



SOUTH AFRICAN QUALIFICATIONS AUTHORITY (SAQA)

In accordance with regulation 24(c) of the Regulations of 28 March 1998, the Standards Generating Body (SGB) for

Manufacturing and Assembly

registered by Organising Field 06, Manufacturing, Engineering and Technology, publishes the following qualifications and unit standards for public comment.

This notice contains the titles, fields, sub-fields, NQF levels, credits, and purpose of the qualifications and unit standard. The qualifications and unit standard can be accessed via the SAQA web-site at www.saqqa.org.za. Copies may also be obtained from the Directorate of Standards Setting and Development at the SAQA offices, SAQA House, 1067 Arcadia Street, Hatfield, Pretoria.

Comment on the qualification and unit standards should reach SAQA at the address **below and no later than 23 December 2006**. All correspondence should be marked **Standards Setting – SGB for Chemical Industries** and addressed to

The Director: Standards Setting and Development
SAQA
Attention: Mr. D. Mphuthing
Postnet Suite 248
Private Bag X06
Waterkloof
0145
or faxed to 012 – 431-5144
e-mail: dmphuthing@saqa.org.za

DR. S BHIKHA
DIRECTOR: STANDARDS SETTING AND DEVELOPMENT



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

National Certificate: CNC Production Machining

SAQA QUAL ID	QUALIFICATION TITLE		
57878	National Certificate: CNC Production Machining		
SGB NAME	ORGANISING FIELD ID	PROVIDER NAME	
SGB Manufacturing and Assembly Processes	6		
QUAL TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD	
National Certificate	Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	MINIMUM CREDITS	NQF LEVEL	QUALIFICATION CLASS
Undefined	131	Level 2	Regular-Unit Stds Based

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of the qualification is to provide learners, education and training providers and employers with the standards and the range of learning required to work effectively in various industries making use of CNC production machining skills and to meet the challenges of such an environment.

This is the first qualification in a learning pathway for learners who want to follow a career in the field of CNC production machining, specifically in facilities which use machining and turning centres.

People working in the CNC production machining field require specialised technical skills and knowledge which combine some hand skills and an understanding of machining processes with more intensive production methods, greater control over the accuracy of dimensions and the maintenance of quality standards.

The primary skills that are recognised in this qualification are the ability to operate CNC equipment which manufactures precision machined components and the ability to monitor and record quality data and interpret statistical process control graphs. These capabilities require an understanding of basic machining theory; machinery functioning and maintenance; engineering materials and tools; and concepts of measurement, basic engineering drawings and basic statistics. Hand skills play a role in this qualification.

Qualified learners will also understand:

- > The basics of how a business functions.
- > Their role in the business, i.e. in production and related activities.
- > How they are affected by legislation, regulations, agreements and policies related to their particular work environment.

With this understanding learners will be able to participate effectively in workplace activities.

Rationale:

The rapid uptake of new technology in the form of computerised numeric control (CNC) systems in South Africa and the emergence of South Africa as a cost-effective supplier to international markets has created a demand for people with the skills to operate, set and programme such equipment. In order to meet this demand, the industry needs an engineering machining qualification which focuses on the understanding and use of CNC systems and statistical process control (SPC). This qualification represents a shift away from the traditional field of engineering machining, which is characterised by work-to-order, low volume manufacture of components using various machining methods. The emerging industry is characterised by greater precision, higher volumes, and higher standards of quality. This qualification spells out the skills needed to

operate successfully in this new field.

This is the first in a learning pathway of four qualifications in a learning pathway for CNC production machining. The pathway ends with the National Certificate in CNC Production Machining NQF Level 5. The qualifications provide a developmental pathway for the full range of activities required for production machining. The skills and knowledge required are described in a generic manner so that the changing needs of particular worksites can be met without requiring changes to the qualification or the unit standards.

Typical learners would be new entrants to the industry and existing employees with some experience in CNC production machining. Once qualified, they would typically monitor machining processes and product quality. They would perform tasks under supervision within the context of an overall team. This role represents a recognised position in the organisation.

This qualification represents the learning progression for an occupation which focuses on the machining of precision parts and components using computer numerical control (CNC). The stages of development related to CNC machining equipment are:

- > Operator.
- > Setter, including elements of programming.
- > Programmer, including trouble shooting and management of manufacturing processes.
- > Specialist, including process design, costing, trouble shooting and selection and implementation of new technology.

Machining includes processes such as cutting, boring, turning, milling and grinding. It may also include punching and nibbling.

These occupations have evolved from the traditional mechanical engineering trades such as machinist, turner and tool, jig and die maker. CNC has replaced manual operations and the focus has become the repeatable precision machining of components in a production environment, often as mass-production but not excluding small batches of product.

This qualification series recognises skills, knowledge and values relevant to a workplace and requires workplace experience. It is suitable for learners who:

- > Attend courses and then apply the knowledge gained to activities in the workplace (Portfolio to reflect formative assessment).
- > Are already workers and have acquired the skills and knowledge without attending formal courses (RPL can be done through the summative assessment and portfolio of evidence).
- > Participate in skills programmes and have the appropriate work experience.
- > Are part of a learnership programme which integrates structured learning and work experience.
- > Acquire their learning through any combination of the above.

The outcomes of this qualification combine skills and knowledge in the technical, inter-personal and business spheres, enabling the learner to perform the operational aspects of the work, function within a team context and contribute to value-adding processes within the organisation.

This qualification provides learners who have gained relevant experience in the workplace with an opportunity to obtain credits through an RPL process.

It also forms the basis for further learning in the field of CNC production machining where the learner will be able to specialise in setting and programming CNC machinery.

Learner achievements will contribute to the ability of South African companies to compete for work in the global economy, thus securing jobs and employment opportunities.

RECOGNIZE PREVIOUS LEARNING?

Y

LEARNING ASSUMED TO BE IN PLACE

The following competencies are assumed for a learner accessing this qualification:

- > Communication, NQF Level 1
- > Mathematical Literacy, NQF Level 1.

Recognition of Prior Learning:

This qualification may be obtained through a process of RPL. The learner should be thoroughly briefed prior to the assessment and support should be provided to assist the learner in the process of developing a portfolio. The guidelines for integrated assessment should be used to develop the RPL assessment process. As with integrated assessment, while this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the Exit Level Outcomes.

Access to the qualification:

There is open access to this qualification. A workplace is, however, a prerequisite to obtaining the relevant work experience and evidence required for the assessment of the Exit Level Outcomes.

QUALIFICATION RULES

- > The total number of credits for this qualification is 131.
- > The total number of credits in the Fundamental component is 36.
- > The total number of credits in the Core component is 83.
- > The minimum number of Elective credits is 12.

The elective credits should be chosen in accordance with the requirements of the selected context and the interests of the learner.

EXIT LEVEL OUTCOMES

1. Demonstrate an understanding of a CNC machining method and the ability to produce precision components.
 - > Range: Producing precision components includes deburring and any other finishing operation machining method: either turning, milling, boring, cutting or grinding.
2. Carry out routine machine operations and maintenance tasks.
3. Monitor and record production and quality data and respond to error conditions, malfunctions and faults.
 - > Range: Monitoring includes understanding the use and purpose of gauges and measuring instruments.
4. Communicate with peers and members of supervisory/management levels.

