No. 229 16 March *2007*

SOUTH AFRICAN QUALIFICATIONS AUTHORITY (SAQA)

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

Generic Manufacturing, Engineering and Technology

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

This notice contains the titles, fields, sub-fields, NQF levels, credits, and purpose of the qualification and unit standards. The full qualification and unit standards can be accessed via the SAQA web-site at **www.saqa.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 13 April 2007.*** All correspondence should be marked **Standards Setting – Generic Manufacturing, Engineering and Technology** and addressed to

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SAQA

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

SAQA QUAL ID	***QUALIFICATION TITLE***		
58269	National Certificate: Electro-Mechanics		
SGB		***PROVIDER***	
SGB Generic Manufacturing, Engineering & Technolog			
ETQA			
QUALIFICATION TYPE	***FIELD***	***SUBFIELD***	
National Certificate	**6 -** Manufacturing, Engineering and Technology	Engineering and Related Design	
ABET BAND	***MINIMUM CREDITS***	***NQF LEVEL***	***QUAL CLASS***
Undefined	**166**	Level **2**	Regular-Unit Stds Based
REGISTRATION STATUS	***SAQA DECISION NUMBER***	***REGISTRATION START DATE***	***REGISTRATION END DATE***
Draft - Prep for **P** Comment			

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of this qualification is to build knowledge and skills that are required by employees in an engineering support environment (in various sectors of the economy) that would add value to the qualifying learner in terms of enrichment of the person, status and recognition. It provides an opportunity for learners to learn and apply skills in relation to the workplace.

In practice, most artisans become multi-skilled informally. Fitters, for example, acquire electrical skills and knowledge, and vice versa. This qualification however forms a structured and formal learning path, resulting in outcomes which are assessed and recognized in terms of the relevant national structures such as ETQAs and the NQF.

Typical entrants to this qualification could be:

- People currently working in industry who have acquired some engineering skills and have the potential to complete this qualification successfully.
- People working in industry from fields other than engineering who have the interest and potential to complete this qualification successfully.
- School leavers who have not yet had any work experience or vocational learning, but who have the potential to achieve this qualification.

The NC Electro-mechanics **L2** is an introductory qualification and focuses largely on "tools and techniques" required for further development towards the L3 and **L4** qualifications respectively. **A** learner in possession of the NC Electro-Mechanics **L2** can however already make a meaningful contribution to the industry within which he/she operates, typically as an artisan aide, maintenance assistant or similar.

This qualification will allow a learner in the engineering industry to obtain a nationally recognised qualification in electro-mechanics. The status and relevance of this qualification will attract and

retain quality learners and employees, and is the first step along a recognised and meaningful career path. This qualification can be attained by means of RPL (Recognition of Prior Learning) thereby enabling recognition of people with existing knowledge and skills. This will not only allow a learner to gain credits towards this qualification, but also to move across the different occupational areas.

People credited with this qualification contribute to the maintenance of machinery and equipment by applying mechanical and electrical knowledge and skills. They are able to:

- Understand and solve problems by communicating in verbal or written form with peers, members of supervisory/management levels and others.
- Understand and solve problems by applying mathematical practical applications.
- Demonstrate an understanding of electro-mechanical principles and requirements.
- Understand and use appropriate hand and power tools, machinery and equipment in order to respond to equipment component maintenance requirement.
- Maintain and monitor plant and equipment in order to enhance levels of occupational health and safety, quality assurance or plant and equipment efficiency.

The Unit standards in this unit standards-based qualification are intended as building blocks for the further development of skills that will make the learner a more fulfilled, informed, efficient and cost effective worker in the industry. This should result in more efficient service to the customer and make the industry more competitive in the global market.

After completing this qualification and gaining appropriate working experience, a learner will then be able to progress to the Level 3 qualification, and later to the Level 4 qualification. It will also be possible to articulate to one of the "Pure" trades (such as Fitter or Electrician) or even into a production related qualification.

Rationale:

The Engineering sector serves the need of the society and the economy by providing support services in the provision and maintenance of machinery, plant and equipment in industries such as mining, manufacturing, transport and chemicals. These industries are vital to the existence, performance and growth of the South African economy. A healthy economy is in turn vital in terms of the development and upliftment of the country, its infrastructure and all its people.

Companies invest considerable sums of money in plant, equipment, processes, raw materials and other resources. These investments can only be justified if the plants and equipment operate to the optimum capacity and efficiency. Stoppages and breakdowns need to be kept to the absolute minimum, as such stoppages lead to undue increases in costs. The effective maintenance and repair of plant and equipment is thus of utmost importance. Competent (qualified) engineering practitioners (engineers, technicians, artisans and supporting staff) are required for this purpose.

A growing number of industries and companies within industries are moving towards applying "millwrights" in maintenance situations, especially where engineering support services are rendered on a shift basis. "Multiskilled" artisans, or millwrights, will thus work on shift together with operations staff, performing maintenance support and even doing routine maintenance while on shift. This is in contrast to the more traditional practice of having specialist artisans like fitters and electricians on standby.

Through its design this qualification will meet the needs of learners in the Engineering sector (or those wish to enter the Engineering sector) who require technical expertise and essential knowledge needed to earn a formal qualification relevant to electro-mechanics. The qualification facilitates access from previously disadvantaged groups and other learners to acquire the technical knowledge and skills that are required.

The National Certificate Electro-Mechanics L2 will produce competent learners who are able to contribute to improved productivity and efficiency within the sector. They will be able to work with due care to Occupational Health and Safety requirements, while maintaining the relevant quality standards, which are particularly important in the engineering sector.

This qualification will enhance the status, productivity and employability of the learner within the engineering sector as well as contribute to quality, production rate and growth. This allows for access, progression, portability and mobility within and between the different sectors to which the engineering sector provides maintenance services.

RECOGNIZE PREVIOUS LEARNING?
Y

LEARNING ASSUMED TO BE IN PLACE
In the Engineering function, employees are appointed on technical knowledge and experience and the potential to achieve relevant technical qualifications. It is therefore assumed that learners attempting this qualification are competent in the following at least NQF Level **1** or equivalent:

- Communication and Mathematics.
- Introduction to work and safety.

Recognition of Prior Learning:

This qualification can be achieved wholly or in part through recognition of prior learning in terms of the criteria laid out above.

Evidence can be presented in a variety of forms, including international or previous local qualifications, reports, testimonials mentioning functions performed, work records, portfolios, videos of practice and performance records.

Access to the Qualification:

There is open access to the qualification.

QUALIFICATION RULES
A minimum of **166** credits are required to complete the qualification. In this qualification, credits are allocated as follows:

Fundamental:

- All 36 credits must be achieved.

Core:

- All **118** credits must be achieved.

Electives:

- A minimum of 12 credits must be selected from the list of elective unit standards.

EXIT LEVEL OUTCOMES
1. Understand and solve problems by communicating in verbal or written form with peers, members of supervisory/management levels and others.
2. Understand and solve problems by applying mathematical principles and techniques in the engineering context.

3. Demonstrate an understanding of electro-mechanical principles and requirements.
4. Understand and use appropriate hand and power tools, machinery and equipment in order to respond to equipment component maintenance requirements.
5. Maintain and monitor plant and equipment in order to enhance levels of occupational health and safety, quality assurance or plant and equipment efficiency.

