

# SEMPEO2-05 - SQA Unit Code FP27 04

## Producing components using hand fitting techniques



### Overview

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

You will be expected to prepare for the hand fitting activities by obtaining all the necessary information, documentation, tools and equipment required, and to plan how you intend to carry out the required fitting activities and the sequence of operations you intend to use. You will be required to select the appropriate equipment to use, based on the operations to be carried out and the accuracy required.

In producing the components, you will be expected to use appropriate tools and equipment to mark out the material for a range of features to be produced, and then to use hand tools, portable power tools, and shaping and fitting techniques appropriate to the type of material and operations being performed. These activities will include hand sawing, band sawing, filing, drilling, chiselling, threading, scraping, lapping and off-hand grinding. The components produced will have features that include flat, square, parallel and angular faces, radii and curved profiles, drilled holes, internal and external threads, and sliding or mating parts.

During, and on completion of, the fitting 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 fitting 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 fitting activities, you will be expected to return all tools and equipment to the correct locations, and to leave the 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 fitting activities undertaken. You will need to take account of any potential difficulties or problems that may arise with the fitting 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

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will enable you to apply appropriate hand fitting techniques safely. You will understand the hand fitting 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 using hand fitting techniques, and when using hand and power tools. 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 fitting operations, 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 7.

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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 plan the fitting activities before you start them
  - P3 obtain the appropriate tools and equipment for the hand fitting operations, and check that they are in a safe and usable condition
  - P4 mark out the components for the required operations, using appropriate tools and techniques
  - P5 cut and shape the materials to the required specification, using appropriate tools and techniques
  - P6 measure and check that all dimensional and geometrical aspects of the component are to the specification
  - P7 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
  - P8 leave the work area in a safe and tidy condition on completion of the fitting activities

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### Knowledge and understanding

*You need to know and understand:*

- K1 the health and safety requirements and safe working practices and procedures required for the hand fitting activities undertaken
- K2 the importance of wearing appropriate protective clothing and equipment (PPE), and of keeping the work area safe and tidy
- K3 the hazards associated with the hand fitting activities (such as use of power tools, trailing leads or hoses, damaged or badly maintained tools and equipment, using files with damaged or poor fitting handles), and how they can be minimised
- K4 the procedure for obtaining the required drawings, job instructions and other related specifications
- K5 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
- K6 how to interpret first and third angle drawings, imperial and metric systems of measurement, workpiece reference points and system of tolerancing
- K7 how to prepare the materials in readiness for the marking out activities, in order to enhance clarity, accuracy and safety (such as visually checking for defects, cleaning the materials, removing burrs and sharp edges, applying a marking out medium)
- K8 how to select and establish a suitable datum; the importance of ensuring that marking out is undertaken from the selected datum, and the possible effects of working from a different datum
- K9 methods of holding and supporting the workpiece during the marking out activities, and equipment that can be used (such as surface plates, angle plates, vee blocks and clamps, parallel bars, screw jacks)
- K10 use of marking out conventions when marking out the workpiece (including datum lines, cutting guidelines, square and rectangular profiles, circular and radial profiles, angles, holes which are linearly positioned, boxed and on pitch circles)
- K11 ways of laying out the marking out shapes or patterns to maximise use of materials
- K12 the need for clear and dimensional accuracy in marking out to specification and drawing requirements
- K13 setting and adjusting tools (such as squares, protractors and verniers)
- K14 the importance of using tools only for the purpose intended; the care that is required when using the equipment and tools; the proper way of storing tools and equipment between operations
- K15 the cutting and shaping methods to be used, and the sequence in which the operations are to be carried out
- K16 the various types of file that are available, and the cut of files for different

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- applications
- K17 the importance of ensuring that file handles are secure and free from embedded foreign bodies or splits
  - K18 how to prepare the components for the filing operations (cleaning, deburring, marking out)
  - K19 the use of vice jaw plates to protect the workpiece from damage
  - K20 how to file flat, square and curved surfaces, and how to achieve a smooth surface finish (such as by draw filing, the use of abrasive cloth, lapping using abrasive pastes)
  - K21 how to select saw blades for different materials, and how to set the saw blades for different operations (such as cutting externally and internally)
  - K22 how to cut external threads using hand dies, and the method of fixing and adjusting the dies to give the correct thread fit
  - K23 how to determine the drill size for tapped holes, and the importance of using the taps in the correct sequence
  - K24 how to prepare drilling machines for operations (such as adjustment of table height and position; mounting and securing drills, reamers, countersink and counterbore tools in chucks or morse taper sockets; setting and adjusting spindle speeds; setting and adjusting guards/safety devices)
  - K25 how to mount the workpiece (such as in a machine vice, clamped to table, clamped to angle brackets); techniques of positioning drills to marking out, use of centre drills and taking trial cuts and checking accuracy, and how to correct holes which are off centre
  - K26 how to produce a sliding or mating fit using filing, scraping and lapping techniques
  - K27 the problems that can occur with the hand fitting activities, and how these can be overcome (such as defects caused by incorrectly ground drills, inappropriate speeds, damage by workholding devices)
  - K28 when to act on your own initiative and when to seek help and advice from others
  - K29 the importance of leaving the work area in a safe and clean condition on completion of the fitting activities (such as removing and storing power leads, isolating machines, removing and returning drills, cleaning the equipment 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 during the hand fitting 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 follow job instructions, assembly drawings and procedures
  - 1.3 ensure that all power tool cables, extension leads or air supply hoses are in a serviceable condition
  - 1.4 check that all measuring equipment is within calibration date
  - 1.5 ensure that the components used are free from foreign objects, dirt or other contamination
  - 1.6 return all tools and equipment to the correct location on completion of the fitting activities
  