Critical Cross-Field Outcomes:

The critical cross-field outcomes are supported by the exit level outcomes as follows:

- > Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made. Refer Exit Level Outcomes 1, 2, 3, 4.
- > Working effectively with others as a member of a team, group, organization and community. Refer to Exit Level Outcomes 1, 2, 3, 4.
- > Organising and managing oneself and one's activities responsibly and effectively. Refer to Exit Level Outcomes 1, 2, 3, 4.
- > Collecting, analyzing, organizing and critically evaluating information. Refer to Exit Level Outcomes 1, 2, 3, 4.
- > Communicating effectively using visual, mathematical and/or language skills. Refer to Exit Level Outcomes 1, 2, 3, 4.
- > Using science and technology effectively and critically, showing responsibility toward the environment and health of others, Refer to Exit Level Outcomes 1, 2, 3, 4.
- > Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation. Refer to Exit Level Outcomes 1, 2, 3, 4.

ASSOCIATED ASSESSMENT CRITERIA

1.
 - > Engineering drawings are read and interpreted to produce components.
 - > Materials used in the workplace are identified and described in accordance with specified requirements.
 - > Safe working practices are adhered to at all times.
 - > Output and quality requirements are met in accordance with set standards.
 - > The theoretical principles of machining, the various machining methods and the functioning of machinery are explained in accordance with specified requirements.
2.
 - > Process agents are applied consistently and systematically.

- > Pre-operational checks are performed in accordance with specified procedures.
- > Problems are identified and reported to appropriate personnel.
- > Key concepts of routine maintenance on machinery are explained in accordance with specified requirements.

3.

- > Data is recorded in accordance with the requirements of the appropriate statistical process control method.
- > Error conditions, faults and malfunctions are recognised and communicated effectively and timeously to the appropriate person.
- > Responses to error conditions are carried out to the nature of the problem.
- > Issues related to routine problems encountered while working are explained in accordance with requirements.

4.

- > Terminology related to engineering concepts, machinery, components and manufacturing processes is used in accordance with requirements.
- > Information is conveyed in a timely manner.
- > Relationships with peers and supervisory/management levels are established and functioning in accordance with organisational requirements.
- > Regular and ongoing communication is carried out in accordance with requirements.

Integrated Assessment:

The integrated assessment should be based on a summative assessment guide. The guide will specify how the assessor will assess different aspects of the performance and will include:

- > Evaluating evidence in a portfolio of evidence, particularly projects which integrate various aspects of the qualification and which demonstrate the integration of all aspects of learning: fundamental and core; knowledge, skills and values; the development of the critical outcomes.
- > Observing and listening to the learner at work, both in primary activities as well as in other interactions, or in relevant simulations.
- > Asking questions and initiating short discussions to test understanding and to verify other evidence.
- > Looking at records and reports.
- > Formative and summative assessment of unit standards.

Assessment of competence for this qualification is based on the experience acquired by the learner in the workplace, within the particular CNC production machining context. The assessment process should cover the explicit tasks required for the qualification as well as the understanding of the underlying concepts and principles. The assessment process should also establish how the learning process has advanced the Critical Cross-field Outcomes.

The learner may choose in which language he/she wants to be assessed. This should be established as part of a process of preparing the learner for assessment and familiarising the learner with the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be presented if pertinent to any of the Exit Level Outcomes.

Assessors should also evaluate evidence that the learner is able to perform consistently over a period of time.

Learners can be assessed on:

- > A machining centre.
- > A CNC lathe or turning centre.
- > Any other equipment in which material is removed to form the part, eg cutting, boring, grinding.

INTERNATIONAL COMPARABILITY

Comparison was done with the following countries on the basis of best practice and how the practice is incorporated in the South African CNC Production Machining qualifications.

- > Australia
- > Canada
- > Botswana
- > Germany

- > India
- > Kenya
- > Nigeria
- > Sweden
- > UK
- > USA

The general finding is that CNC courses in the countries above are not designed for occupational development on a step-by-step basis. Generally the courses assume a general knowledge of machining or engineering and build specific CNC knowledge and skills onto this.

Sweden offers a 450-hour course in CNC. Other courses are designed to focus on specific pieces of equipment and trade stream such as a turning.

Training processes for the occupations are varied. The following encompass some of the options:

- > Skills and knowledge upgrading of qualified tradespersons in the mechanical engineering field.
- > Short courses and on-the-job training.
- > Apprenticeships.
- > Vocational education and training programmes followed by a work experience component.

Comparisons was therefore done by looking at occupational profiles in the following way:

- > Occupational role: Exit level outcomes
- > Occupational activities: Unit standards and specific outcomes

The occupations and the related career path described in this qualification are similar to descriptions found in various countries belonging to the Organisation for Economic Co-operation and Development (OECD), eg the United States of America.

There are a number of common characteristics found in most general education and training programmes in addition to CNC-specific training. These include:

- > Knowledge and ability to perform manual machining operations in at least one discipline
- > Ability to read and interpret engineering drawings.
- > Knowledge of and ability to use and apply statistical process control techniques.
- > Principles and application of quality management systems, including customer focus.

In addition to these occupation-specific requirements, general requirements such as communication, mathematical literacy, safety, health and the environment, risk assessment, team skills, computer literacy and problem solving abilities are also required.

At operator level the occupational profile becomes less distinct. In most OECD countries the occupation is referred to as CNC machining operator but sometimes also as CNC machining setter. The range of activities can vary from the very simple to those performed by the programmer. The following summarises the most common activities for the CNC setter/operator:

A typical training or re-training programme for such operators is found in this Canadian example:

- > 3 weeks of McBride Training
 - > Personal Skills Development
 - > Computers
 - > Job Search Techniques
 - > Supported Job Search
- > 16 weeks of NAIT Technical Training
 - > Manual Machining Training (Equivalent to Level 1 Apprentice Training)
 - > CNC Machinist Operator Training
- > 3 weeks unpaid work experience at an employer site

The total programme consists of 22 weeks. The programme includes elements which allow the aspirant operator to develop a career in the CNC field.

Comparison with South African NQF level 2 and 3 qualifications

The overall level of responsibility in the above list corresponds with NQF level 3, based on the following activities:

- > Interpret drawings to accurately and efficiently complete parts as specified using shop mathematics.
- > Operate Computerized Numerical Control (CNC) as required.
- > Properly machine all types of material to achieve complete and accurate parts within established/expected timeframes.
- > Use various tools including, but not limited to, deburring tools, hand tools, power tools, overhead cranes (for handling materials and fixtures), various inspection tools as required to fully inspect part, and tool sharpening devices.
- > Detect and report faulty operations, defective material, and any unusual or unsafe conditions to supervisor.

This is reflected in the Exit Level Outcomes:

- > Set up and initiate CNC manufacturing processes.
- > Monitor and control the flow of work.
- > Monitor safety, health and environmental practices.
- > Monitor and maintain the quality of the product.

The type of CNC operator at NQF Level 2 found in South Africa is probably found in most developing countries. It is a low-skill occupation and consists mostly of monitoring the production process and alerting technical staff to problems. Parts finishing, cleaning and routine maintenance may also be required. This qualification reflects the following from the above list:

- > Deburr, clean, and inspection as required.
- > Properly machine all types of material to achieve complete and accurate parts within established/expected timeframes.
- > Use various tools including, but not limited to, deburring tools, hand tools, power tools, overhead cranes (for handling materials and fixtures), various inspection tools as required to fully inspect part, and tool sharpening devices.
- > Maintain work area as required, keeping it free from all scrap material. This includes separating all scrap and machining chips by various alloys as instructed.
- > Maintain work area in a clean and orderly condition.
- > Observe prescribed safety regulations.
- > Keep count and tallies as required.
- > Complete time and work reports.
- > Detect and report faulty operations, defective material, and any unusual or unsafe conditions to supervisor.
- > Maintain proper application of oils and lubricants, and make minor maintenance repairs as necessary.

