

## Producing off-line programs for CNC turning machines

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### Overview

This standard identifies the competences you need to produce computer numerically controlled (CNC) turning programs off-line, in accordance with approved procedures. You will be required to set up and activate the programming software, to produce the program, and to check that the system is operating correctly. You must ensure that you have been provided with accurate, current, complete data and information in order to produce the program. You will be required to produce efficient and effective programs, combining a range of different operations. The program format will avoid unnecessary operations and tool movements, by using appropriate commands such as repeat programs/sub-routines, correct reference codes, and preparatory commands for the machine management and auxiliary functions. On completion of the programming activities, you will be required to save and/or convert the program in the correct format and save it in the correct location.

Your responsibilities will require you to comply with organisational policy and procedures for producing the CNC turning programs, and to report any problems with these activities that you cannot personally resolve, or are outside your permitted authority, to the relevant people. You will be expected to work with a minimum of supervision, taking personal responsibility for your own actions and for the quality and accuracy of the work that you carry out.

Your underpinning knowledge will provide a good understanding of your work and will provide an informed approach to applying the CNC turning programming methods and procedures. You will understand the CNC machining capabilities, tools used in the process, and their application, the materials being machined and the effect this has on material removal rates, speeds and feeds and surface finish. You will know about the CNC programming codes, in adequate depth to provide a sound basis for carrying out the activities, correcting faults and ensuring that the program produced will manufacture the components to the required specification in the most efficient way.

You will understand the safety precautions required when working on computer systems and associated 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.

Direct machine programming and proving are the subject of other standards.

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### Performance criteria

You must be able to:

1. work safely at all times, complying with health and safety legislation and other relevant regulations, directives and guidelines
2. produce computer control programs that contain all the relevant and necessary data for the engineering activity to be carried out
3. produce the control programs using the appropriate formats
4. make sure that codes and other references used in the programs are applicable to the type of controller used
5. send the programs to the appropriate people, within agreed timescales
6. save and back up the program detail, and store securely in accordance with organisational requirements
7. undertake changes to program details, within agreed control procedures

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## Knowledge and understanding

## You need to know and understand:

1. the specific safety precautions to be taken when working with computer systems (to include safety guidance relating to the use of visual display unit (VDU), equipment and workstation environment, repetitive strain injury (RSI); the dangers of trailing leads and cables; how to spot faulty or dangerous electrical leads, plugs and connections)
2. how to return the work area to a safe and useable condition (such as cleaning down work surfaces; putting media, manuals and unwanted items of equipment into safe storage; leaving the work area in a safe and tidy condition)
3. the basic set-up and operation of the computer system, and any peripheral devices that are used
4. the correct start-up and shutdown procedures to be used for the computer system
5. how to access the specific programming software, and the use of manuals and related documents to solve problems and aid the efficient programming of CNC turning machines
6. the importance of protecting the computer system from viruses, and the implications if the correct procedure is not followed
7. how to power up, log on and activate the computer system and programming software correctly
8. how to deal with system problems (such as error messages received, peripherals which do not respond as expected)
9. the checks to be carried out to ensure that peripheral devices are connected correctly
10. the correct procedure to shut down the operating and programming system
11. how to create and structure directories and files correctly (such as importing, copying, transferring, exporting, deleting, backing up and saving files)
12. the different types of storage media that can be used to save program files
13. the offline programming methods used in CNC turning (such as computer aided machining (CAM), G code and conversational code)
14. the different programming codes used to identify factors such as machine axes, positional information, tooling identification and selection, tool/cutter direction, material removal, speeds and feeds, machine management and auxiliary functions
15. the main machine controllers that are available, and the importance of understanding that a different machine controller may use completely different codes for similar functions
16. the information and data required in order to produce complete and

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- accurate CNC turning programs
17. how to extract and interpret general and technical data and information from different sources (such as drawings, computer models, symbols and conventions, BS or ISO standards), in order to produce the CNC turning program
  18. the importance of undertaking test runs to prove the program is following the correct operational sequence
  19. the factors to be considered when producing CNC programs (including the type of CNC turning machine and its machining capabilities, the tooling available, safety, workholding equipment, the material being machined, component tolerances and surface finish required)
  20. the different methods used to set tooling (such as manual methods, probing and tool setting arms)
  21. how to produce effective and efficient programs to avoid unnecessary operations, tool movements and tool changes (including the use of macro programs and canned cycles, to reduce program size)
  22. the methods and procedures used to check that the completed program will produce the required component safely, accurately and efficiently
  23. how to save the completed programs in the appropriate format, and the need to store programs safely and correctly
  24. how to back up completed or edited programs, and the implications if this is not carried out effectively
  25. the problems that can occur with the downloading and running of the CNC turning program, and how these can be overcome
  26. the correct procedure to be followed before the program is released to the end user
  27. the extent of your own responsibility, and whom you should report to if you have problems that you cannot resolve

### Scope/range

1. Carry out all of the following in preparation for the CNC programming:
  1. check that all the equipment is correctly connected, and is in a safe, tested and usable condition (such as cables undamaged, correctly connected, safely routed)
  2. power up the equipment and activate the programming software
  3. set up the computer system to be able to produce the program
  4. ensure that you have the necessary component data and information to produce the program
  5. identify and deal with problems (such as information based and/or technical)
2. Produce computer control programs using one of the following methods:
  1. computer aided machining (CAM)
  2. conversational code
  3. G code
  4. other specific method (such as macros)
3. Carry out all of the following, as applicable to the programming method selected:
  1. interpret technical information and work to drawing dimensions and tolerance criteria
  2. import the component data file and/or produce the shape/geometry of the component
  3. select a suitable or specified datum point
  4. select absolute and/or incremental system of measurement
  5. select imperial or metric system of measurement
  6. input the safe start/finishing position
  7. input material parameters
  8. select or create tool/cutter information (such as number, type, lengths and offsets, radius compensation)
  9. select appropriate reference codes
  10. input the required positional information
  11. input cutting parameters (such as depth of cut, direction, feed in/out, correct spindle speed, tool clearance)
  12. input preparatory commands and machine management/auxiliary functions
  13. use repetitive programs (sub-routines, canned cycles, labels, macros)

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14. determine tool/cutter path order and sequence
  15. select and input tool change positions
  16. input any additional information (such as work-shift position)
  17. convert the program into the correct format (post processing)
  18. check tool wear allowances
4. Produce turning programs, combining different operations that will produce twelve of the following features:
1. parallel diameters
  2. external screw threads
  3. stepped diameters
  4. internal screw threads
  5. tapered diameters
  6. chamfers and radii
  7. flat faces
  8. bored holes
  9. angled faces
  10. grooves
  11. internal undercuts
  12. special finishes (such as knurls)
  13. external undercuts
  14. internal profiles
  15. external profiles
  16. reamed holes
  17. tapped holes
  18. drilled holes
  19. parting-off
  20. eccentric features
  21. other specific features
5. Carry out all of the following on completion of the programming activity:
1. check and review the program format and content
  2. edit the program using the correct procedure (where appropriate)
  3. produce tooling sheets (to include information such as tool identification, tips and grades, fixtures and methods of setting up, where appropriate)
  4. check that the program has the correct identification name and reference
  5. ensure that programs are stored safely and correctly, in the correct format and location
  6. ensure that the program has been checked and approved before forwarding to the end user
  7. send a copy of the approved program to the correct location for the end user
  8. create a separate back-up copy of the program, in case of file

corruption or accidental deletion

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