outcomes 2 (a) and (b) as a workshop exercise where the assessor could ask the candidate to identify transmissions and selected parts.

With regard to Outcome 2 (a), candidates should identify types and operating principles of the following gearboxes and transmission assemblies:

- (i) Sliding mesh
- (ii) Constant mesh
- (iii) Synchromesh
- (iv) Range and reduction gearboxes
- (v) Forward and reverse shuttle
- (vi) PTO drives

## **National Unit Specification: statement of standards (cont)**

### **UNIT            Land-based Engineering: Mechanical Transmission Systems (SCQF level 6)**

For Outcome 2(b) the candidate should identify the types and operating principles of the following powered front and rear axle components.

- (i) Front and rear axle reduction units
- (ii) Differentials
- (iii) Differential locks
- (iv) Half shafts
- (v) Constant velocity joints

For Outcome 2 (c) the candidate should identify a power flow drive path on a manufacturer's schematic diagram for a selected gear.

#### **Outcome 3**

Outcome 3 is a practical exercise which is assessed in four parts: the first part would generate evidence of the candidate's ability to work in a safe and methodical manner removing transmission ancillary components, the second would generate evidence that the candidate demonstrates the ability to remove the main transmission assembly safely following manufacturers' recognised procedures, the third would generate evidence of the candidate's ability to refit a transmission assembly following manufacturers recognised procedures, the fourth part requires the candidate to satisfactorily refit ancillary components to a transmission assembly. Assessment must be carried out under supervised conditions; an observation checklist must be used to record whether the candidates have satisfied the criteria in parts one, two, three and four.

#### **Outcome 4**

Outcome 4 is a practical exercise to rebuild a mechanical clutch and gearbox which is assessed in four parts: the first to ensure that the candidate can demonstrate the ability to dismantle a transmission assembly safely following manufacturers' service procedures, identifying component orientation and storing dismantled parts in a systematic manner. The second to generate evidence of the candidate's ability to clean components correctly observing recognised health and safety procedures when using cleaning solution. The third relates to the candidate's ability to carry out a visual inspection of dismantled components to identify unusual wear characteristics. The fourth requires the candidate to evaluate components against the manufacturer's standard to identify when parts are outwith recommended wear limits and no longer serviceable. Assessment must be carried out under supervised conditions using an observation checklist to record whether the candidates have satisfied the criteria in parts one and two; a written report would be used to satisfy the criteria of parts three and four.

## **National Unit Specification: statement of standards (cont)**

### **UNIT** Land-based Engineering: Mechanical Transmission Systems (SCQF level 6)

#### **Outcome 5**

Outcome 5 must be assessed by a series of practical assessments designed to generate evidence of the candidate's ability to rebuild a transmission system used in land-based vehicles and equipment.

Candidate evidence must be in the form of an observation checklist which would be completed by the assessor working in a closely supervised practical situation. Oral questioning may be used to verify the candidate's understanding of the task undertaken.

- ◆ Candidates must interpret and use manufacturer's workshop manual/data correctly.
- ◆ Candidates must reassemble components correctly ensuring correct orientation and fit.
- ◆ Candidates should build sub assemblies using the correct tightening techniques and recommended torque settings.
- ◆ Clearances should be checked and set according to manufacturers' recommendations.

## National Unit Specification: support notes

### UNIT Land-based Engineering: Mechanical Transmission Systems (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

This Unit forms part of the National Qualification Group Award in Land-based Engineering at SCQF level 6, but may also be offered on a free standing basis.

The aim of this Unit is to allow candidates to develop basic knowledge, understanding and skills to undertake the removal, dismantling, condition assessment, rebuild and testing of mechanical transmission systems found in land-based engineering. They will also develop skills in data interpretation and evaluation.

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 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 Health Safety and the Environment Unit

**In Outcome 1** candidates will learn about the type, construction and operating principles of typical clutches used in land-based equipment. It is anticipated that this Outcome will be mainly theoretical but the subject can be enhanced by looking at clutches in a practical environment where a clutch can be dismantled, rebuilt and set up. When possible it is desirable to give the candidates examples of where these clutches can be found and to outline and give examples of applications of other clutch types used in land-based engineering, for example — Overrun clutches, torque limiting or slip clutches, cone clutches, dog clutch, electro magnetic clutch.

**In Outcome 2** candidates will learn about the type, construction and operating principles of a range of mechanical transmission systems and ancillary components. This Outcome is likely to be delivered in a classroom environment utilising sectional schematic diagrams. This approach could be enhanced by relating the theoretical element of the Unit to the transmission system that is being refurbished as part of a practical learning exercise or by relating the theory to model gearboxes if available. Schematic diagrams showing a sectioned gearbox is an ideal method of relating a drive path through a transmission. Candidates should be encouraged to utilise colour to make the interpretation of power flow easier to follow.

**In Outcome 3** candidates should learn how to remove and replace transmissions and ancillary components from vehicles/machines used in land-based engineering. It is important to reinforce all the health and safety aspects to create a safe working environment. Particular emphasis should be placed on good housekeeping and the safe use of lifting equipment. A formal risk assessment could be considered prior to undertaking this task.



## National Unit Specification: support notes (cont)

### UNIT Land-based Engineering: Mechanical Transmission Systems (SCQF level 6)

Where possible this task should be related to a transmission to be rebuilt. Candidates will learn about safe working practices, how transmissions are mounted in vehicles/machines and the safe use of lifting equipment.