Consistency of Exit Level Outcomes with Critical Cross Field Outcomes (CCFOs):

The following CCFOs have been addressed in this qualification:

- Understand and solve problems by communicating in verbal or written form with peers, members of supervisory/management levels and others.
- Understand and solve problems by applying mathematical practical applications.
- Demonstrate an understanding of electro-mechanical principles and requirements.
- Understand and use appropriate hand and power tools, machinery and equipment in order to respond to equipment component maintenance requirement.
- Maintain and monitor plant and equipment in order to enhance levels of occupational health and safety, quality assurance or plant and equipment efficiency.

Critical Cross-Field Outcomes:

- Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.
  - Exit Level Outcomes 1, 2, 5.

- Working effectively with others as a member of **a** team, group, organization and community.
  - Exit Level Outcomes 1, **4,** 5.

- Organising and managing oneself and one's activities responsibly and effectively.
  - Exit Level Outcomes 1, 2, **4,5.**

- Collecting, analyzing, organizing and critically evaluating information.
  - Exit Level Outcomes 1, 2, **4,5.**

- Communicating effectively using visual, mathematical and/or language skills.
  - Exit Level Outcomes 1, 2, **3,5.**

- Using science and technology effectively and critically, showing responsibility toward the environment and health of others.
  - Exit Level Outcomes 2, **4,** 5.

- Demonstrating an understanding of the world as a set of related systems by recognizing that problem contexts do not exist in isolation.
  - Exit Level Outcomes **1,** 2, 3, **4,5.**

- Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of:
  - Exit Level Outcome 1,2,3,4,5.
  - Reflecting on and exploring a variety of strategies to learn more effectively.
  - Participating as responsible citizens in the life of local, national and global communities.
  - Being culturally and aesthetically sensitive across **a** range of contexts.
  - Exploring education and career opportunities.
  - Developing entrepreneurial opportunities.

ASSOCIATED ASSESSMENT CRITERIA

1.
o Effective verbal communication is used in the interaction with other role players in the maintenance process to determine and understand the extent of maintenance problems, find and implement solutions and giving and getting feedback.
• Effective written communication is used in order to understand, evaluate and report on maintenance problems.
o Technical reading skills are applied in order to understand engineering and related information.
o Technical writing skills are applied in order to record engineering and related information.

2.
o Engineering related calculations are conducted and applied in the engineering context, such as:
o Electrical calculations.
o Volume, mass, dimensions.
o Ratios and percentages.

3.
o The impact of electro-mechanical maintenance activities are demonstrated in terms of their effect on and contribution to the efficient operation of plant and equipment.
o An understanding of routine electro-mechanical maintenance procedures and operations is demonstrated.
o Mechanical theory and principles are understood and applied in the engineering context.
o Electrical theory and principles are applied in the engineering context.
o Engineering drawings are read, interpreted and produced in the engineering context.

4.
o An understanding of hand tools, power tools, machinery and equipment is demonstrated in terms of their design, terminology and application.
o Hand tools, power tools, machinery and equipment are used in accordance with manufacturers specifications and good engineering practice.
o Hand tools, power tools, machinery and equipment are used safely.
o Tools, machinery equipment are cared for and stored in accordance with requirements.

5.
o Tools and equipment are used in accordance with manufacturers specifications.
• Equipment component maintenance requirements are planned and responded to based on given maintenance procedures.
o Equipment and process adjustments are made in accordance with plant requirements and manufacturers specifications.
o Electro-mechanical components are maintained in accordance with plant requirements and manufacturers specifications.
• Reports are completed and submitted in accordance with procedure.
• Quality, occupational health, safety and environmental practices are adhered to in accordance with the relevant legislation and other requirements.

Integrated Assessment:

Integrated assessment at the level of the qualification provides an opportunity for learners to show they are able to integrate concepts, actions and ideas achieved across a range of unit standards and contexts.

Integrated assessment must evaluate the quality of observable performance as well as the thinking behind the performance, and must be based on an assessment guide. The guide will spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in the primary activity as well as other interactions).
- Asking questions and initiating short discussions to test understanding.
- Looking at records and reports in the portfolio and reviewing previous assessments.

In some cases inference will be necessary to determine competence depending on the nature and context within which performance takes place.

It is necessary to ensure that the fundamental part of the qualification is also targeted to ensure that while the competence may have been achieved in a particular context, learners are able to apply it in a range of other contexts and for future learning. The assessment should also ensure that all the critical cross-field outcomes have been achieved.

The learner may choose in which language s/he 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 introduced if pertinent to any of the exit-level outcomes. The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles that underpin the activities associated with electro-mechanical engineering principles.

INTERNATIONAL COMPARABILITY

This qualification has been named "NC Electro-Mechanics" and does not use the colloquial term "millwright" in its definitions. The purpose of this is on the one hand to be more accurate in terms of the outcomes, and on the other to prevent any confusion or restriction that may be caused by different interpretations of the term "millwright" across different industries. However, in benchmarking the proposed qualification against international ones, we refer (below) to terms such as "millwright" and "flexi-trade" as used in the international context.

The NC Electro Mechanics L2 is the first of a learning path of three consecutive qualifications which culminate in the FETC Electro-Mechanics L4. The international qualifications found do not lead to three different qualifications, but culminate in one qualification over a typicaLLY four-year period. The three Electro-Mechanical qualifications (L2, L3 and L4 respectively) collectively compare well to similar international qualifications.

The NC Electro-Mechanics L2 compares well to the qualifications found in Canada and the United States of America in terms of:

- Content: The qualifications from the various countries all address mechanical, electrical, hydraulic, pneumatic, industrial electronic (PLC) and other related competencies.

- Progression: The international qualifications all address a progression of competencies, e.g. Replace components (L2), Maintain and repair (L3) and Programme systems (PLC's) (L4), albeit in a single apprenticeship of typically **4-5** years.

The content of the first year of the typical millwright apprenticeship relates favourably to the content of the NC Electro-Mechanics L2 and Learning Assumed to be in Place:

Demonstrate Work Practices:

- Explain Federal/Provincial Occupational Health and Safety regulations.
- Explain Environmental Regulations.
- Use Personal Protective Equipment.
- Maintain Safe Working Area.
- Describe Fire Prevention and Control.

- Identify Ergonomic Considerations.
- Use Communication and Team Skills.
- Interpret Plans and Sketches.
- Use References Resources.
- Describe Trade Science.

Use Trade Math:

- Describe Principles of Metallurgy.
- Use Fasteners.
- Use Tools.

Use Hand Tools:

- Use Measuring and layout Tools and Instruments.
- Use Portable Hand Tools.
- Use Fixed Shop Machines and Equipment.
- Use Mobile Equipment.

- Conclusion: These outcomes are covered within the **L2** certificate developed for South Africa.

- Learning delivery: The learning delivery process in all the examples included on-the-job (practical) and off-the-job (theoretical) components.

- Outcomes-Based: All the examples found either directly or indirectly comply with principles of outcomes-based learning, particularly in terms of outcomes (modules) representing meaningful units of learning and assessment being conducted continuously (formatively). There is generally a final integrated assessment, typically called a trade test, where the candidate is required to demonstrate specific and core (cross-field) knowledge and skills. While the United States example does not specifically refer to outcomes-based learning, this should be seen in the context of the USA being at the forefront of competency-based training since the 1970s. The term "competency-based" is often used interchangeably with "outcomes-based" or "standards-based".

- Apprenticeship/Learnership: In all the examples found, learning is vocational-based. In some countries (Scotland, New Zealand) these are called "modern apprenticeships". Learners are engaged in a formal contract of learning and most learning is workplace-based. In most cases learners "earn while they learn".

