

## Overview

This standard covers a broad range of basic milling competences that will prepare you for entry into the engineering or manufacturing sectors, creating a progression between education and employment, or that will provide a basis for the development of additional skills and occupational competences in the working environment.

The milling operations may be carried out on horizontal, vertical or universal milling machines. You will be expected to prepare for the machining activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how you intend to carry out the required milling activities and the sequence of operations you intend to use.

You will be required to prepare for the milling activities by mounting, positioning and correctly setting a range of workholding devices, to mount the workpiece and cutting tools and to set and use cutting feeds/speeds and techniques appropriate to the type of material, tooling, workpiece rigidity and operations being performed. You will be expected to produce components that combine a number of different features, such as flat faces, parallel faces, faces square to each other, angular faces, steps, open and enclosed slots, drilled, bored and reamed holes, internal threads, and special forms/profiles.

During, and on completion of, the milling operations, you will be expected to check the quality of the workpiece, using measuring equipment appropriate to the aspects being checked and the tolerances to be achieved. You will need to be able to recognise milling defects, to take appropriate action to remedy any faults that occur and to ensure that the finished workpiece is within the drawing requirements. On completion of the machining activities, you will be expected to remove cutters and workholding devices, and to leave the milling machine and work area in a safe and tidy condition.

Your responsibilities will require you to comply with health and safety requirements and organisational policy and procedures for the milling activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the milling activities, and to seek appropriate help and advice in determining and implementing a suitable solution. You will work under a high level of supervision, whilst taking responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide an understanding of your work, and will enable you to apply appropriate milling techniques safely. You will understand the milling process, and its application, and will know about the equipment, materials and consumables, to the required depth to provide a sound basis for carrying out the activities to the required specification.

You will understand the safety precautions required when working with the milling machine, and with its associated tools and equipment. You will be required to demonstrate safe working practices throughout, and will understand the responsibility you owe to yourself and others in the workplace.

### **Specific Standard Requirements**

In order to prove your ability to combine different milling features, at least one of the components produced must be of a significant nature, and must have a minimum of **five** of the features listed in scope 5.

## Performance criteria

### *You must be able to:*

1. work safely at all times, complying with health and safety legislation, regulations, directives and other relevant guidelines
2. plan the machining activities before you start them
3. obtain and prepare the appropriate materials, tools and equipment
4. mount and set the required workholding devices, workpiece and cutting tools
5. set and adjust the machine tool speeds and feeds to achieve the component specification
6. use the machine tool controls safely and correctly, in line with operational procedures to produce components
7. measure and check that all dimensional and geometrical aspects of the component are to the specification
8. deal promptly and effectively with problems within your control, and seek help and guidance from the relevant people if you have problems that you cannot resolve
9. shut down the equipment to a safe condition on completion of the machining activities

## Knowledge and understanding

### *You need to know and understand:*

1. the safe working practices and procedures to be followed when preparing and using milling machines (such as ensuring the correct isolation of the machine before mounting cutters and workholding devices; fitting and adjusting machine guards, ensuring that the workpiece is secure and that cutters are free from the workpiece before starting the machine)
2. the hazards associated with the milling operations (such as revolving/moving parts of machinery, airborne and hot metal particles, sharp cutting tools and burrs and sharp edges on component), and how they can be minimised
3. the personal protective equipment (PPE) to be worn for the milling activities (such as correctly fitting overalls and safety glasses; ensuring that, if you have long hair, it is tied back or netted; and removing any jewellery or other items that can become entangled in the machinery)
4. the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
5. the correct operation of the machine controls in both hand and power modes, how to stop the machine in both normal and emergency situations, and the procedure for restarting after an emergency
6. planning and preparing to carry out the machining operations (such as obtaining the component drawing, determining the machines required, selecting materials, selecting workholding methods and devices, selecting cutting tools, determining a suitable sequence of operations, determining quality checks to be made and equipment to be used)
7. how to use and extract information from engineering drawings and related specifications (to include symbols and conventions to appropriate BS or ISO standards) in relation to work undertaken (to include first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)
8. the main features of the milling machine, and the accessories that can be used (such as vertical heads, indexing devices)
9. how to position and secure workholding devices to the machine table, and the checks to be made (such as ensuring all seating/location faces are clean and undamaged, ensuring that the device is suitably aligned using instruments or tenons, as appropriate, and checking that all bolts or other securing devices are

tightened securely)

10. the effects of clamping the workpiece in a vice or other workholding device, and how this can cause damage or distortion in the finished components

11. the various milling operations that can be performed, and the types of cutters that are used (such as face mills, slab/cylindrical cutters, side and face cutters, end mills, slot drills, form cutters, twist drills)

12. how to mount and secure the cutting tools in the tool holding devices and to the machine spindle (such as face mills on stub arbors or direct to the machine spindle; slab mills/cylindrical cutters and side and face cutters on long arbors; end mills and slot drills in collet chucks; mounting drills in chucks or by the use of morse taper sockets)

13. how to position the workpiece in relation to the milling cutters to give conventional or climb milling conditions

14. how to check that the milling cutters are in a safe and usable condition, and how to handle and store cutters safely

15. the effects of backlash in machine slides and screws, and how this can be overcome

16. the techniques of taking trial cuts and checking dimensional accuracy; the application of roughing and finishing cuts and the effect on tool life, surface finish and dimensional accuracy

17. factors that affect the selection of cutting feeds and speeds, and the depth of cut that can be taken (such as type of material, type of tool used, operations being performed, workholding method/security of workpiece, condition of machine, finish and tolerance required)

18. the application of cutting fluids and compounds with regard to a range of different materials, and why some materials do not require cutting fluids to be used

19. the checks to be carried out on the components before removing them from the machine, and the equipment that will need to be used (including micrometers, verniers and surface texture comparison methods)

20. how to check that the measuring equipment is within current calibration dates and that the instruments are correctly zeroed; measuring linear dimensions (such as lengths, depths, slots, positions, angles, profiles); measuring geometric features (such as flatness, squareness, parallelism); how to check surface finish (such as by using comparison blocks or instruments)

21. the problems that can occur with the milling activities (such as defects caused by worn cutters, inappropriate feeds/speeds, damage by workholding devices), and how these can be overcome

- 22. when to act on your own initiative and when to seek help and advice from others
- 23. the importance of leaving the work area and machine in a safe condition on completion of the milling activities (such as correctly isolated, cutting tools removed, cleaning the machine and removing and disposing of waste)

## Scope/range related to performance criteria

1.

