National Unit Specification: general information

UNIT Material Removal Practice: Milling (SCQF level 6)

CODE F5KF 12

SUMMARY

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

This predominantly practical Unit is designed to allow candidates to develop the knowledge and skills to perform complex milling machining operations. During the delivery of the Unit candidates will develop the knowledge, understanding and skills to interpret complex features on engineering drawings and source and extract milling related information from specialist documents. They will also learn to complete planning and inspection documentation. Candidates will have an opportunity to develop knowledge and skills to identify and use milling cutters and specialist auxiliary devices to perform complex milling techniques in manufacturing component(s). They will also measure and record component(s) dimensions to verify if the component(s) complies with a given specification(s). An essential aspect of Unit delivery will be that candidates comply with current Health and Safety legislation and safe working practices when performing milling operations. Candidates will also complete a risk assessment associated with producing a component on a milling machine.

This Unit is suitable for candidates training to be manufacturing, mechanical or multi-disciplinary engineering technicians. It is also suitable for craftspersons who wish to develop more advanced skills in milling.

OUTCOMES

1 Interpret complex information from engineering sources in relation to milling operations.
2 Use a milling machine to manufacture a component(s) to a given specification.
3 Comply with current Health and Safety regulations and safe working practices and conduct a risk assessment involving milling operations on a component(s).

Administrative Information

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National Unit Specification: general information (cont)

UNIT Material Removal Practice: Milling (SCQF level 6)

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:

- Material Removal Practice: Milling (SCQF level 5)
- appropriate industrial experience in the field of manufacturing engineering or machining

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 is no automatic certification of Core Skills in this Unit.

This Unit provides opportunities for candidates to develop aspects of the following Core Skills:

Problem Solving (SCQF level 6)

Numeracy (SCQF level 6)

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

Interpret complex information from engineering sources in relation to milling operations.

Performance Criteria

(a) Drawing conventions and abbreviations are identified correctly in terms of current British standards.
(b) Complex dimensioning, tolerances and surface finish information is interpreted correctly from given component drawing(s).
(c) Detailed technical information relating to the manufacture of a given component s) using milling processes is extracted successfully from a specialised source(s).

OUTCOME 2

Use a milling machine to manufacture a component(s) to a given specification.

Performance Criteria

(a) Complete a planning document correctly for the manufacture of a component(s).
(b) Select, set-up and use a milling machine correctly to manufacture a component(s).
(c) Use specialised auxiliary devices correctly for machining complex forms.
(d) Use measuring equipment correctly to verify component(s) conform to given specification.
(e) Record measurement results correctly on inspection documentation and identify any non-conforming measurement(s) correctly.
(f) Explain correctly the differences between conventional milling and climb milling and state appropriate applications of each.

OUTCOME 3

Comply with current Health and Safety regulations and safe working practices and conduct a risk assessment involving milling operations on a component(s).

Performance Criteria

(a) Use machine guards correctly during milling operations.
(b) Use appropriate Personal Protective Equipment correctly.
(c) Comply fully with safety requirements, good housekeeping and appropriate tool/equipment storage.
(d) Complete a partially completed risk assessment correctly for a milling machining process.
(e) Cooperate effectively with others in an engineering workshop.

National Unit Specification: statement of standards (cont)

UNIT Material Removal Practice: Milling (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.

Outcomes may be assessed by a single, holistic assessment covering all three Outcomes or assessed as a combination of Outcomes (eg Outcome 1 on its own and Outcomes 2 and 3 together).

Outcome 1 (Written and/or Recorded Oral Evidence)

Outcome 1 may be assessed as part of a holistic assessment or separately at a single assessment event lasting 30 minutes. Assessment must be conducted under supervised, closed-book conditions in which candidates may use reference materials provided by the centre but are not allowed to bring their own notes, handouts, textbooks or other materials into the assessment.

With regard to Outcome 1:

- candidates must correctly identify four drawing conventions and abbreviations from a given selection
- candidates must be given milling component drawings and asked to extract a minimum of six pieces of complex information relating to dimensions, dimensional tolerance, geometric tolerances and surface finishes
- candidates must source and extract a minimum of four items of information from a specialist source(s)

Outcomes 2 and 3 (Written and/or Recorded Oral, Product and Performance Evidence)

The assessment of Health and Safety, safe working practices and risk assessment in Outcome 3 must always be integrated with the practical assessment in Outcome 2 and all other practical work activities undertaken by candidates while taking this Unit.