- Application (Purpose): As is the intention with the South African qualifications, the international qualifications all prepare learners for working in process or manufacturing oriented industries where they contribute to the effective and efficient maintenance of plant and equipment.

- Status: In all countries researched "millwrights" are sought after individuals and their skills are highly rated.

In benchmarking the proposed Electro-Mechanical Qualifications against international qualifications, we looked for examples in different parts of the world:

- The United States was chosen because it has one of the largest economies of the world and has a strongly organised millwright community.
- Canada was chosen inasmuch it represents a multicultural society (French and British) and its proximity and similarity to the United States of America.
- Botswana was chosen because it is a neighbouring country (part of the SADEC community) with a stable socio-economical system.

e We also looked at examples of South African millwrights from the era before the current skills development dispensation.

Canada:

The following information was obtained on the website: http://www.logos-net.net/Skills with regards to "flexi training" programmes.

Niagara College, the Lincoln County Board of Education and the Ontario Training and Adjustment Board trained learners for work as millwrights in pipefitting, electrical trades, instrumentation, machining and welding. The concept of "Flexi-Trades" was intended to train workers to perform tasks to agreed levels within their associated trade area. For example, a trained millwright would be able to carry out welding and pipefitting tasks up to the agreed level, depending on the individual's competence. The Flexi-Trades concept will allow for more efficient use of personnel within the mechanical and electrical (maintenance) areas. In addition, each tradesperson will gain a higher skill level and an understanding of interdisciplinary relations.

Information regarding training was also found on the website of the British Columbia Institute of Technology (www.bcit.ca), The College of The Rockies (www.cotr.bc.ca) and North Alberta Institute of Technology (www.nait.ca). The full millwright qualification is obtained over a four-year period. The "job description" of the millwright is in essence similar to the basic purpose of the proposed Electro-Mechanical qualifications: "Millwrights are often described as masters of all trades as they are expected to install, maintain and repair all types of machinery in almost any industry. Millwrights install, repair, overhaul and maintain all types of machinery and heavy mechanical equipment".

Conclusion: The term "Flexi-trades" can be used interchangeably with the term "millwright" as intended in the proposed Electro-Mechanic qualifications. The qualifications developed for the South African industries serve a similar purpose.

United States:

The millwright trade is very strong in the **USA** and highly organized in terms of union representation. The site of Union Millwrights (www.unionmillwright.com) describes the function and training (apprenticeship) of millwrights in similar vein to the purpose of the electro-Mechanical qualifications, i.e. multi-skilled artisans receiving their training by means of apprenticeships which include on-the-job and off-the-job (theoretical) components.

The site of the University of Virginia (www.ccps.virginia.edu) also gives good descriptions of the tasks performed by millwrights, knowledge and skills required:

o "They fit bearings, align gears and wheels, attach motors and connect belts according to the manufacturer's specifications. Precision leveling and alignment are important to getting the job right. As the machinery is put into use, millwrights perform preventive maintenance and *fix* broken or malfunctioning parts.

o This type of work requires many different skills. Millwrights need to understand how machines work, be able to follow drawings and blueprints, use precision assembly equipment, and calculate angles and measurement.

e They also need to know how to use power tools, cutting torches, welding machines, and soldering guns. In addition to old-fashioned tools, they must know something about computers since more machinery, controls and equipment-testing has become computerized. Much of their work is performed under pressure, since a machine or the entire production process may have to be halted to complete installation, repairs or maintenance."

More information was found on the websites www.realapprenticeship.com and www.stc.edu (State of Wisconsin).

In the United States model, the millwright qualification is also achieved over a four-year period.

Conclusion: The proposed Electro-Mechanical qualifications are in line with the US examples.

South Africa:

The term "millwright" in the former Skills Development dispensation in South Africa had different meanings in different contexts, which is why this term is not being used in the proposed qualifications.

Formerly, millwrights were trained by larger industrial organisations such as:

- Iscor - typical heavy industrial application.
- SATS (Railways) - petrol and diesel as well as heavy industry.
- SASOL - process plant application.
- Unilever - manufacturing plant application.

With the decline in the training of artisans over the past decade or so, there has been a drastic decline in the training of millwrights and one of the objectives of this qualification is to reintroduce the training of this valuable trade albeit in the guise of Electro-Mechanics.

Generic conclusions:

There are different definitions referring to millwrights and their "job descriptions" all over the world, depending on the particular industry. However, there is sufficient consensus that it refers to a multi-skilled artisan responsible for installation, maintenance and repair of plant and equipment typically in an industrial or process environment.

In terms of training and qualification, it is clear that a learner will obtain a specific qualification (Millwright) after a vocational learning process (apprenticeship or Learnership) of approximately 4-5 years.

Typical outcomes of the various Millwright training programmes are:

- Maintain and repair production or processing machines and equipment with minimal downtime.
- Check, set up and operate various types of production tools and equipment prior to approving for production use).
- Report any information that may impede the operation of the plant as soon as it becomes known.
- Practice safe work habits.
- Basic training and skills in Industrial Electronics and application of those skills to plant electronic problems or demonstrate industrial electronic ability.
- Understand and apply knowledge about most commonly used programmable controllers or demonstrate ability to work with programmable controllers.
- Thoroughly understand and apply knowledge to troubleshoot all types of AC and DC.
- Control Systems or demonstrate electrical troubleshooting abilities.
- Troubleshoot all types of DC drives.

Conclusion: These outcomes are covered within the L2, L3 and L4 certificates developed for South Africa.

Millwrights are highly sought after individuals who make valuable contributions to the industries in which they work, as effective and efficient maintenance is the key to the safe and efficient operation of plant and equipment. A trained millwright is not restricted to working in a particular industry or environment only, but can easily adapt to different working environments. Some "conversion learning" may be required e.g. when moving from one process to another, but the core competencies will largely be the same across different industries.

ARTICULATION OPTIONS
This qualification allows for both vertical and horizontal articulation.

Horizontal articulation exists with:

o ID **48473:** National Certificate: Electrical Engineering, NQF Level **2.**
o ID **23273:** National Certificate: Mechanical Engineering: Fitting, NQF Level **2.**

Vertical articulation exists with:

o ID **58288:** National Certificate: Electro-Mechanics, NQF Level **3.**

MODERATION OPTIONS
o Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

o Any institution offering learning that will enable the achievement of this qualification must be accredited as a provider with the relevant Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

• Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, 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.

o Moderation must include both internal and external moderation of assessments, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards.

o Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

CRITERIA FOR THE REGISTRATION OF ASSESSORS
Assessors should be in possession of:

o An appropriate qualification at or above the level of the qualification and preferably relevant workplace practical experience.
o Registration as an assessor with the relevant ETQA.