Other activities and related knowledge is contained in the choice of unit standards and the specific outcomes in the unit standards. In addition to this, the South African qualifications include the tracking of part dimensions in statistical process control charts and recognising and responding to error conditions. As in many of the courses for aspirant operators, manual machining processes and hands-on experience of manual machining have been included as the basis for understanding the process and for recognising problems at this and later stages.

ARTICULATION OPTIONS

This qualification articulates vertically with the National Certificate in CNC Production Machining: NQF Level 3, SAQA ID: 57877.

This qualification articulates horizontally with other engineering qualifications at this level, eg National Certificate: Mechanical Engineering: Fitting and Machining, Level 2, SAQA ID: 23254 or National Certificate: Mechanical Engineering: Machining at NQF Level 2, SAQA ID: 23277.

MODERATION OPTIONS

- > Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education, Training, Quality Assurance (ETQA) Body or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
- > Any institution offering learning that will enable the achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
- > Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a

Memorandum of Understanding with the relevant ETQA, according to the ETQA's policies and guidelines for assessment and moderation.

> Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

The following criteria should be applied by the relevant ETQA:

- > Appropriate qualification with a minimum of 2 years' experience of a relevant process of CNC production machining.
- > Registration as an **assessor** with a relevant ETQA.
- > A relevant qualification at one level higher than the level of the qualification.

NOTES

N/A

UNIT STANDARDS

(Note: A blank space after this line means that the qualification is not based on Unit Standards.)

core	12476	Select, use and care for engineering measuring equipment	Level 2	4	Registered
Elective	12463	Understand and deal with HIV/AIDS	Level 2	3	Registered
Elective	12465	Develop a learning plan and a portfolio for assessment	Level 2	6	Registered
Elective	12466	Explain the individual's role within business	Level 2	4	Registered
Elective	13202	Apply study and learning techniques	Level 2	3	Registered
Elective	110001	Communicate effectively in teams	Level 2	5	Registered
Elective	110016	Hand over responsibility for a manufacturing operation	Level 2	5	Registered
Fundamental	7469	Use mathematics to investigate and monitor the financial aspects of personal and community life	Level 2	2	Reregistered
Fundamental	7480	Demonstrate understanding of rational and irrational numbers and number systems	Level 2	3	Reregistered
Fundamental	9007	Work with a range of patterns and functions and solve problems	Level 2	5	Reregistered
Fundamental	9008	Identify, describe, compare, classify, explore shape and motion in 2- and 3-dimensional shapes in different contexts	Level 2	3	Reregistered
Fundamental	119460	Use language and communication in occupational learning programmes	Level 2	5	Registered
Fundamental	119463	Access and use information from texts	Level 2	5	Registered



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

National Certificate: CNC Production Machining

SAQA QUAL ID		QUALIFICATION TITLE	
57877		National Certificate: CNC Production Machining	
SGB NAME		ORGANISING FIELD ID	PROVIDER NAME
SGB Manufacturing and Assembly Processes		6	
QUAL TYPE		ORGANISING FIELD DESCRIPTION	SUBFIELD
National Certificate		Manufacturing, Engineering and Technology	Fabrication and Extraction
ABET BAND	MINIMUM CREDITS	NQF LEVEL	QUALIFICATION CLASS
Undefined	128	Level 3	Regular-Unit Stds Based

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of the qualification is to provide learners, education and training providers and employers with the standards with the standards and the range of learning required to set up, monitor and troubleshoot the manufacturing process in a CNC production machining environment.

This is the second qualification in a learning pathway for learners who want to follow a career in the field of CNC production machining, specifically in facilities, which use machining and turning centres.

People working in the CNC production machining field require specialised technical skills and knowledge which combine some hand skills and an understanding of machining processes with more intensive production methods, greater control over the accuracy of dimensions and the maintenance of quality standards.

The primary skills that are recognised in this qualification are the ability to set up and initiate CNC machining processes, monitor and control the flow of work, monitor safety, health and environmental practices and monitor and maintain the quality of the product. These capabilities require an understanding of machining theory; machinery functioning, materials, production processes, statistical process control and problem solving.

Qualified learners will also understand:

- > How to maintain business systems and business processes.
- > Their role in the business in production and related activities.
- > How they are affected by legislation, regulations, agreements and policies related to their particular work environment.

With this understanding learners will be able to participate effectively in workplace activities.

Rationale:

The rapid uptake of new technology in the form of computerised numeric control (CNC) systems in South Africa and the emergence of South Africa as a cost-effective supplier to international markets has created a demand for people with the skills to operate, set and programme CNC equipment. In order to meet this demand, the industry needs an engineering machining qualification which focuses on the understanding and use of CNC systems and statistical process control (SPC). This qualification represents a shift away from the traditional field of engineering machining, which is characterised by work-to-order, low volume manufacture of components using various machining methods. The emerging industry is characterised by greater precision, higher volumes, and higher standards of quality. This qualification spells out the skills needed to

operate successfully in this new field.

This is the second in a learning pathway of four qualifications in a learning pathway for CNC production machining. The pathway begins with the National Certificate in CNC Production Machining NQF Level 2 and ends with the National Certificate in CNC Production Machining NQF Level 5. The series provides a developmental pathway for the full range of activities required for production machining. The skills and knowledge required are described in a generic manner so that the changing needs of particular worksites can be met without requiring changes to the qualification or the unit standards.

Typical learners would have achieved the National Certificate in CNC Production Machining NQF Level 2 or be existing employees with some experience in CNC production machining. Once qualified, they would typically set up and operate CNC equipment. They would perform tasks semi-autonomously within the context of an overall team. This role represents a recognised position in the organisation.

This qualification series recognises skills, knowledge and values relevant to a workplace and requires workplace experience. It is suitable for learners who:

- > Attend courses and then apply the knowledge gained to activities in the workplace (Portfolio to reflect formative assessment).
- > Are already workers and have acquired the skills and knowledge without attending formal courses (RPL can be done through the summative assessment and portfolio of evidence).

The outcomes of this qualification combine skills and knowledge in the technical, inter-personal and business spheres, enabling the learner to perform the operational aspects of the work, function within a team context and contribute to value-adding processes within the organisation.

This qualification provides learners who have gained relevant experience in the workplace with an opportunity to obtain credits through an RPL process.

It also forms the basis for further learning in the field of production machining where the learner will be able to plan, set up and improve the manufacturing process, and respond to problems.

Learner achievements will contribute to the ability of South African companies to compete for work in the global economy, thus securing jobs and employment opportunities.

RECOGNIZE PREVIOUS LEARNING?

Y

LEARNING ASSUMED TO BE IN PLACE

The following competencies are assumed for a learner embarking on this qualification:

- > Communication and Mathematical Literacy at NQF Level 2.

In addition, learners are assumed to have the following skills at NQF Level 2 in the context of CNC production machining:

- > Demonstrate an understanding of a machining method and the ability to produce precision components.
- > Carry out routine machine operations and maintenance tasks.
- > Monitor and record production and quality data and recognise and respond to error conditions, malfunctions and faults.

Recognition of Prior Learning:

This qualification may be obtained through a process of RPL. The learner should be thoroughly briefed prior to the assessment and support should be provided to assist the learner in the process of developing a portfolio. The guidelines for integrated assessment should be used to develop the RPL assessment process. As with integrated assessment, while this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the Exit Level Outcomes.

Access to the qualification:

There is open access to this qualification. A workplace is, however, a prerequisite to obtaining the relevant work experience and evidence required for the assessment of the Exit Level Outcomes.

QUALIFICATION RULES

- > The total number of credits for this qualification is 128

- > The total number of credits in the Fundamental component is 36
- > The total number of credits in the Core component is 80
- > The minimum number of Elective credits is 12

The elective credits should be chosen in accordance with the requirements of the selected context and the interests of the learner.