For Outcome 2 each candidate will require to manufacture a milling component(s) from a given engineering drawing(s) which has as a minimum the following features: two parallel faces, two flat faces, two square faces, two angles and two open ended slots. The component(s) will be manufactured throughout the delivery of the Unit and must be manufactured under supervised conditions.

National Unit Specification: statement of standards (cont)

UNIT Material Removal Practice: Milling (SCQF level 6)

Candidates will manufacture a component, or components, to the following tolerances:

- general engineering manufacturing tolerance of ±0.25mm
- one specified length within ±0.1mm
- flatness within 0.125mm per 25mm
- square-ness within 0.125mm per 25mm
- angles ± 1O
- surface finish in the range of 1.6–3.2 µm (microns)

The flatness, square-ness, angles and surface tolerances should be achieved on at least two occasions.

With regard to Outcomes 2 and 3

Candidates must be asked to finalise a partially completed planning document in which at least six operations have to be completed for the given component(s) to be manufactured.

Candidates must set-up and safely use milling machine(s) to undertake the following: tool selection and securing, speeds and feed selection and auxiliary equipment selection. Candidates should undertake appropriate selection of speeds/feeds for cutter/material type from given charts.

The following cutters must be used: face mills, slot drills, end mills and a form tool.

Candidates must use a minimum of two different auxiliary devices: vice, universal vice, angle plate, vee block, jig or fixture and /or a variety of machine clamps

The following measuring equipment must be used to verify component(s) measurements against specification(s): micrometer, vernier calliper, Dial Test Indicators and surface texture comparison gauges. A minimum of eight dimensions should be recorded on the inspection documentation provided.

Candidate evidence in the form of written and or recorded oral evidence should be gathered for Outcome 2 Performance Criterion (f). Candidates should state two applications of conventional and climb milling.

For Outcome 3 an observation checklist must be used to record evidence that candidates have complied with Performance Criteria (a), (b), (c) and (e) while undertaking all practical milling work.

For Outcome 3 Performance Criterion (d) candidates must record information on a partially completed Risk Assessment form. Candidates should identify a minimum of four hazards associated with using a milling machine to produce a component. They should also estimate the level of risk associated with each hazard and identify steps to minimise the risk(s) associated with each hazard.

National Unit Specification: support notes

UNIT Material Removal Practice: Milling (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 (NQGA) in Manufacturing Engineering at SCQF level 6, but may also be offered on a free-standing basis.

This Unit is particularly suitable for those candidates who have successfully completed the Unit *Material Removal Practice: Milling* at SCQF level 5.

The overall aim of this Unit is to provide candidates with the opportunity to develop advanced milling machine skills. On successful completion of the Unit candidates will be able to interpret complex information on engineering drawings relevant to milling operations and source and extract milling related information from specialist sources. They will also be able to recognise cutting speeds and feeds for selected cutter types and component materials. Candidates will have developed a range of specialised milling machining skills. These will include the selection and care of complex cutting tools to perform specialised techniques such as machining forms, facing, forming internal slots and milling external features. In addition, they will have learnt to select and operate specialised auxiliary milling equipment. Candidates will also have developed the knowledge and understanding to complete planning and inspection documentation fully and accurately. Candidates will also have learnt to apply appropriate Health and Safety procedures and safe working practices while undertaking milling machine activities and be able to undertake a risk assessment involving the use of a milling machine to produce a component.

Outcome 1 involves candidates in interpreting complex dimensioning, tolerance, geometric tolerances and surface finish information on engineering drawings and sourcing and extracting milling related information from specialist sources such as detailed manufacturer's charts.

Outcome 2 provides candidates with an opportunity to develop advanced milling skills which include making decisions on machining processes and selection of specialised tools. Candidates will learn the techniques to produce complex profiles. The emphasis should always be placed on correct tool and feeds and speeds selection taking into account tool type, materials being milled and milling machine capability and maintenance. Candidates should complete inspection documentation recording component dimensional information to verifying if component(s) conform to given specification(s) or not.

Outcome 3 involving Health and Safety regulations and safe working practices should be integrated with all practical milling activities. Candidates should complete a risk assessment associated with a component being manufactured on a milling machine. It is important that candidates correctly identify hazards associated with producing a component on a milling machine, the level of risk associated with each hazard and methods for minimising risks associated with each hazard.