NOTES
N/A

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	116450	Demonstrate a broad understanding of pneumatic and hydraulic systems and concepts	Level 3	4
Core	9881	Mark off basic regular engineering shapes	Level 2	6

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	10624	Install a lighting system	Level 2	4
Core	12215	Read, interpret and produce basic engineering drawings	Level 2	6
Core	13221	Perform routine maintenance	Level 2	8
Core	10740	Lift and move a load using a mechanical lifting equipment	Level 3	7
Core	119744	Select, use and care for engineering hand tools	Level 2	8
Core	12476	Select, use and care for engineering measuring equipment	Level 2	4
Core	13214	Operate and monitor a drilling machine to produce simple components	Level 2	6
Core	113863	Apply soldering techniques	Level 2	2
Core	10237	Select, use and care for electrical measuring instruments	Level 2	4
Core	113876	Identify, inspect and clean electrical machines	Level 2	4
Core	10626	Repair a lighting system	Level 2	2
Core	10603	Restore power by joining a low voltage electrical cable	Level 2	4
Core	10253	Install electric wire ways	Level 2	6
Core	11954	Design and construct a single phase circuit	Level 2	5
Core	113877	Understand fundamentals of electricity	Level 2	8
Core	12481	Sling loads	Level 2	4
Core	12219	Select, use and care for engineering power tools	Level 2	6
Core	10784	Grind steel by means of a pedestal / bench grinding machine	Level 2	2
Core	243780	Monitor bearing performance and conduct routine bearing maintenance	Level 2	8
Core	13219	Maintain static seals in machines and / or equipment	Level 2	4
Core	13216	Maintain indirect drives	Level2	6
Elective	116932	Operate a personal computer system	Level 1	3
Elective	243781	Identify, select and examine different types of bearings	Level 1	1
Elective	114616	Cany out basic gas welding, brazing and cutting in an electrical environment	Level2	8
Elective	113858	Maintain transformers	Level2	5
Elective	10254	Maintain electrical distribution boards, panels and enclosures	Level2	6
Elective	114669	Cany out basic electric arc welding in an electrical environment	Level2	8
Elective	10233	Install or replace electrical metering units or measuring instrument	Level 2	4
Elective	243769	Demonstrate knowledge of lubrication	Level2	2
Elective	243782	Identify select and apply mechanical fasteners	Level2	4
Elective	243762	Demonstrate knowledge of the principles of the transfer of mechanical power	Level 1	2
Elective	13297	Grind tools and drill bits	Level3	4
Elective	13205	Operate and monitor a lathe to produce simple components	Level 2	12
Elective	13204	Operate and monitor a milling machine to produce simple components	Level 2	12
Elective	243783	Identify and select engineering equipment and materials	Level 1	4
Elective	13218	Maintain pipe systems	Level2	20
Fundamental	119454	Maintain and adapt orallsigned communication	Level2	5
Fundamental	119463	Access and use information from texts	Level2	5
Fundamental	119456	Write/present for a defined context	Level2	5
Fundamental	119460	Use language and communication in occupational learning programmes	Level2	5
Fundamental	7469	Use mathematics to investigate and monitor the financial aspects of personal and community life	Level 2	2
Fundamental	7480	Demonstrate understanding of rational and irrational numbers and number systems	Level2	3
Fundamental	9009	Apply basic knowledge of statistics and probability to influence the use of data and procedures in order to investigate life related problems	Level2	3
Fundamental	9008	Identify, describe, compare, classify, explore shape and motion in 2-and 3-dimensional shapes in different contexts	Level 2	3
Fundamental	9007	Work with a range of patterns and functions and solve problems	Level 2	5

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

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Purpose:

The purpose of this qualification is to build knowledge and skills that are required by employees in an engineering support environment (in various sectors of the economy) that **would** add value to the qualifying learner in terms of enrichment of the person, status and recognition. It provides an opportunity for learners to learn and apply skills in relation to the workplace.

In practice; most artisans become multi-skilled informally, e.g. Fitters acquiring electrical skills and knowledge, and vice versa. This qualification however forms a structured and formal learning path, resulting in outcomes which are assessed and recognized in terms of the relevant national structures such as ETQA's and the NQF.

This qualification will allow a learner in the engineering industry to obtain a nationally recognised qualification in electro-mechanics and is a stepping stone between the introductory and advanced qualifications in Electro-Mechanics (Levels 2 and **4** respectively). The outcomes build on the basic "trade theory", tools and techniques of the **L2** qualification and prepare learners for the advanced and specialised learning outcomes of the **L4** qualification.

Typical entrants *to* this qualification could be:

e Learners who have completed the **L2** qualification and. who are engaged in a learning path towards the L4 qualification. While some practical experience achieving the **L2** qualification may be advisable, this is not necessarily a requirement.

e People currently working in industry who have acquired engineering skills at the appropriate level and have the potential to complete this qualification successfully (RPL candidates).

The Level 3 qualification enables the learner for the first time to accept responsibility for maintaining plant and/or equipment without working under direct supervision. The status and relevance of this qualification will attract and retain quality learners and employees, and is the second step along a recognised and meaningful career path. This qualification can also be attained by means of RPL (Recognition of Prior Learning) thereby enabling recognition of people with existing knowledge and skills. RPL will not only allow a learner to gain credits towards this qualification, but also to move across the different occupational areas.

People credited with this qualification contribute to the maintenance of machinery and equipment by applying both mechanical and electrical knowledge and skills. They are able to:

- Understand and solve problems by communicating in verbal or written form with peers, members of supervisorylmanagement levels and others.
- Understand and solve problems by applying mathematical practical applications.
- Install, maintain and. repair plant and. equipment and. systems.
- Solve plant and equipment related problems in order to ensure plant and equipment availability and reliability.

The Unit standards in this qualification are intended as building blocks for the further development of skills that will make the learner a more fulfilled, informed, efficient and cost effective worker in the industry. This should result in more efficient service to the customer and make the industry more competitive in the global market.

After completing this qualification and preferably gaining appropriate working experience, a learner will then be able to progress to the Level 4 certificate. It will also be possible to articulate to one of the "Pure" trades (such as Fitter or Electrician) or even into a production related qualification. Learners may also articulate to a production environment.

Rationale:

The Engineering sector serves the need of the society and the economy by providing support services in the provision and maintenance of machinery, plant and equipment in industries such as mining, manufacturing, transport and chemicals. These industries are vital to the existence, performance and growth of the South African economy. A healthy economy is in turn vital in terms of the development and upliftment of the country, its infrastructure and its entire people.

Companies invest considerable sums of money in plant, equipment, processes, raw materials and other resources. These investments can only be justified if the plants and equipment operate to the optimum capacity and efficiency. Stoppages and breakdowns need to be kept to the absolute minimum, as such stoppages lead to undue increases in costs. The effective maintenance and repair of plant and equipment is thus of utmost importance. Competent (qualified) engineering practitioners (engineers, technicians, artisans and supporting staff) are required for this purpose.

A growing number of industries and companies within industries are moving towards applying "millwrights" in maintenance situations, especially where engineering support services are rendered on a shift basis, e.g. in continuous process operations. "Multi-skilled" artisans, or millwrights as they are commonly known, could thus work on shift together with operations staff, performing maintenance support and even doing routine maintenance while on shift. This is in contrast to the more traditional practice of having artisans like fitters and electricians on standby. Millwrights are particularly useful in smaller organizations which cannot afford to employ e.g. both a Fitter and Electrician.

Through its design this qualification will meet the needs of learners in the Engineering sector (or those wish to enter the Engineering sector) who require technical expertise and essential knowledge needed to earn a formal qualification relevant to electro-mechanics.

The National Certificate Electro-Mechanics L3 will produce competent learners who are able to contribute to improved productivity and efficiency within the sector. They will be able to work with due care to Occupational Health and Safety requirements, while maintaining the relevant quality standards, which are particularly important in the engineering sector.

This qualification will enhance the status, productivity and employability of the learner within the engineering sector as well as contribute to quality, production rate and growth. This allows for access, progression, portability and mobility within and between the different sectors to which the engineering sector provides maintenance services.