EXIT LEVEL OUTCOMES

1. Set up and initiate CNC manufacturing processes.
 - > Range: Enter tool off-sets unless tools have been preset; load or manually enter and edit machining instructions, includes selecting a programme and producing the final product.
2. Monitor and control the flow of work.
3. Monitor safety, health and environmental practices.
4. Monitor and maintain the quality of the product.

Critical Cross-field Outcomes:

The Critical Cross-Field Outcomes are supported by the Exit Level Outcomes as follows:

- > Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.

Refer to Exit Level Outcomes 1, 2, 3 and 4.

- > Working effectively with others as a member of a team, group, organization and community.

Refer to Exit Level Outcomes 1, 2, 3 and 4.

- > Organising and managing oneself and one's activities responsibly and effectively.

Refer to Exit Level Outcomes 1, 2, 3 and 4.

- > Collecting, analyzing, organizing and critically evaluating information.

Refer to Exit Level Outcomes 1, 2, 3 and 4

- > Communicating effectively using visual, mathematical and/or language skills.

Refer to Exit Level Outcomes 1, 2, 3 and 4

- > Using science and technology effectively and critically, showing responsibility toward the environment and health of others.

Refer to Exit Level Outcomes 1, 2, 3 and 4.

- > Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation.

Refer to Exit Level Outcomes 1, 2, 3 and 4.

ASSOCIATED ASSESSMENT CRITERIA

1.
 - > The product is manufactured in accordance with specifications.
 - > Range: This includes obtaining first-off approval; making adjustments and rectifying any non-conformance.
 - > The relationship between the part drawings and the manufactured product is shown and explained with examples.
 - > Set up processes are performed in accordance with requirements.
 - > the principles and issues underpinning manufacturing, machine set up and machine functioning are explained and discussed in accordance with requirements.
 - > Range: This includes knowledge of project management principles (production schedules, dates, times, planning, providing feedback on progress); and CNC programmes.

2.
 - > Correct materials are used in the CNC manufacturing operation

- > All materials are identified and are related to specifications.
- > Manufacturing operations are carried out, monitored and controlled in accordance with procedures and standards.

> Range: This includes informing operators of manufacturing requirements, advancing operator skills, supervising operations and no stoppages as result of unavailability of materials.

- > Materials are requisitioned and finished parts are dispatched.

3.

- > Health, safety and environmental principles and practices are explained and applied within a CNC production environment.

> Range: This includes compiling a log of such issues over a period of time; unsafe working practices; use of PPE; disposal of waste; waste reduction techniques; lean manufacturing principles.

- > Safety devices and mechanisms are checked and maintained in accordance with specifications.

4.

- > Quality conformance is achieved in accordance with set standards.

> Range: Includes use of correct materials.

- > Issues and problems are raised and discussed with relevant personnel.

> Types of manufacturing problems are discussed and explained with examples.

- > Monitoring measures are explained and applied within a CNC manufacturing process.

Integrated Assessment:

The integrated assessment should be based on a summative assessment guide. **The** guide will specify how the assessor will assess different aspects of the performance and will include:

> Evaluating evidence in a portfolio of evidence, particularly projects which integrate various aspects of the qualification and which demonstrate the integration of all aspects of learning: fundamental and core: knowledge, skills and values; the development of the critical outcomes.

> Observing and listening to the learner at work, both in primary activities as well as in other interactions, or in relevant simulations.

> Asking questions and initiating short discussions to test understanding and to verify other evidence.

> Looking at records and reports.

> Formative and summative assessment of unit standards.

Assessment of competence for this qualification is based on experience acquired by the learner in the workplace, within the particular CNC production-machining context. The assessment process should cover the explicit tasks required for the qualification as well as the understanding of the underlying concepts and principles. The assessment process should also establish how the learning process has advanced the Critical Cross-field Outcomes.

The learner may choose in which language he/she wants to be assessed. This should be established as part of a process of preparing the learner for assessment and familiarising the learner with the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be presented if pertinent to any of the Exit Level Outcomes.

Assessors should also evaluate evidence that the learner is able to perform consistently over a period of time.

INTERNATIONAL COMPARABILITY

Comparison was done with the following countries on the basis of best practice and how the practice is incorporated in the South African CNC Production Machining qualifications.

- > Australia
- > Canada
- > Botswana
- > Germany
- > India
- > Kenya
- > Nigeria
- > Sweden
- > UK
- > USA

The general finding is that CNC courses in the countries above are not designed for occupational development on a step-by-step basis. Generally the courses assume a general knowledge of machining or engineering and build specific CNC knowledge and skills onto this.

Sweden offers a 450-hour course in CNC. Other courses are designed to focus on specific pieces of equipment and trade stream such as a turning.

Training processes for the occupations are varied. The following encompass some of the options:

- > Skills and knowledge upgrading of qualified tradespersons in the mechanical engineering field
- > Short courses and on-the-job training.
- > Apprenticeships.
- > Vocational education and training programmes followed by a work experience component.

Comparisons was therefore done by looking at occupational profiles in the following way:

- > Occupational role; exit level outcomes.
- > Occupational activities: unit standards and specific outcomes.

The occupations and the related career path described in this qualification are similar to descriptions found in various countries belonging to the Organisation for Economic Co-operation and Development (OECD), eg the United States of America:

There are a number of common characteristics found in most general education and training programmes in addition to CNC-specific training. These include:

- > Knowledge and ability to perform manual machining operations in at least one discipline.
- > Ability to read and interpret engineering drawings.
- > Knowledge of and ability to use and apply statistical process control techniques.
- > Principles and application of quality management systems, including customer focus.

In addition to these occupation-specific requirements, general requirements such as communication, mathematical literacy, safety, health and the environment, risk assessment, team skills, computer literacy and problem solving abilities are also required.

At operator level the occupational profile becomes less distinct. In most OECD countries the occupation is referred to as CNC machining operator but sometimes also as CNC machining setter. The range of activities can vary from the very simple to those performed by the programmer. The following summarises the most common activities for the CNC setter/operator:

A typical training or re-training programme for such operators is found in this Canadian example:

3 weeks of McBride Training:

- > Personal Skills Development.
- > Computers.
- > Job Search Techniques.
- > Supported Job Search.

16 weeks of NAIT Technical Training:

- > Manual Machining Training (Equivalent to Level 1 Apprentice Training)
- > CNC Machinist Operator Training

3 weeks unpaid work experience at an employer site

The total programme consists of 22 weeks. The programme includes elements, which allow the aspirant operator to develop a career in the CNC field.

Comparison with South African NQF level 2 and 3 qualifications

The overall level of responsibility in the above list corresponds with NQF level 3, based on the following activities:

- > Interpret drawings to accurately and efficiently complete parts as specified using shop mathematics.

- > Operate Computerized Numerical Control (CNC) as required.
- > Properly machine all types of material to achieve complete and accurate parts within established/expected timeframes.
- > Use various tools including, but not limited to, deburring tools, hand tools, power tools, overhead cranes (for handling materials and fixtures), various inspection tools as required to fully inspect part, and tool sharpening devices.
- > Detect and report faulty operations, defective material, and any unusual or unsafe conditions to supervisor.

This is reflected in the Exit Level Outcomes:

- > Set up and initiate CNC manufacturing processes.
- > Monitor and control the flow of work.
- > Monitor safety, health and environmental practices.
- > Monitor and maintain the quality of the product.