National Unit Specification: support notes (cont)

UNIT Material Removal Practice: Milling (SCQF level 6)

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. Delivery of Unit content should be principally by lecturer demonstration followed by candidates practising the skills demonstrated. It is recommended that the same components are used throughout the delivery and assessment of the Outcomes (ie from initial drawing stage to final manufacture of components). The components manufactured by candidates should, as far as possible, reflect their current or future areas of employment and their own personal interests and must cover the machining features listed in Outcome 2.

Centres may wish to provide candidates with instruction on Health and Safety regulations, safe working practices and risk assessment as part of Unit delivery. Alternatively, such instructions may be given as part of another Unit such as the Unit Health and Safety SCQF at level 5. Where this approach is taken it is important that sufficient attention is paid to Health and Safety, safe working practices and risk assessment as these apply to milling processes.

A large range of paper based and electronic materials exist on Health and Safety and risk assessment. Centres may wish to show candidates Health and Safety videos/DVDs to highlight, for example, the dangers of working in engineering workshops.

Wall charts of milling machines, milling cutters etc. may also assist candidate learning.

OPPORTUNITIES FOR CORE SKILL DEVELOPMENT

Elements of the Core Skill of *Problem Solving*, that is, Critical Thinking, Planning and Organising, can be developed as candidates learn to interpret and apply complex information from a range of sources including engineering drawings. They have to consider all factors affecting the set up and operation of a milling machine and conduct a risk assessment. They complete a planning document taking into account tool type, materials being milled and milling machine capability and maintenance. Adhering to safety requirements they select methods and techniques and produce components on a manually operated milling machine. Feedback from assessors could encourage on going evaluation of both process and product.

Numeracy skills will be naturally enhanced as the Unit is undertaken. Candidates have to interpret and translate complex information on dimensioning, tolerances and surface finish. They record and verify component dimensional information against given specifications. Formative activities should be contextualised with a focus on the practical interpretation, use and application of number and graphics in engineering.

National Unit Specification: support notes (cont)

UNIT Material Removal Practice: Milling (SCQF level 6)

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 Communication 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)*.

Formative assessment exercises involving candidates in interpreting complex information on engineering drawings, sourcing and extracting milling related information from specialist sources and practising specialist milling activities will play a particularly important role in building candidate knowledge, understanding, skills and confidence of Unit content.

Outcome 1 may be assessed by an assessment paper consisting of appropriate engineering drawings, specialist documentation and a question paper comprising of a balance of short answers/restricted response questions or objective questions or a combination of both. More specifically each candidate may be provided with a series of detailed engineering drawings with certain complex features highlighted. Each candidate would be required to identify the highlighted features. A specialist source of information may be a detailed manufacturer's chart involving milling cutter speed and feed selection for different size cutters made from different materials when used in milling operations on various types of materials.

Outcome 2 may be assessed by a practical exercise, or exercises, in which candidates manufacture a component or components which meets, at least, the minimum features and tolerances stated under the Evidence Requirements for Outcome 2. Centres may choose to limit the time candidates have to complete the manufacture of a components(s) to a maximum of 6 hours. It is also recommended that any checklists and inspection records used as part of the assessment of Outcome 2 should cross reference component features to the following:

- tools/equipments
- feeds/speeds selection
- advanced machining operations
- inspection and making accurate machine adjustments
- safe working practices

so that the finished component(s) can be assessed in terms of compliance with tolerances, surface finish requirements and functionality.

Outcome 2 Performance Criterion (f) may be assessed by each candidate being provided with graphical information on milling and climb milling, and orally questioned. A checklist should be used to record evidence of the candidate's answers. Alternatively, this Performance Criterion may be evidenced by all candidates sitting an assessment paper (which includes graphical information on milling and climb milling) lasting 15 minutes and conducted under supervised, closed-book conditions.

National Unit Specification: support notes (cont)

UNIT Material Removal Practice: Milling (SCQF level 6)

Candidate evidence for Performance Criteria (a), (b), (c) and (e) in Outcome 3 should be recorded by completing an appropriate observation checklist. With regard to the risk assessment in Outcome 3(d), Centres may use their own standard forms.

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**

History of changes to Unit

Version	Description of change	Date
02	Text referring to Assessment Support Pack (ASP) has been removed. There is no ASP for this Unit specification.	02/06/2015