RECOGNIZE PREVIOUS LEARNING?
Y

LEARNING ASSUMED TO BE IN PLACE
It is assumed that learners attempting this qualification are competent in the following at, at least NQF Level **2** or equivalent:

- Communication and Mathematical Literacy.
- The application of relevant physics and chemistry principles in an engineering environment.
- Learning outcomes of the NC Electro-Mechanics (L2).

Recognition of Prior Learning:

This qualification can be achieved wholly or in part through recognition of prior learning in terms of the criteria laid out above.

Evidence can be presented in a variety of forms, including international or previous local qualifications, reports, testimonials mentioning functions performed, work records, portfolios, videos of practice and performance records.

Access to the Qualification:

There is open access to the qualification.

QUALIFICATION RULES
The qualification is made up of standards that are classified as Fundamental, Core and Electives for the purpose of this qualification.

A minimum of 141 credits are required to complete the qualification. In this qualification, credits are allocated as follows:

Fundamental:

- **All** 36 credits must be achieved.

Core:

- All 93 credits must be achieved.

Electives:

- 12 credits must be selected from the list of elective standards to make up a minimum of 141 credits.

EXIT LEVEL OUTCOMES

1. Understand and solve problems by communicating in verbal or written form with peers, members of supervisory/management levels and others.
2. Understand and solve problems by applying mathematical practical applications.
3. Install, maintain and. repair plant and. equipment and. systems.
4. Solve plant and equipment related problems in order to ensure plant and equipment availability and reliability.

Consistency of Exit Level Outcomes with Critical Cross field Outcomes:

The following CCFO's have been addressed in this qualification:

- Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.
  - Exit Level Outcomes 1, **2,** 3, **4.**

- Working effectively with others as a member of a team, group, organization and community.
  - Exit Level Outcomes 1, 3, **4.**

- Organising and managing oneself and one's activities responsibly and effectively.
  - Exit Level Outcomes **2,** 3, **4.**

- Collecting, analyzing, organizing and critically evaluating information.
  - Exit Level Outcomes **2,** 3, **4.**

- Communicating effectively using visual, mathematical and/or language skills.
  - Exit Level Outcome 1.

- Using science and technology effectively and critically, showing responsibility toward the environment and health of others.
  - Exit Level Outcomes 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.
  - Exit Level Outcomes **2,** 3, **4.**

- Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of:
  - Exit Level Outcomesl, 2, 3, **4.**

  - Reflecting on and exploring a variety of strategies to learn more effectively.
  - Participating as responsible citizens in the life of local, national and global communities.
  - Being culturally and aesthetically sensitive across a range of contexts.
  - Exploring education and career opportunities.
  - Developing entrepreneurial opportunities.

ASSOCIATED ASSESSMENT CRITERIA

1.

- Effective verbal communication is used in the interaction with other role players in the maintenance process to determine and understand the extent of maintenance problems, find and implement solutions and giving and getting feedback.
- Effective written communication is used in order to understand, evaluate and report on maintenance problems.

- Technical reading skills are applied in order to understand engineering and related information.
- Technical writing skills are applied in order to record engineering and related information.

2.

- Mathematical principles and techniques are applied while performing tasks in the engineering context in respect of calculations relating to e.g.:

- Electricity (current, resistance).
- Pressure.
- Volume, mass, dimensions.
- Ratios and percentages.
- Geometrical forms.

3.

- Maintenance principles and techniques are explained in terms of the maintenance philosophy and system in a particular context.
- Electrical, mechanical and basic electronic principles and theory are applied while maintaining, repairing, installing and inspecting plant and equipment.
- Components are installed, maintained and replaced in accordance with the manufacturers specifications.
- Plant and equipment is maintained in accordance with specified requirements.
- Plant and equipment is inspected and tested after maintenance and repair to ensure that it will function according to requirements.
- Work is done in accordance with the relevant Occupational Health and. Safety, environmental and. quality management requirements.

4.

- Fault finding techniques are applied to establish the location, nature and causes of plant and equipment related problems.
- Solutions are implemented, inspected and Plant and equipment related problems are resolved by conducting repairs in accordance with sound engineering practice.
- Solutions impklemented are inspected and tested to ensure that plant and equipment are restored to the required operating capacity.
- Reporting is conducted in order to record information, deal with non conformances and prevent incidents from occurring in future.

Integrated Assessment:

Integrated assessment at the level of the qualification provides an opportunity for learners to show they are able to integrate concepts, actions and. ideas achieved across a range of unit standards and contexts.

Integrated assessment must evaluate the quality of observable performance as well as the thinking behind the performance, and must be based on an assessment guide. The guide will spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in the primary activity as well as other interactions).
- Asking questions and initiating short discussions to test understanding.
- Looking at records and reports in the portfolio and reviewing previous assessments.

In some cases inference will be necessary to determine competence depending on the nature and context within which performance takes place.

It is necessary to ensure that the fundamental part of the qualification is also targeted to ensure that while the competence may have been achieved in a particular context, learners are able to apply it in a range of other contexts and for future learning. The assessment should also ensure that all the critical cross-field outcomes have been achieved.

The learner may choose in which language s/he 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 introduced if pertinent to any of the exit-level outcomes. The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles that underpin the activities associated with electro-mechanical engineering.

INTERNATIONAL COMPARABILITY

This qualification has been named "NC Electro Mechanics" and does not use the colloquial term "millwright" in its definitions. The purpose of this is on the hand to be more accurate in terms of the title, and on the other to prevent any confusion or restriction that may be caused by different interpretations of the term "millwright" across different industries. However, in benchmarking the proposed qualification against international ones, we refer (below) to terms such as "millwright" and "flexi-trade" as used in the international context.

The NC Electro-Mechanics L3 learning outcomes compare favourably to approximately the 2nd/3rd year of the typical international millwright qualification. The three Electro-Mechanical qualifications (L2, L3 and L4 respectively) compare well to similar to the whole international qualifications in terms of:

- Content: The qualifications from the various countries all address mechanical, electrical, hydraulic, pneumatic, industrial electronic (PLC) and other related competencies.

- Progression: The qualifications all address a progression of competencies, e.g. Replace components (L2), Maintain and repair (L3) and Programme systems (PLC's) (L4).

The content of the 2nd and. 3rd years of the typical millwright apprenticeship relates favourably to the content of the proposed NC Electro-Mechanics L3 qualification:

- Year Two

  - Describe the Science Trade:
    - Use Trade Math.
    - Explain simple machines.
    - Use Fits and Tolerances.

  - Service Lubricants, Seals and Bearings:
    - Select lubricants.
    - Maintain lubricating systems.
    - Select seals.
    - Install and maintain seals.
    - Select bearings.
    - Install and maintain bearings.

  - Install Equipment:
    - Use safe rigging practices.
    - Describe equipment layout.

> Prepare equipment foundations.
> Explain leveling and alignment procedures.
> Describe methods of securing equipment.

○ Year Three

◦ Install Equipment:
> Explain Leveling and Aligning Procedures.

◦ Service Power Transmissions:
> Describe Power Transmission Theory.
> Service Couplings.
> Service Gear Types.
> Service Belt Types.
> Service Clutches and brakes.
> Service Chain Drive.

◦ Service Fluid Power:
> Explain Hydraulic Theory.
> Interpret Hydraulic Schematics.
> Describe Hydraulic Components.
> Identify Hydraulic Pumps.
> Assemble Hydraulic Circuits.
> Maintain and Troubleshoot Hydraulic Circuits.