The type of CNC operator at NQF Level 2 found in South Africa is probably found in most developing countries. It is a low-skill occupation and consists mostly of monitoring the production process and alerting technical staff to problems. Parts finishing, cleaning and routine maintenance may also be required. This qualification reflects the following from the above list:

- > Deburr, clean, and inspection as required.
- > Properly machine all types of material to achieve complete and accurate parts within established/expected timeframes.
- > Use various tools including, but not limited to, deburring tools, hand tools, power tools, overhead cranes (for handling materials and fixtures), various inspection tools as required to fully inspect part, and tool sharpening devices.
- > Maintain work area as required, keeping it free from all scrap material. This includes separating all scrap and machining chips by various alloys as instructed.
- > Maintain work area in a clean and orderly condition.
- > Observe prescribed safety regulations.
- > Keep count and tallies as required.
- > Complete time and work reports.
- > Detect and report faulty operations, defective material, and any unusual or unsafe conditions to supervisor.
- > Maintain proper application of oils and lubricants, and make minor maintenance repairs as necessary.

Other activities and related knowledge is contained in the choice of unit standards and the specific outcomes in the unit standards. In addition to this, the South African qualifications include the tracking of part dimensions in statistical process control charts and recognising and responding to error conditions. As in many of the courses for aspirant operators, manual machining processes and hands-on experience of manual machining have been included as the basis for understanding the process and for recognising problems at this and later stages.

ARTICULATION OPTIONS

This qualification articulates vertically with the Further Education and Training Certificate: CNC Production Machining, 57885.

This qualification articulates horizontally with other engineering qualifications at this level, National Certificate: Mechanical Engineering: Fitting and Machining, Level 3, 23255; National Certificate: Mechanical Engineering: Machining, Level 3, 23278; National Certificate: Mechanical Engineering: Tooling Manufacture, Level 4, 23281.

MODERATION OPTIONS

> Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education and Training Quality Assurance Body (ETQA) or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

> Any institution offering learning that will enable *the* achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

> Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQAs policies and guidelines for assessment and moderation.

> Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

The following criteria should be applied by the relevant ETQA:

- > Appropriate qualification at one level higher than the level of the qualification with a minimum of 2 years' experience of a relevant process of CNC production machining.
- > Registration as an assessor with a relevant ETQA.

NOTES

N/A

UNIT STANDARDS

(Note: A blank space after this line means that the qualification is not based on Unit Standards.)

	UNIT STANDARD ID AND TITLE	LEVEL	CREDITS	STATUS
core	115091 Monitor compliance to safety, health and environmental requirements in a workplace	Level 2	2	Registered
core	12456 Explain and use organisational procedures	Level 3	6	Registered
core	12488 Complete feasibility and commissioning reports	Level 3	3	Registered
core	13234 Apply quality procedures	Level 3	8	Registered
core	14688 Develop work instructions for thermoplastic fabrication using drawings	Level 3	10	Registered
core	114952 Apply problem-solving techniques to make a decision or solve a problem in a real life context	Level 3	2	Registered
Core	114978 Use a word processing package to produce business documents	Level 3	3	Registered
core	116218 Explain the planning and scheduling of tasks in a production environment	Level 3	3	Registered
core	117877 Perform one-to-one training on the job	Level 3	4	Registered
	process			
core	120383 Provide assistance in implementing and assuring project work meets quality requirements	Level 3	6	Registered
core	243024 Set up and start CNC machining processes	Level 3	14	Draft - Prep for P Comment
core	243025 Monitor machining process, interpret statistical process control charts, and rectify production problems	Level 3	7	Draft - Prep for P Comment
Elective	12455 Perform the role of a safety, health and environmental protection representative	Level 3	4	Registered
Elective	13915 Demonstrate knowledge and understanding of HIV/AIDS in a workplace, and its effects on a business sub-sector, own organisation and a specific workplace	Level 3	4	Reregistered
Elective	13916 identify and keep the records that a team manager is responsible for keeping	Level 3	4	Reregistered
Elective	113899 Demonstrate an understanding of basic programmable logic controllers	Level 3	6	Registered
Fundamental	7456 Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	Level 3	5	Reregistered
Fundamental	9010 Demonstrate an understanding of the use of different number bases and measurement units and an awareness of error in the context of relevant calculations	Level 3	2	Reregistered
Fundamental	9012 Investigate life and work related problems using data and probabilities	Level 3	5	Reregistered
Fundamental	9013 Describe, apply, analyse and calculate shape and motion in 2- and 3-dimensional space in different contexts	Level 3	4	Reregistered
Fundamental	119457 Interpret and use information from texts	Level 3	5	Registered
Fundamental	119465 Write/present/sign texts for a range of communicative contexts	Level 3	5	Registered
Fundamental	119467 Use language and communication in occupational learning programmes	Level 3	5	Registered



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

Further Education and Training Certificate: CNC Production Machining

SAQA QUAL ID		QUALIFICATION TITLE	
57885		Further Education and Training Certificate: CNC Production Machining	
SGB NAME		ORGANISING FIELD ID	PROVIDER NAME
SGB Manufacturing and Assembly Processes		6	
QUAL TYPE		ORGANISING FIELD DESCRIPTION	SUBFIELD
Further Ed and Training Cert		Manufacturing, Engineering and Technology	Manufacturing and Assembly
ABET BAND	MINIMUM CREDITS	NQF LEVEL	QUALIFICATION CLASS
Undefined	162	Level 4	Regular-Unit Stds Based

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of the qualification is to provide learners, education and training providers and employers with the standards and the range of learning required to plan, set up and improve the manufacturing process, and respond to problems in a CNC production machining environment.

This is the third qualification in a series for learners who want to follow a career in the field of CNC production machining, specifically in facilities which use machining and turning centres.

People working in the CNC production machining field require specialised technical skills and knowledge which combine some hand skills and an understanding of machining processes with more intensive production methods, greater control over the accuracy of dimensions and the maintenance of quality standards.

The primary skills that are recognised in this qualification are the ability to interpret drawings and develop CNC machining process plans, programmes and work instructions for new components, set up and qualify all the processes and identify and rectify manufacturing problems. These capabilities require an understanding of computer numerical controlled programmes and machines, issues related to quality productivity safety, health and the environment.

Qualified learners will also understand:

- > How to work with business systems and apply and use procedures.
- > Their role in the business, i.e. in production and related activities.
- > How they are affected by legislation, regulations, agreements and policies related to their particular work environment.

With this understanding learners will be able to participate effectively in workplace activities.

Rationale:

The rapid uptake of new technology in the form of computerised numeric control (CNC) systems in South Africa and the emergence of South Africa as a cost-effective supplier to international markets has created a demand for people with the skills to operate, set and programme CNC equipment. In order to meet this demand, the industry needs an engineering machining qualification which focuses on the understanding and use of CNC systems and statistical process control (SPC). This qualification represents a shift away from the traditional field of engineering machining which is characterised by work-to-order, low volume manufacture of components using various machining methods. The emerging industry is characterised by greater precision, higher volumes, and higher standards of quality. This qualification spells out the skills needed to operate

successfully in this new field.

This qualification together with the associated qualifications in the series provides a developmental pathway for the full range of activities required for production machining. The skills and knowledge required are described in a generic manner so that the changing needs of particular worksites can be met without requiring changes to the qualification or the unit standards.

This is the third in a learning pathway of four qualifications in a learning pathway for CNC production machining. The pathway begins with the National Certificate in CNC Production Machining NQF Level 2 and ends with the National Certificate in CNC Production Machining NQF Level 5. Typical learners would have achieved the National Certificate in CNC Production Machining NQF Level 3. Once qualified, they would typically be responsible for initiating and maintaining production processes. They would perform a range of tasks autonomously within the context of an overall team. This role represents a recognised position in the organisation.