In **Outcome 4** candidates will dismantle a land-based vehicle and equipment transmission system. This could be a transmission specifically used for this exercise or a commercially used transmission which is in need of refurbishment. Manufacturers' service procedures should be adhered to when working on the transmission system. When components have been removed and cleaned they should be stored in a logical manner in sub assemblies if possible. All components should be thoroughly cleaned using an appropriate cleaning solution. Candidates must wear appropriate PPE and observe recognised health and safety procedures. All cleaned parts should be stored in a clean and safe environment until further use. Candidates will carry out a visual inspection of components to identify any unusual wear characteristics. If a component is suspected of being worn it could be compared to a new component or measured and compared with data in the manufacturers' workshop manual. This information will aid the candidate to evaluate whether a component can be re-used or is outwith serviceable wear limits. The information would be used as supporting evidence for the candidate's conclusion which would be presented in a written report.

In **Outcome 5** candidates will reassemble the transmission assembly replacing components that are outwith manufacturers' recommended wear limits. All components must be clean with orientation checked at each stage. All work should be carried out in a clean environment with good housekeeping evident. Where applicable candidates should be encouraged to use workshop manuals/manufacturers data supplemented by any notes they may have taken during disassembly. Components should be assembled into sub assemblies before being fitted to the transmission. Where possible the use of an 'assembly quality checklist' by the assessor ensures that critical torque setting and operating clearances have been correctly adhered to. Candidates should be encouraged to reflect on the work carried out and although the work should be completed to commercial timescales the emphasis should always be on quality.

### GUIDANCE ON LEARNING AND TEACHING APPROACHES FOR THIS UNIT

It is recommended that the Unit is delivered in the same sequence as the Outcomes are presented in the National Unit Specification: statement of standards section of the Unit. The Unit is designed to be delivered as a practical exercise; it should be carried out in a workshop environment with access to a range of hand tools and lifting equipment.

#### Health Safety and the Environment

As Outcomes 3, 4 and 5 require candidates to practically service and repair equipment either on site or in the workshop situation, it is strongly recommended that candidates are inducted into current legislation, regulations and safe working procedures and practices before starting practical work.

Manufacturers' standards should be observed at all times; workshop manuals and technical data can provide key information for the exercise and are a useful source of learning material for the candidates.

## National Unit Specification: support notes (cont)

### UNIT Land-based Engineering: Mechanical Transmission Systems (SCQF level 6)

It is important to be disciplined when delivering this Unit. When candidates remove components they should be cleaned and stored in a logical fashion. Where possible components should be checked for manufacturers marking; if no marking is evident components should be marked carefully avoiding damage to wearing surfaces. Candidates should be encouraged to reflect on work completed and to take notes which will aid them in the re-assembly of the transmission.

#### OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

The Core Skill *Problem Solving* at SCQF level 5 may be developed in Outcomes 4 and 5 where critical thinking, planning, organising, reviewing and evaluating are evident when the candidate dismantles, inspects and rebuilds a transmission system. There is a need to use factual and theoretical information to determine transmission wear characteristics and likely causes. Manufacturer's data would be used for evaluation purposes.

The Core Skill *Working with Others* at SCQF level 4 may be developed in Outcomes 3, 4 and 5 where the candidate will work as part of a small team to remove a transmission assembly from a land-based vehicle/equipment, dismantle a transmission system, carry out wear assessment and rebuild the transmission using new components as required. Good practice in using and sharing service engineering workshop areas, tools and equipment could be discussed in terms of the nature and scope of team goals, roles and responsibilities. Candidates could be given constructive feedback to encourage review and evaluation of their approaches to practical work including their contribution to team working.

Elements of the Core Skill *Communication* at SCQF level 5 will be developed in Outcomes 1, 2, 3, 4 and 5 where the candidate uses a wide range of oral and written communication skills in familiar and unfamiliar contexts. Although the candidate works as part of a team where effective verbal interaction with other team members can be observed they will be required to demonstrate practical skills independently and may be questioned by the assessor. The candidate will be required to read and apply information gained from manufacturers' workshop manuals/data discs and as part of the assessment for Outcome 4 will be required to produce a detailed evaluative report. Outcomes 1 and 2 may be assessed using written/oral questions.

Elements of *Numeracy* at SCQF level 4 may be developed in Outcome 4 where the candidate uses a range of numerical and graphical data to determine transmission component wear. The candidate will use precision measuring equipment to compare actual measurements against the manufacturer's standard; the difference calculated will determine component wear.

The Core Skill *ICT* at SCQF level 4 may be developed in Outcomes 3, 4 and 5 where the candidate may have to access information on manufacturer's databases or data discs. Reports required for assessment can be completed and submitted using word application and Email.

#### GUIDANCE ON APPROACHES TO ASSESSMENT FOR THIS UNIT

**Assessment of health and safety and environment 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: Mechanical Transmission Systems (SCQF level 6)**

The Unit is a practical exercise based on commercial practice. Where possible the Outcome sequence should be followed with practical assessment carried out using observation checklists. The transmission should operate effectively on completion. Written assessment could be a closed-book assessment or an ‘on line’ e-assessment.

#### **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)*.

#### **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](http://www.sqa.org.uk/assessmentarrangements)