

Overview

This standard covers a 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 milling activities by obtaining all the necessary job instructions, materials, tools, equipment and any documentation that may be required.

In machining the workpieces, you will be required to work to instructions, to mount, position and set the workpiece, and to use cutting feeds and speeds and techniques appropriate to the type of material, tooling and operations 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 holes and special forms/profiles.

During, and on completion of, the milling operations, you will be expected to check the quality of your work, 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 put right any faults that occur, and to ensure that the finished workpiece is within the drawing requirements. On completion of the milling activities, you will be expected to leave the 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 report any difficulties or problems that may arise, and to carry out any agreed actions. 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 produce.

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

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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

At least one of the components produced must combine different features and techniques, for example: by producing a component which involves milling a block flat and square, and cutting out a slot.

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Performance criteria

- You must be able to:*
- P1 work safely at all times, complying with health and safety legislation, regulations and other relevant guidelines
 - P2 obtain and prepare the appropriate materials, tools and equipment
 - P3 mount the workpiece safely and securely, in line with instructions
 - P4 set and adjust the machine tool speeds and feeds, in line with instructions
 - P5 use the machine tool controls safely and correctly, in line with operational procedures
 - P6 check that the finished components meet the standard required
 - P7 report any difficulties or problems that may arise with the milling activities, and carry out any agreed actions
 - P8 shut down the equipment to a safe condition on completion of the milling activities

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Knowledge and understanding

You need to know and understand:

- K1 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)
- K2 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
- K3 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)
- K4 the safety mechanisms on the machine (such as emergency stop buttons, emergency brakes), and the procedure for checking that they function correctly
- K5 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
- K6 the importance of keeping the work area clean and tidy (such as cleaning the machine, disposal of waste, ensuring that any spilt cutting fluids are correctly dealt with)
- K7 how to use and extract information from engineering drawings and related specifications (to include BS or ISO standard symbols and abbreviations, imperial and metric systems of measurement, workpiece reference points and system of tolerancing)
- K8 the effects of clamping the workpiece in a vice or other work holding device, and how this can cause damage or distortion in the finished components
- K9 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)
- K10 how to position the workpiece in relation to the milling cutters, to give conventional or climb milling conditions
- K11 how to check that the milling cutters to be used are in a safe and usable condition
- K12 the effects of backlash in machine slides and screws, and how this can be overcome
- K13 the techniques of taking trial cuts and checking dimensional accuracy
- K14 the application of roughing and finishing cuts, and the effect on tool life,

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- surface finish and dimensional accuracy
- K15 the type of cutting tool, cutting feeds and speeds to be used, and the depth of cut that can be taken
- K16 the application of cutting fluids and compounds, and why some materials do not require cutting fluids to be used
- K17 how to recognise machining faults, and how to identify when cutters need re-sharpening
- K18 the checks to be carried out on the components before removing them from the machine (such as have all operations been completed, dimensional checks, surface finish checks)
- K19 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
- K20 when to act on your own initiative and when to seek help and advice from others
- K21 the importance of leaving the machine in a safe condition on completion of activities (such as correctly isolated, cutting tools removed, cleaning the machine, and removing and disposing of waste)

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Additional Information

Scope/range related to performance criteria

You must be able to:

1. Carry out **all** of the following at all times during the milling 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 ensure that machine guards are in place and correctly adjusted
 - 1.3 ensure that components are held securely (without damage or distortion)
 - 1.4 ensure that cutting tools are maintained in a suitable/safe condition
 - 1.5 apply safe and appropriate milling techniques and procedures at all times
 - 1.6 ensure that the work area is maintained and left in a safe and tidy condition

2. Machine components made from **one** 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 **one** 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. Use **two** of the following types of milling cutter/tool:
 - 4.1 face mills

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- 4.2 slot drills
 - 4.3 slitting saws
 - 4.4 slab/cylindrical cutters
 - 4.5 side and face cutters
 - 4.6 form cutters (such as vee or radius)
 - 4.7 end mills
 - 4.8 slot cutters
 - 4.9 twist/core drills
5. Produce machined components which combine different operations and have features that cover **six** of the following:
- 5.1 flat faces
 - 5.2 angular faces
 - 5.3 drilled holes
 - 5.4 parallel faces
 - 5.5 open ended slots
 - 5.6 bored holes
 - 5.7 square faces
 - 5.8 enclosed slots
 - 5.9 tee slots
 - 5.10 steps/shoulders
 - 5.11 recesses
 - 5.12 indexed or rotated forms
 - 5.13 profile forms (such as vee, concave, convex, serrations)
6. Carry out checks for accuracy, to include **four** of the following:
- 6.1 linear dimensions
 - 6.2 surface finish
 - 6.3 flatness
 - 6.4 slots (such as position, width, depth)
 - 6.5 squareness
7. Use **four** of the following types of measuring equipment during the machining and checking activities:
- 7.1 rules
 - 7.2 gauges
 - 7.3 external micrometers
 - 7.4 protractors
 - 7.5 squares
 - 7.6 surface finish equipment (such as comparison plates, machines)
 - 7.7 Vernier callipers
8. Produce components to **all** of the following quality and accuracy standards applicable to the operation:
- 8.1 components to be free from false tool cuts, burrs and sharp edges

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- 8.2 dimensional tolerance +/- 0.25mm or +/- 0.010"
- 8.3 flatness and squareness within 0.125mm per 25mm or 0.005" per inch
- 8.4 surface finish 63 μin or 1.6 μm
- 8.5 angles within +/- 1 degree

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Developed by SEMTA

Version number 2

Date approved December 2011

Indicative review date December 2016

Validity Current

Status Original

Originating organisation SEMTA

Original URN 08

Relevant occupations Engineering; Engineering and manufacturing technologies;

Suite Performing Engineering Operations Suite 1

Key words performing engineering operations, milling machines, manufacturing, horizontal milling, vertical milling, universal milling, tooling, cutting feeds, cutting speeds, material