This qualification series recognises skills, knowledge and values relevant to a workplace and requires workplace experience. It is suitable for learners who:

- > Attend courses and then apply the knowledge gained to activities in the workplace (Portfolio to reflect formative assessment), or
- > Are already workers and have acquired the skills and knowledge without attending formal courses (RPL can be done through the summative assessment and portfolio of evidence), or
- > Participate in skills programmes and have the appropriate work experience, or
- > Are part of a learnership programme which integrates structured learning and work experience, or
- > Acquire their learning through any combination of the above.

The outcomes of this qualification combine skills and knowledge in the technical, inter-personal and business spheres, enabling the learner to perform the operational aspects of the work, function within a team context and contribute to value-adding processes within the organisation.

This qualification provides learners who have gained relevant experience in the workplace with an opportunity to obtain credits through an RPL process.

The qualification also forms the basis for further learning in the field of CNC production machining where the learner will be able to manage and develop manufacturing capabilities, optimise manufacturing processes and plan and cost production.

Learner achievements will contribute to the ability of South African companies to compete for work in the global economy, thus securing jobs and employment opportunities.

RECOGNIZE PREVIOUS LEARNING?

Y

LEARNING ASSUMED TO BE IN PLACE

The following competencies are assumed for a learner embarking on this qualification:

- > Communication and Mathematical Literacy, NQF Level 3.
- > In addition, learners are assumed to have the following skills at NQF Level 3 in the context of CNC production machining:
 - > Set up and initiate manufacturing processes.
 - > Monitor and control the flow of work.
 - > Monitor safety, health and environmental practices.
 - > Monitor and maintain the quality of the product.

Recognition of Prior Learning:

This qualification may be obtained through a process of RPL. The learner should be thoroughly briefed prior to the assessment and support should be provided to assist the learner in the process of developing a portfolio. The guidelines for integrated assessment should be used to develop the RPL assessment process. As with integrated assessment, while this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the Exit Level Outcomes.

Access to the qualification:

There is open access to this qualification. A workplace is, however, a prerequisite to obtaining the relevant

work experience and evidence required for the assessment of the Exit Level Outcomes.

QUALIFICATION RULES

- > The total number of credits for this qualification is **162**.
- > The total number of credits in the Fundamental component is **56**.
- > The total number of credits in the Core component is 94.
- > The minimum number of Elective credits is **12**.
- > The Elective credits should be chosen in accordance with the requirements of the selected context and the interests of the learner.

EXIT LEVEL OUTCOMES

1. Interpret drawings and develop CNC machining process plans, programmes and work instructions for new components.

- > Range: Drawings include CAM.
- > Range: Lay out includes using the correct references to determine the holding methods and reduce the number of clamping operations, choice of tooling, jigs, fixtures, manufacturing equipment; speeds and feeds.
- > Range: Programmes include manual programming (manual data input- MDI).

2. Set up and qualify all the processes.

- > Range: Processes includes manufacturing and measurement processes.

3. Identify and rectify manufacturing problems.

- > Range: Identify includes checking with and listening to relevant operators, and reporting issues to relevant personnel.

4. Work as part of the manufacturing team and coach and support manufacturing personnel and learners.

- > Range: Working as part of the team includes providing inputs to projects, (processes, planning, scheduling principles, progress reports).

Critical Cross-Field Outcomes:

These are embedded in the unit standards which make up the qualification and are thus also reflected in the Exit Level Outcomes of the qualification.

The Critical Cross-Field Outcomes are supported by the Exit Level Outcomes as follows:

> Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made:

- > Evident in all Exit Level Outcomes.

> Working effectively with others as a member of a team, group, organization and community:

- > Evident in all Exit Level Outcomes.

> Organising and managing oneself and one's activities responsibly and effectively:

- > Evident in all Exit Level Outcomes.

> Collecting, analysing, organizing and critically evaluating information:

- > Evident in all Exit Level Outcomes.

> Communicating effectively using visual, mathematical and/or language skills:

- > Evident in all Exit Level Outcomes.

> Using science and technology effectively and critically, showing responsibility toward the environment and health of others:

- > Evident in all Exit Level Outcomes.

> Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation:

- > Evident in all Exit Level Outcomes.

ASSOCIATED ASSESSMENT CRITERIA

1:

- > Layout is prepared in accordance with design specification.
 - > Range: Layout includes choice of jigs, fixtures, cutting tools.
- > Manufacturing layout is aligned to the plan for producing a product within specification.
 - > Range: Manufacturing layout: i.e. the manufacturing sequence as per the process plan.
- > The correct version of documents are used in the CNC machining process.
- > Choices are justified and issues relating to the choices are discussed and applied in accordance with requirements.
 - > Range: Processes and equipment; understanding of lean manufacturing techniques; knowledge of materials, manufacturing processes (including heat treatment) and equipment principles of metal cutting (including cutting fluids, speeds and feeds); measuring methods, equipment, tolerances, finishes and fits.
- > Work instructions are complete and clear as per requirements.
 - > Range: Complete includes all operations and instructions.
 - > Range: Clear means language appropriate to users and correct use of terminology; all manufacturing aids are identified and specified.
- > Documents are sequenced in accordance with procedures.
- > Stage drawings are produced in accordance with specifications.
- > Processes relating to the development of work instructions are explained and discussed in accordance with requirements.
 - > Range: Engineering drawings, symbols (fits, surface finishes), relevant standards, (e.g. ISO, BS, DIN, API, SAE, IAS); using website to access relevant standards; knowledge of configuration management.

2:

- > Manufacturing and measurement processes are adjusted to meet design specifications.
 - > Range: Specifications include remarks, redline drawings.
- > Methods are robust and verified to mass-produce within the specifications.
 - > Range: Demonstrate statistically that the equipment will consistently produce the right quality component; calculate control limits; update data pack.
- > Issues and principles related to process qualification are explained and applied in accordance with requirements.
 - > Range: Knowledge of manufacturing statistics, statistical process control, basic metrology, basic metallurgy, quality management systems applicable to his context (e.g. ISO 9000, motor industry specific QMS, armaments industry QMS); processes related to approval of the product for manufacturing.

3:

- > The manufacturing process is checked and verified for efficiency and competitiveness.
 - > Range: Efficient and competitive: that which is within the limits of available machinery and resources
- > Layout and the data pack is revised and improved in accordance with requirements.
- > A systematic approach is taken to the problem solving.
 - > Range: Methods of problem solving, e.g. Ishikawa (fishbone) diagrams; 8-D TOPS (8 Discipline Team Oriented Problem Solving).
- > All available resources are consulted in accordance with procedures.
- > Statistical process control is explained in accordance with requirements.
 - > Range: Purpose of various types of charts; error conditions.

4:

- > Issues are communicated to the relevant personnel in accordance with requirements.
 - > Range: Relevant personnel include operators, supervisors, production and quality management; in small companies includes the customer.
 - > Range: Communication includes listening to and evaluating inputs from all sources, and using the information.
- > Performance of manufacturing personnel and learners is improved and meets requirements.

> Issues related to communication, inter-personal relationships and diversity are explained and discussed in accordance with requirements.

Integrated assessment:

The integrated assessment should be based on a summative assessment guide. The guide will specify how the assessor will assess different aspects of the performance and will include:

- > Evaluating evidence in a portfolio of evidence, particularly projects which integrate various aspects of the qualification and which demonstrate the integration of all aspects of learning: fundamental and core; knowledge, skills and values; the development of the critical outcomes.
- > Observing and listening to the learner at work, both in primary activities as well as in other interactions, or in relevant simulations.
- > Asking questions and initiating short discussions to test understanding and to verify other evidence.
- > Looking at records and reports.
- > Formative and summative assessment of unit standards.

Assessment of competence for this qualification is based on experience acquired by the learner in the workplace, within the particular CNC production machining context. The assessment process should cover the explicit tasks required for the qualification as well as the understanding of the underlying concepts and principles. The assessment process should also establish how the learning process has advanced the Critical Cross-Field Outcomes.