◦ Service Pumps:
> Explain Pump Theory.
> Identify Types of Pumps.
> Maintain and Troubleshoot Positive Displacement Pumps.
> Maintain and Troubleshoot Non Positive Displacement Pumps.

o Learning delivery: The learning delivery process in all the examples included on-the-job (practical) and off-the-job (theoretical) components.

o Outcomes-Based: All the examples found either directly or indirectly comply with principles of outcomes-based learning, particularly in terms of outcomes (modules) representing meaningful units of learning and assessment being conducted continuously. There is generally a final integrated assessment, typically called a trade test, where the candidate is required to demonstrate specific and core (cross-field) knowledge and skills. While the United State's example does not specifically refer to outcomes-based learning, this should be seen in the context of the USA being at the forefront of competency-based training since the **1970's.** The term "competency-based" is often used interchangeably with "outcomes-based" or "standards-based".

● Apprenticeship/Learnership: In all the examples found, learning is vocational-based. In some countries (Scotland, New Zealand) these are called "modern apprenticeships". Learners are engaged in a formal contract of learning and most learning **is** workplace-based. In most cases learners "earn while they learn".

● Application (Purpose): As is the intention with the South African qualifications, the international qualifications all prepare learners for working in process or manufacturing oriented industries where they contribute to the effective and efficient maintenance of plant and equipment.

● Status: In all countries researched "millwrights" are sought after individuals and their skills are highly rated.

In benchmarking the proposed Electro-Mechanical Qualifications against international qualifications, we looked for examples in different parts of the world:

- Canada was chosen inasmuch it represents a multicultural society (French and British) and its proximity and similarity to the United States of America.
- The United States was chosen because it has one of the largest economies of the world.
- Botswana was chosen because it is a neighbouring country (part of the SADEC community) with a stable socio-economical system.
- South Africa - We also looked at a variety of millwright applications from the era before the current skills development dispensation.

Canada:

The following information was obtained on the website: http://www.logos-net.net/Skills with regards to "flexi training" programmes.

Niagara College, the Lincoln County Board of Education and the Ontario Training and Adjustment Board trained learners for work as millwrights in pipefitting, electrical trades, instrumentation, machining and welding. The concept of "Flex-Trades" was intended to train workers to perform tasks to agreed levels within their associated trade area. For example, a trained millwright would be able to carry out welding and pipefitting tasks up to the agreed level, depending on the individual's competence. The Flexi-Trades concept will allow for more efficient use of personnel within the mechanical and electrical (maintenance) areas. In addition, each tradesperson will gain a higher skill level and an understanding of interdisciplinary relations.

Information regarding training was also found on the website of the British Columbia Institute of Technology (www.bcit.ca). The full millwright qualification is obtained over a four-year period. The "job description" of the millwright is in essence similar to the basic purpose of the proposed Electro-Mechanical qualifications:

- "Millwrights are often described as masters of all trades as they are expected to install, maintain and repair all types of machinery in almost any industry. Millwrights install, repair, overhaul and maintain all types of machinery and heavy mechanical equipment".

Conclusion: The term "Flexi-trades" can be used interchangeably with the term "millwright" as intended in the proposed Electro-Mechanic qualifications. The qualifications developed for the South African industries serve a similar purpose.

United'States:

The millwright trade is very strong in the USA and highly organized in terms of union representation. The site of Union Millwrights (www.unionmillwright.com) describes the function and training (apprenticeship) of millwrights in similar vein to the purpose of the electro-Mechanical qualifications, i.e. multi-skilled artisans receiving their training by means of apprenticeships which include on-the-job and off-the-job (theoretical) components.

The site of the University of Virginia (www.ccps.virginia.edu) also gives good descriptions of the tasks performed by millwrights, knowledge and skills required:

- "They fit bearings, align gears and wheels, attach motors and connect belts according to the manufacturer's specifications. Precision leveling and alignment are important to getting the job right. As the machinery is put into use, millwrights perform preventive maintenance and fix broken or malfunctioning parts.

- This type of work requires many different skills. Millwrights need to understand how machines work, be able to follow drawings and blueprints, use precision assembly equipment, and calculate angles and measurement.

- They also need to know how to use power tools, cutting torches, welding machines, and soldering guns. In addition to old-fashioned tools, they must know something about computers since more machinery, controls and equipment-testing has become computerized.

- Much of their work is performed under pressure, since a machine or the entire production process may have to be halted to complete installation, repairs or maintenance.

Conclusion: The proposed Electro-Mechanical qualifications are in line with the US examples.

Botswana:

In Botswana Millwrights are trained through the apprenticeship system. The length and duration of the practical and theoretical components differ slightly to the South African apprenticeship system, but the learning outcomes are similar for example millwrights with fitting and electrical competences are trained as there is a great need for them in the country.

South Africa:

The term "millwright" in the former Skills Development dispensation in South Africa had different meanings in different contexts, which is why this term is not being used in the proposed qualifications.

Formerly, millwrights were trained by larger industrial organisations such as:

- Iscor - typical heavy industrial application.
- SATS (Railways) - petrol and diesel.
- **SASOL** - process application.
- Unilever - manufacturing plant application.

With the decline in the training of artisans over the past decade or so, there has been a drastic decline in the training of millwrights and one of the objectives of this qualification is to reintroduce the training of this valuable trade albeit in the guise of Electro-Mechanics.

Generic conclusions:

While there are different definitions referring to millwrights and their "job descriptions" all over the world, there is sufficient consensus that it refers to a multi-skilled artisan responsible for installation, maintenance and repair of plant and equipment typically in an industrial or process environment.

In terms of training and qualification, it is clear that a learner will obtain a specific qualification (Millwright) after a vocational learning process (apprenticeship or learnership) of 3-4 years.

Typical outcomes of the various Millwright training programmes are:

- Maintain and repair production or processing machines and equipment with minimal downtime.
- Check, set up and operate various types of production tools and equipment prior to approving for production use.
- Report any information that may impede the operation of the plant as soon as it becomes known.

- Practice safe work habits.
- Basic training and skills in Industrial Electronics and application of those skills to plant electronic problems or demonstrate industrial electronic ability.
- Understand and apply knowledge about most commonly used programmable controllers or demonstrate ability to work with programmable controllers.
- Thoroughly understand and apply knowledge to troubleshoot all types of AC and DC Control Systems or demonstrate electrical troubleshooting abilities.
- Troubleshoot all types of DC drives.

Conclusion: These outcomes are covered within the L2, L3 and L4 certificates developed for South Africa.

Millwrights are highly sought after individuals who make valuable contributions to the industries in which they work, as effective and efficient maintenance is the key to the safe and efficient operation of plant and equipment. A trained millwright is not restricted to working in a particular industry or environment only, but can easily adapt to different working environments. Some "conversion learning" may be required e.g. when moving from one process to another, but the core competencies will largely be the same across different industries.

ARTICULATION OPTIONS

This qualification allows for both vertical and horizontal articulation.

Horizontal articulation exists with:

- ID 23274: National Certificate: Mechanical Engineering: Fitting, NQF Level 3.
- ID 48475: National Certificate: Electrical Engineering, NQF Level 3.

Vertical articulation exists with:

- ID 58270: Further Education and Training Certificate: Electro-Mechanics, NQF Level 4.
- ID 48474: Further Education and Training Certificate: Electrical Engineering, NQF Level 4.
- ID 23275: Further Education and Training Certificate: Mechanical Engineering: Fitting, NQF Level 4.