2. Mark out a range of material forms, to include **two** of the following:
  - 2.1 square/rectangular (such as bar stock, sheet material, machined components)
  - 2.2 circular/cylindrical (such as bar stock, tubes, turned components, flat discs)
  - 2.3 sections (such as angles, channel, tee section, joists, extrusions)
  - 2.4 irregular shapes (such as castings, forgings, odd shaped components)
  
3. Use marking out methods and techniques, to include:
  - 3.1 direct marking using instrumentsPlus **one** more of the following:
  - 3.2 use of templates
  - 3.3 tracing/transfer methods
  
4. Use a range of marking out equipment, to include **all** of the following:
  - 4.1 rules/tapes
  - 4.2 scribes
  - 4.3 scribing blocks
  - 4.4 protractor
  - 4.5 dividers/trammels
  - 4.6 punches
  - 4.7 squares

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- 4.8 vernier instruments
  
- 5. Mark out workpieces which include **all** of the following features:
  - 5.1 datum/centre lines
  - 5.2 circles
  - 5.3 linear hole positions
  - 5.4 square/rectangular profiles
  - 5.5 radial profilesPlus **one** more from the following:
  - 5.6 angles/angular profiles
  - 5.7 allowances for bending
  - 5.8 simple pattern development
  - 5.9 radial hole positions
  
- 6. Use both of the following hand fitting activities:
  - 6.1 filing
  - 6.2 hand sawingPlus **one** more from the following:
  - 6.3 power sawing
  - 6.4 scraping
  - 6.5 lapping
  - 6.6 off hand grinding
  - 6.7 chiselling
  
- 7. Produce components which combine different operations and have features that cover **all** of the following:
  - 7.1 flat datum faces
  - 7.2 drilled through holes
  - 7.3 internal threads
  - 7.4 faces which are square to each other
  - 7.5 reamed holes
  - 7.6 external threads
  - 7.7 curved profilesPlus **three** more from the following:
  - 7.8 faces that are parallel to each other
  - 7.9 chamfers and radii
  - 7.10 faces angled to each other
  - 7.11 counterbore, countersink, or spot face
  - 7.12 holes drilled to a depth
  - 7.13 sliding or mating parts
  
- 8. Cut and shape **two** different types of material from the following:
  - 8.1 low carbon/mild steel
  - 8.2 stainless steel
  - 8.3 plastic/nylon/synthetic

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- 8.4 high carbon steel
  - 8.5 aluminium/aluminium alloys
  - 8.6 composite
  - 8.7 cast iron
  - 8.8 brass/brass alloys
  - 8.9 other specific material
9. Carry out the necessary checks for accuracy, to include **all** of the following:
- 9.1 linear dimensions
  - 9.2 hole position
  - 9.3 flatness
  - 9.4 hole size/fit
  - 9.5 squareness
  - 9.6 depths
  - 9.7 angles
  - 9.8 thread size and fit
  - 9.9 profiles
  - 9.10 surface finish
10. Use **all** of the following measuring equipment during the hand fitting and checking activities:
- 10.1 external micrometers
  - 10.2 surface finish equipment (such as comparison plates, machines)
  - 10.3 Vernier calliper
- Plus **four** more of the following:
- 10.4 rules
  - 10.5 feeler gauges
  - 10.6 squares
  - 10.7 bore/hole gauges
  - 10.8 callipers
  - 10.9 slip gauges
  - 10.10 protractors
  - 10.11 radius/profile gauges
  - 10.12 depth micrometers
  - 10.13 thread gauges
  - 10.14 depth verniers
  - 10.15 dial test indicators (DTI)
  - 10.16 coordinate measuring machine (CMM)
11. Produce components to **all** of the following standards, as applicable to the process:
- 11.1 components to be free from false tool cuts, burrs and sharp edges
  - 11.2 general dimensional tolerance  $\pm 0.25\text{mm}$  or  $\pm 0.010''$
  - 11.3 there must be one or more specific dimensional tolerances within  $\pm 0.1\text{mm}$  or  $\pm 0.004''$



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- 11.4 flatness and squareness 0.05mm per 25mm or 0.002" per inch
- 11.5 angles within +/- 1 degree
- 11.6 screw threads to BS Medium fit
- 11.7 reamed and bored holes within H8
- 11.8 surface finish 63 µin or 1.6 µm

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