The learner may choose in which language he/she wants to be assessed. This should be established as part of a process of preparing the learner for assessment and familiarising the learner with the approach being taken.

While this is primarily a workplace-based qualification, evidence from other areas of endeavour may be presented if pertinent to any of the Exit Level Outcomes.

Assessors should also evaluate evidence that the learner is able to perform consistently over a period of time.

Learners can be assessed on:

- > A machining centre, or
- > A CNC lathe or turning centre, or
- > Any other equipment in which material is removed to form the part, e.g. cutting, boring, grinding.

INTERNATIONAL COMPARABILITY

These qualifications represent the learning progression for an occupation which focuses on the machining of precision parts and components using computer numerical control (CNC). The stages of development related to CNC machining equipment are:

- > Operator.
- > Setter, including elements of programming.
- > Programmer, including trouble shooting and management of manufacturing processes.
- > Specialist, including process design, costing, trouble shooting and selection and implementation of new technology.

Machining includes processes such as cutting, boring, turning, milling and grinding. It may also include punching and nibbling.

Many CNC courses are not designed for occupational development on a step-by-step basis. Generally the courses assume a general knowledge of machining or engineering and build CNC knowledge and skills specific onto this. An example can be given with a 450-hour course in Sweden. The course cuts across 3 NQF levels. Other courses are design to focus on specific pieces of equipment such as a turning centre.

Training processes for the occupations outlined above are varied. The following encompass some of the options:

- > Skills and knowledge upgrading of qualified tradespersons in the mechanical engineering field
- > Short courses and on-the-job training.
- > Apprenticeships.

> Vocational education and training programmes followed by a work experience component.

Comparisons was therefore conducted on occupational profiles in the following way:

- > Occupational role - Exit Level Outcomes.
- > Occupational activities - Unit standards and specific outcomes.

This approach can be supported by referring to curriculum contents and course outlines.

The above occupations and the related career path are similar to descriptions found in various OECD countries belonging to the Organisation for Economic Co-operation and Development (OECD), e.g. the United States of America.

Apart from CNC-specific training, there are a number of common characteristics found in most general education and training programmes. These include:

- > Knowledge and ability to perform manual machining operations in at least one discipline.
- > Ability to read and interpret engineering drawings.
- > Knowledge of and ability to use and apply statistical process control techniques.
- > Principles and application of quality management systems, including customer focus.

In addition to these occupation-specific requirements, general requirements such as communication, mathematical literacy, safety, health and the environment, risk assessment, team skills, computer literacy and problem solving abilities are also required.

A survey of a range of occupational profiles and training courses from a variety of countries including India, the United Kingdom, Sweden, Canada and the United States of America reveal the following features at the level of the programmer:

- > Review three-dimensional computer aided/automated design (CAD) blueprints of the part.
- > Calculate where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove.
- > Select tools and materials for the job and plan the sequence of cutting and finishing operations.
- > Turn the planned machining operations into a set of instructions.
- > Translate into a computer aided/automated manufacturing (CAM) program.
- > Check new programs to ensure that the machinery will function properly and that the output will meet specifications. Because a problem with the program could damage costly machinery and cutting tools, computer simulations may be used to check the program instead of a trial run.
- > If errors are found program must be changed and retested until any problems are resolved.

Other aspects of this occupation relate to:

- > Co-ordinating activities and workflow.
- > Ensuring continuous quality.
- > Ensuring safety, health and environmental issues.
- > Working with various team members and other departments.
- > Troubleshooting, solving logistical materials and human resources issues.
- > Scheduling and monitoring maintenance.

Comparison with the South African NQF Level 4 qualifications:

The Exit Level Outcomes map well to the occupational profile:

- > Interpret drawings and develop CNC machining process plans, programmes and work instructions for new components.
- > Set up and qualify all the processes.
- > Identify and rectify manufacturing problems.
- > Work as part of the manufacturing team and coach and support manufacturing personnel and learners.

These processes are reflected in the choice of technical unit standards for the NQF Level 4 qualification. The link to CAD/CAM has been included in the NQF Level 5 qualification.

References:

- > Australia:
- > http://www.nmit.vic.edu.au/courses/manufacturing/engmech_cer3_a.html

- > <http://www.tafe.swin.edu.au/eng/>
- >
- http://domino.swin.edu.au/_CA256F56001FE705.nsf/0/3D02C44303D6F632CA25690E000A2FB8?OpenDocument&filter=D
- > McLennan, W (Statistician General) 1997. Australian Standard Classification of Occupations, Second Edition Canberra: Australian Bureau of Statistics

- > Canada:
 - > http://www.skiitiscanada.com/en/corporate/profiles/index_cnctuming.php
 - > <http://www.mcbridecareergroup.com/images/pdfs/cnc-machinist.pdf>

- > Botswana:
 - > http://www.ub.bw/departments/engineering/technology_mission.cfm

- > Germany:
 - > <http://www.bibb.de/en/9673.htm>
 - > <http://www.bibb.de/de/11988.htm>

- > India:
 - > <http://delhigovt.nic.in/newdelhi/dept/industries/about.asp>

- > Kenya:
 - > www.learningresources.co.ke/downloads/SHE.PDF

- > Nigeria:
 - > <http://fmst.gov.ng/docs/2004MiniserialPressBriefing.pdf>

- > Sweden:
 - > <http://kaplanskolan.skelleftea.se/Skrivbord/Dokument%20KP/Site%20KP/English?templates=eduPage>

- > UK:
 - > <http://www.learn-direct-advice.co.uk/helpwithyourcareer/jobprofiles/profii>
 - > <http://www.connexions-direct.com/jobs4u/jobfamily/engineering/toolmaker/machinesetter.cfm?fd=503>

- > USA:
 - > <http://www.bis.gov/oco/ocos286.htm>
 - > <http://www.umsl.edu/services/govdocs/oooh20002001/356.htm>
 - > <http://www.btc.ctc.edu/coursedocs/Programs/pComputerizedMachining.asp>
 - > <http://www.ntma.org/eweb/StartPage.aspx>
 - > <http://www.i-train.org/CourseDisplay.asp?db=I&provider=C8088>
 - > <http://www.akronmach.com/cnc2.htm>

Country specific searches were also made for Brazil, Korea, Japan, Swaziland, Zimbabwe, Zambia.

ARTICULATION OPTIONS

This qualification articulates vertically with the:

- > National Certificate: CNC Production Machining, NQF Level 5 (Under development).

This qualification articulates horizontally with other engineering qualifications at this level, e.g.

- > 23256: National Certificate: Mechanical Engineering: Fitting and Machining, NQF Level 4.
- > 23279: National Certificate: Mechanical Engineering: Machining, NQF Level 4.
- > 23281: National Certificate: Mechanical Engineering: Tooling Manufacture, NQF Level 4.

MODERATION OPTIONS

> Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with an appropriate Education and Training Quality Assurance Body (ETQA) or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

> Any institution offering learning that will enable the achievement of this Qualification must be accredited as a provider with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

> Moderation of assessment will be overseen by the relevant ETQA or by an ETQA that has a Memorandum of Understanding with the relevant ETQA, according to the ETQAs policies and guidelines for assessment and moderation.

> Moderation must include both internal and external moderation of assessments at exit points of the Qualification, unless ETQA policies specify otherwise. Moderation should **also** encompass achievement of the competence described both in individual Unit Standards as well as in the exit level outcomes described in the Qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

The following criteria should be applied by the relevant ETQA:

- > Appropriate qualification at one level higher than the level of the qualification with a minimum of 2 years' experience of a relevant process of CNC production machining.
- > Registration as an assessor with a relevant ETQA.