MODERATION OPTIONS

- Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant 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 Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

- Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, 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, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards.

- Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

CRITERIA FOR THE REGISTRATION OF ASSESSORS
Assessors should be in possession of:

- An appropriate qualification at or above the level of the qualification and preferably relevant workplace practical experience.
- Registration as an assessor with the relevant **ETQA.**

NOTES
N/A

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	13134	Install and program basic programmable logic controllers	Level 3	20
Core	13117	Install, test and maintain a basic hydraulic system	Level 3	10
Core	13277	Maintain lubricating systems	Level3	4
Core	13279	Maintain dynamic seals in machines and / or equipment	Level 3	3
Core	13283	Maintain bearings in machines and equipment	Level3	8
Core	10281	Connect and commission a three-phase direct on line motor control system	Level 3	6
Core	13639	Fault find on alternating current (AC) and direct current (DC) systems	Level 3	8
Core	114406	Understand basic electronic theory and components	Level3	4
Core	114388	Install, joint and terminate Low Voltage cables and conductors	Level3	8
Core	113899	Demonstrate an understanding of basic programmable logic controllers	Level 3	6
Core	10270	Construct Basic Electronic Circuits	Level3	4
Core	13282	Maintain brakes and clutches	Level3	6
Core	13280	Maintain direct drives	Level3	6
Elective	119735	Remove, test, fit and service automobile batteries	Level2	4
Elective	10746	Repair a single-stage centrifugal pump	Level3	7
Elective	10261	Install and Commission Single Phase AC Machines and Control Gear	Level 3	8
Elective	10653	Carry out a detailed inspection of an auto electrical system on a self-propelled mobile machine	Level2	5
Elective	10260	Install and commission electrical measuring instruments and control devices	Level 3	5
Elective	243773	Repair an air compressor	Level3	10
Elective	13139	Install, test and maintain a basic pneumatic system	Level 3	10
Elective	10800	Replace the final-drive axle assembly of a self-propelled mobile machine	Level 2	4
Elective	10829	Repair the transfer gearbox of a self-propelled mobile machine	Level2	3
Elective	10828	Replace the manual transmission of a vehicle	Level2	3
Elective	10779	Overhaul of a multi-stage centrifugal pump	Level3	6
Elective	10788	Repair the liquid cooling system of an internal combustion engine	Level 2	3
Elective	13818	Maintain low voltage switchgear	Level 4	4
Elective	113969	Inspect, record and report condition of Medium / High Voltage station apparatus and related equipment	Level 4	6
Elective	10262	Maintain and repair three phase AC machines and control gear	Level 4	12
Elective	113891	Install / replace mini substations and ring-main units / switches	Level3	6
Elective	114660	Install Medium Voltage transformers	Level3	6
Elective	14134	Maintain and repair single phase **AC** machines and control gear	Level3	6
Elective	10778	Repair a multi-stage centrifugal pump	Level3	7
Elective	10777	Replace a multi-stage centrifugal pump	Level2	2
Elective	13276	Maintain pumps	Level3	24
Elective	10766	Replace the diesel engine of a self-propelled mobile machine	Level3	5
Elective	10773	Repair the hydraulic braking system of a self-propelled	Level 3	7

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
		machine		
Elective	13278	Maintain heat exchangers and pressure vessels	Level3	8
Elective	110403	Carry out a detailed inspection on low voltage switchgear	Level 2	3
Fundamental	119472	Accommodate audience and context needs in orallsigned communication	Level 3	5
Fundamental	119457	Interpret and use information from texts	Level3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level3	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level3	5
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	Level3	2
Fundamental	7456	Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	Level 3	**5**
Fundamental	9012 .	Investigate life and work related problems using data and probabilities	Level 3	5
Fundamental	9013	Describe, apply, analyse and calculate shape and motion in 2-and 3-dimensional space in different contexts	Level 3	4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

SAQA QUAL ID	***QUALIFICATION TITLE***		
58270	Further Education and Training Certificate: Electro-Mechanics		
SGB		***PROVIDER***	
SGB Generic Manufacturing, Engineering & Technolog			
ETQA			
QUALIFICATION TYPE	***FIELD***	***SUBFIELD***	
Further Ed and Training Cert	6 - Manufacturing, Engineering and Technology	Engineering and Related Design	
ABET BAND	***MINIMUM CREDITS***	***NQF LEVEL***	***QUAL CLASS***
Undefined	**171**	Level 4	Regular-Unit Stds Based
REGISTRATION STATUS	***SAQA DECISION NUMBER***	***REGISTRATION START DATE***	***REGISTRATION END DATE***
Draft - Prep for P Comment			

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of this qualification is to build knowledge and skills that are required by employees in an engineering support environment (in various sectors of the economy) that would add value to the qualifying learner in terms of enrichment of the person, status and recognition. It provides an opportunity for learners to learn and apply skills in relation to the workplace.

The FETC Electro-Mechanics (L4) is the culmination of a learning path spanning three qualifications and is intended to produce a highly competent artisan who can perform his/her duties competently and confidently. They will apply electrical, mechanical and industrial electronics engineering skills in order to meet the challenges of a competitive and demanding environment. This qualification will provide learners, education and training providers and employers with the standards and the range of learning required to produce these individuals.

Typical entrants to this qualification could be:

- Learners who have achieved the L3 qualification and are ready to progress to the L4 qualification.
- Qualified artisans from one of the "pure" trades such as Electricians or Fitters.

This qualification will enable the learner to provide advanced maintenance and fault-finding services, typically in a plant or production environment. The status and relevance of this qualification will attract and retain quality learners and employees, who may even have the potential to progress to more advanced qualifications at Technician or Engineer level.

This qualification can also be attained by means of RPL (Recognition of Prior Learning) thereby enabling recognition of people with existing knowledge and skills. RPL will not only allow a learner to gain credits towards this qualification, but also to move across the different occupational areas.

The field of electrical and mechanical engineering is characterized by the provision of engineering maintenance, repair and installation services and support in a variety of industries. The production equipment requiring such service and support ranges from basic to highly sophisticated equipment. People working in the electrical and mechanical engineering field require specialised technical skills and knowledge to meet the electrical and mechanical engineering requirements of such diverse industries.

People credited with this qualification contribute to the maintenance of machinery and equipment by applying both mechanical and electrical knowledge and skills. They are able to:

- Understand and solve problems by applying mathematical practical applications and communicating in verbal or written form with peers, members of supervisory/management levels and others.
- Understand and solve problems by applying mathematical practical applications.
- Demonstrate an understanding of the functioning of programmable logic controllers and use them in an Electro-Mechanical context.
- Apply fault finding techniques to diagnose and repair equipment and machinery during production/operation.
- Maintain and. repair plant and. equipment.

The Unit standards in this unit standards-based qualification are intended as building blocks for the further development of skills that will make the learner a more fulfilled, informed, efficient and cost effective worker in the industry. This should result in more efficient service to the customer and make the industry more competitive in the global market.

After completing this qualification and preferably gaining appropriate working experience, a learner will then be able to progress to the Level (anticipated) level 5 qualification. It will also be possible to articulate to one of the "Pure" trades (such as Fitter or Electrician) or even into a production related qualification.

This qualification is thus the benchmark for competent people to conduct maintenance activities in a production environment, and also forms the basis for further learning in the field of electrical and mechanical engineering within the higher education and training band.