Ensure that you apply **all** of the following checks and practices at all times during the machining activities:

- 1.1 adhere to procedures or systems in place for risk assessment, COSHH, personal protective equipment (PPE) and other relevant safety regulations
- 1.2 machine guards are in place and correctly adjusted
- 1.3 components are held securely (without damage or distortion)
- 1.4 cutting tools are maintained in a suitable/safe condition
- 1.5 make sure the work area is maintained and left in a safe and tidy condition

2.

Machine components made from **two** of the following types of material:

- 2.1 low carbon/mild steel
- 2.2 cast iron
- 2.3 plastic/nylon/composite
- 2.4 high carbon steel
- 2.5 brass/brass alloys
- 2.6 aluminium/aluminium alloys
- 2.7 other specific material

3.

Mount, secure and machine components, using **two** of the following workholding devices:

- 3.1 fixed vice
- 3.2 direct clamping to machine table
- 3.3 magnetic or pneumatic devices
- 3.4 swivel or universal vice
- 3.5 angle plates
- 3.6 chucks
- 3.7 fixtures
- 3.8 vee block and clamps
- 3.9 indexing device

4.

Mount and use **four** of the following types of milling cutters/tools:

- 4.1 face mills
- 4.2 slot cutters
- 4.3 twist/core drills
- 4.4 slab/cylindrical cutters
- 4.5 slitting saws
- 4.6 reamers
- 4.7 end mills
- 4.8 vee cutters

Preparing and using milling machines

---

- 4.9 boring bars
- 4.10 slot drills
- 4.11 other form cutters
- 4.12 taps
- 4.13 side and face cutters

5.

Produce machined components that combine different operations and have features that cover **all** of the following:

- 5.1 flat faces
- 5.2 parallel faces
- 5.3 open ended slots
- 5.4 square faces
- 5.5 steps/shoulders
- 5.6 enclosed slots

Plus **two** more of the following:

- 7. angular faces
- 8. drilled holes
- 9. bored holes
- 10. indexed or rotated forms
- 11. recesses
- 12. tee slots
- 13. profile forms (such as vee, concave, convex, gear forms, serrations, special forms)

1.

Carry out the necessary checks for accuracy, to include **all** of the following:

- 1.1 linear dimensions
- 1.2 surface finish
- 1.3 depths
- 1.4 slots (such as position, width, depth)
- 1.5 flatness
- 1.6 angles (where appropriate)
- 1.7 squareness
- 1.8 hole size/fit (where appropriate)

2.

Use the following measuring equipment during the machining and checking activities:

- 2.1 external micrometers
- 2.2 dial test indicators (DTI)
- 2.3 Vernier/digital/dial callipers
- 2.4 surface finish equipment (such as comparison plates, machines)

Plus **four** more of the following

- 5. rules

6. feeler gauges
7. squares
8. bore/hole gauges
9. internal micrometers
10. slip gauges
11. depth micrometers
12. radius/profile gauges
13. depth Verniers
14. protractors
15. coordinate measuring machine (CMM)

1.

Produce components to **all** of the following quality and accuracy standards, as applicable to the operation:

- 1.1 components to be free from false tool cuts, burrs and sharp edges
- 1.2 general dimensional tolerance  $\pm 0.25\text{mm}$  or  $\pm 0.010''$
- 1.3 there must be one or more specific dimensional tolerances within  $\pm 0.1\text{mm}$  or  $\pm 0.004''$
- 1.4 flatness and squareness within  $0.125\text{mm}$  per  $25\text{mm}$  or  $0.005''$  per inch
- 1.5 reamed holes within H8
- 1.6 surface finish  $63\ \mu\text{in}$  or  $1.6\ \mu\text{m}$
- 1.7 angles within  $\pm 1$  degree

## Behaviours

# Additional Information

You will be able to apply the appropriate behaviours required in the workplace to meet the job profile and overall company objectives, such as:

- strong work ethic
- positive attitude
- team player
- dependability
- responsibility
- honesty
- integrity
- motivation
- commitment

Preparing and using milling machines
 

---

<b>Developed by</b>	Enginuity
---------------------	-----------

<b>Version Number</b>	3
-----------------------	---

<b>Date Approved</b>	30 Mar 2017
----------------------	-------------

<b>Indicative Review Date</b>	31 Mar 2020
-------------------------------	-------------

<b>Validity</b>	Current
-----------------	---------

<b>Status</b>	Original
---------------	----------

<b>Originating Organisation</b>	Semta
---------------------------------	-------

<b>Original URN</b>	SEMPEO2-12
---------------------	------------

<b>Relevant Occupations</b>	Engineering, Engineering and Manufacturing Technologies
-----------------------------	---

<b>Suite</b>	Performing Engineering Operations Suite 2
--------------	---

<b>Keywords</b>	engineering; engineering operations; milling; manufacturing; horizontal; vertical; universal; mounting; material; tooling
-----------------	---