NOTES

N/A

UNIT STANDARDS

(Note: A blank space after this line means that the qualification is not based on Unit Standards.)

	UNIT STANDARD ID AND TITLE	LEVEL	CREDITS	STATUS
Core	10981 Supervise work unit to achieve work unit objectives (individuals and teams)	Level 4	12	Reregistered
core	13194 Perform statistical process control	Level 4	12	Registered
core	13235 Maintain the quality assurance system	Level 4	5	Registered
core	13254 Contribute to the implementation and maintenance of business processes	Level 4	10	Registered
core	13315 Write simple computer numerical controlled (CNC) programmes and set and operate a CNC machine	Level 4	24	Reregistered
Core	14473 Develop and produce computer aided drawings	Level 4	4	Reregistered
core	14474 Plan and schedule workflow	Level 4	3	Registered
Core	120375 Participate in the estimation and preparation of cost budget for a project or sub project and monitor and control actual cost against budget	Level 4	6	Registered
Core	243016 Qualify a CNC machining process	Level 4	10	Draft - Prep for P Comment
core	243027 Contribute to and improve quality practices in CNC machining operations	Level 4	8	Draft - Prep for P Comment
Elective	114877 Formulate and implement an action plan to improve productivity within an organisational unit	Level 4	8	Registered
Elective	116292 Demonstrate an understanding of the principles of manufacturing and assembly logistics planning	Level 4	12	Registered
Elective	119187 Monitor maintenance of plastics manufacturing equipment, tooling and services	Level 4	4	Registered
Elective	119257 Produce and maintain work activity reports	Level 4	8	Registered
Fundamental	119457 Interpret and use information from texts	Level 3	5	Registered
Fundamental	119465 Write/present/sign texts for a range of communicative contexts	Level 3	5	Registered
Fundamental	119467 Use language and communication in occupational learning programmes	Level 3	5	Registered
Fundamental	119472 Accommodate audience and context needs in oral/signed communication	Level 3	5	Registered
Fundamental	9015 Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	Level 4	6	Reregistered
Fundamental	9016 Represent, analyse and calculate shape and motion in 2- and 3-dimensional space in different contexts	Level 4	4	Reregistered
Fundamental	12153 Use the writing process to compose texts required in the business environment	Level 4	5	Reregistered
	texts			
Fundamental	119471 Use language and communication in occupational learning programmes	Level 4	5	Registered



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

1

SAQA US ID	UNIT STANDARD TITLE		
243014	Operate and monitor computerised numerically controlled (CNC) machining equipment		
SGB NAME	ORGANISING FIELD ID	PROVIDER NAME	
SGB Manufacturing and Assembly Processes	6		
UNIT STANDARD TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD DESCRIPTION	
Regular	Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	CREDITS	NQF LEVEL	UNIT STANDARD TYPE
Undefined	16	Level 2	Regular

SPECIFIC OUTCOME 1

Use the correct terminology to explain, discuss and describe components, machine states and functions of CNC machinery.

SPECIFIC OUTCOME 2

Interpret and follow written and oral job instructions and assist in the preparation of the CNC machining.

SPECIFIC OUTCOME 3

Start and stop the CNC machine, monitor and adjust the machining process and report malfunctions or problems.

SPECIFIC OUTCOME 4

Load material into the machine and produce the product.

SPECIFIC OUTCOME 5

Monitor variations on Statistical Process Control plots, identify when production reaches an error condition and respond.

SPECIFIC OUTCOME 6

Perform housekeeping tasks and dispose of waste.



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

2

Qualify a CNC machining process

SAQA US ID	UNIT STANDARD TITLE		
243016	Qualify a CNC machining process		
SGB NAME	ORGANISING FIELD ID	PROVIDER NAME	
SGB Manufacturing and Assembly Processes	6		
UNIT STANDARD TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD DESCRIPTION	
Regular	Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	CREDITS	NQF LEVEL	UNIT STANDARD TYPE
Undefined	10	Level 4	Regular

SPECIFIC OUTCOME 1

Develop statistical process control tools to measure the product's critical characteristics.

SPECIFIC OUTCOME 2

Set up process to run production, measure production and compile statistical process control charts.

SPECIFIC OUTCOME 3

Determine the frequency of measuring and testing processes.

SPECIFIC OUTCOME 4

Identify any instabilities in the process, identify the cause and rectify.

SPECIFIC OUTCOME 5

Adjust process, tools and equipment until the process is stable.

SPECIFIC OUTCOME 6

Record changes and submit requests for updating the datapack.



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

3

SAQA US ID	UNIT STANDARD TITLE		
243024	Set up and start CNC machining processes		
SGB NAME		ORGANISING FIELD ID	PROVIDER NAME
SGB Manufacturing and Assembly Processes		6	
UNIT STANDARD TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD DESCRIPTION	
Regular	Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	CREDITS	NQF LEVEL	UNIT STANDARD TYPE
Undefined	14	Level 3	Regular

SPECIFIC OUTCOME 1

Perform pre-operational procedures, plan and prepare for setup process.

SPECIFIC OUTCOME 2

Select, lay out and secure tools and fixtures and set up the equipment.

SPECIFIC OUTCOME 3

Select, load and secure material, and unload finished product.

SPECIFIC OUTCOME 4

Set up equipment, produce first off and obtain quality approval.

SPECIFIC OUTCOME 5

Hand over to production operator and ensure the running of the process.

SPECIFIC OUTCOME 6

Identify and report or rectify set up problems.



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

4

Monitor machining process, interpret statistical process control charts, and rectify production problems

SAQA US ID	UNIT STANDARD TITLE	
243025	Monitor machining process, interpret statistical process control charts, and rectify production	
SGB NAME	ORGANISING FIELD ID	PROVIDER NAME
SGB Manufacturing and Assembly Processes	6	
UNIT STANDARD TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD DESCRIPTION
Regular	Manufacturing, Engineering and Technology	Manufacturing and Assembly
ABET BAND (CREDITS)	NQF LEVEL	UNIT STANDARD TYPE
Undefined 7	Level 3	Regular

SPECIFIC OUTCOME 1

Describe and explain the purpose of quality processes and the relationship to work activities.

SPECIFIC OUTCOME 2

Review statistical information and identify unstable processes.

SPECIFIC OUTCOME 3

Analyse the process conditions in unstable processes and determine the cause of the problem.

SPECIFIC OUTCOME 4

Implement remedial action, monitor and evaluate the effect of changes and record and report actions.

SPECIFIC OUTCOME 5

Monitor the production process.



SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

5

SAQA US ID	UNIT STANDARD TITLE		
243027	Contribute to and improve quality practices in CNC machining operations		
SGB NAME	ORGANISING FIELD ID	PROVIDER NAME	
SGB Manufacturing and Assembly Processes	6		
UNIT STANDARD TYPE	ORGANISING FIELD DESCRIPTION	SUBFIELD DESCRIPTION	
Regular	Manufacturing, Engineering and Technology	Manufacturing and Assembly	
ABET BAND	CREDITS	NQF LEVEL	UNIT STANDARD TYPE
			Regular

SPECIFIC OUTCOME 1

Monitor the adherence to quality assurance standards and procedures.

SPECIFIC OUTCOME 2

Review performance, identify areas of possible improvement, record and report to responsible persons.

SPECIFIC OUTCOME 3

Maintain and update quality documentation and instruments.

SPECIFIC OUTCOME 4

Develop and adapt quality procedures to address quality problems and/or meet changing requirements.

SPECIFIC OUTCOME 5

Implement and evaluate improvement on changes made.

SPECIFIC OUTCOME 6

Participate in audits and compile reports on quality assurance issues in area of responsibility.