Rationale:

The Engineering sector serves the need of the society and the economy by providing support services in the provision and maintenance of machinery, plant and equipment in industries such as mining, manufacturing, transport and chemicals. These industries are vital to the existence, performance and growth of the South African economy. **A** healthy economy is in turn vital in terms of the development and upliftment of the country, its infrastructure and its entire people.

Companies invest considerable sums of money in plant, equipment, processes, raw materials and other resources. These investments can only be justified if the plants and equipment operate to the optimum capacity and efficiency. Stoppages and breakdowns need to be kept to the absolute minimum, as such stoppages lead to undue increases in costs. The effective maintenance and repair of plant and equipment is thus of utmost importance. Competent (qualified) engineering practitioners (engineers, technicians, artisans and supporting staff) are required for this purpose.

A growing number of industries and companies within industries are moving towards applying "millwrights" in maintenance situations, especially where engineering support services are rendered on a shift basis, e.g. in continuous process operations. "Multi-skilled" artisans, or millwrights as they are commonly known, could thus work on shift together with operations staff, performing maintenance support and even doing routine maintenance while on shift. This is in

contrast to the more traditional practice of having artisans like fitters and electricians on standby. Millwrights are particularly useful in smaller organizations which cannot afford to employ e.g. both a Fitter and Electrician.

Through its design this qualification will meet the needs of learners in the Engineering sector (or those wish to enter the Engineering sector) who require technical expertise and essential knowledge needed to earn a formal qualification relevant to electro-mechanics,

The FETC Electro-Mechanics L4 will produce competent learners who are able to contribute to improved productivity and efficiency within the sector. They will be able to work with due care to Occupational Health and Safety requirements, while maintaining the relevant quality standards, which are particularly important in the engineering sector.

This qualification will enhance the status, productivity and employability of the learner within the engineering sector as well as contribute to quality, production rate and growth. This allows for access, progression, portability and mobility within and between the different sectors to which the engineering sector provides maintenance services.

RECOGNIZE PREVIOUS LEARNING?
Y

LEARNING ASSUMED TO BE IN PLACE
It is assumed that learners attempting this qualification are competent in the following:

- Communication and Mathematical Literacy at NQF Level 3.
- Outcomes required for NC Electro-Mechanics Level 3.

Recognition of Prior Learning:

This qualification can be achieved wholly or in part through recognition of prior learning in terms of the criteria laid out above.

Evidence can be presented in a variety of forms, including international or previous local qualifications, reports, testimonials mentioning functions performed, work records, portfolios, videos of practice and performance records.

Access to the Qualification:

There is open access to the qualification.

QUALIFICATION RULES
The qualification is made up of standards that are classified as Fundamental, Core and Electives for the purpose of this qualification.

A minimum of 171 credits are required to complete the qualification. In this qualification, credits are allocated as follows:

Fundamental:

- All 56 credits must be achieved.

Core:

- **All** 103 credits must be achieved.

Elective:

o **12** credits must be selected from the list of elective standards to make up a minimum of **171** credits.

EXIT LEVEL OUTCOMES

1. Understand and solve problems by applying mathematical practical applications and communicating in verbal or written form with peers, members of supervisory/management levels and others.
2. Understand and solve problems by applying mathematical practical applications.
3. Demonstrate an understanding of the functioning of programmable logic controllers and use them in an Electro-Mechanical context.
4. Apply fault finding techniques to diagnose and repair equipment and machinery during production/operation.
5. Maintain and repair plant and. equipment.

Critical Cross-Field Outcomes:

o Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.
o Exit Level Outcomes **1, 2,** 3, **5.**

o Working effectively with others as a member of a team, group, organization and community.
o Exit Level Outcomes **1,** 3, 4, 5.

o Organising and managing oneself and one's activities responsibly and effectively.
o Exit Level Outcomes **2,** 3, 4, 5.

o Collecting, analyzing, organizing and critically evaluating information.
o Exit Level Outcomes **2,** 3, 4, **5.**

o Communicating effectively using visual, mathematical and/or language skills.
o Exit Level Outcome **1.**

o Using science and technology effectively and critically, showing responsibility toward the environment and health of others.
o Exit Level Outcomes 2, 3, 4.

o Demonstrating an understanding of the world as a set of related systems **by** recognizing that problem contexts do not exist in isolation.
o Exit Level Outcomes **2,** 3, 4, **5.**

o Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of:
o Exit Level Outcomes 1, **2,** 3, 4, **5.**
- Reflecting on and exploring a variety of strategies to learn more effectively.
- Participating as responsible citizens in the life of local, national and global communities.
- Being culturally and aesthetically sensitive across a range of contexts.
- Exploring education and career opportunities.
- Developing entrepreneurial opportunities.

ASSOCIATED ASSESSMENT CRITERIA

1.

o Effective verbal communication is used in the interaction with other role players in the maintenance process to determine and understand the extent of maintenance problems, find and implement solutions and giving and getting feedback.
o Effective written communication is used in order to understand, evaluate and report on maintenance problems.
o Technical reading **skills** are applied in order to understand engineering and related information.
o Technical writing skills are applied in order to record engineering and related information.

2.
o Mathematical principles and techniques are used to solve problems with regards to e.g."
o General and. personal finance.
o Statistics and. probability.
o Other practical applications such as motoring, building.
o Mathematical principles and techniques are applied while performing tasks in the engineering context in respect of calculations relating to e.g.:
o Electrical calculations.
o Geometric shapes applied to design of structures.
o Mass, volume, temperature, pressure.

3.
o A working knowledge of the design and functioning of PLC's is demonstrated.
- PLC's are maintained and cared for in accordance with manufacturers specification.
- PLC's are used to determine the cause of Inappropriately functioning plant, equipment and systems.
- PLC's are programmed to ensure optimum performance of the equipment they are controlling.

4.
o Faultfindingtechniques are applied to establish the cause of plant, equipment and systems not functioning to the relevant specifications.
o Complex engineering sketches and drawings are used to understand plant, equipment and systems and trace the causes of problems.
- The cause of the problem is identified and appropriate remedies applied or recommended.
- Inspection and testing is conducted to ensure that the plant, equipment and systems have been restored and the cause of the problem rectified.
- Advanced electrical, mechanical and industrial electronics principles and techniques are applied to trace, understand and rectify problems related to plant, machinery and systems.

5.
o Plant and equipment are maintained and repaired to the relevant standards and in accordance with manufacturers specifications.
o Plant and equipment are maintained in accordance with the relevant maintenance philosophy.
o Work is done in accordance with the relevant occupational health and safety, environmental, quality assurance and other requirements.
o Cooperation with operations, engineering and other personnel (teamwork) is effective and constructive.
- Work is planned, scheduled and evaluated in accordance with the relevant procedures and standards'.

IntegratedAssessment:

Integrated assessment at the level of the qualification provides an opportunity for learners to show they are able to integrate concepts, actions and. ideas achieved across a range of unit standards and contexts.

Integrated assessment must evaluate the quality of observable performance as well as the thinking behind the performance, and must be based on an assessment guide. The guide will spell out how the assessor will assess different aspects of the performance and will include:

- Observing the learner at work (both in the primary activity as well as other interactions).
- Asking questions and initiating short discussions to test understanding.
- Looking at records and reports in the portfolio and reviewing previous assessments.

In some cases inference will be necessary to determine competence depending on the nature and context within which performance takes place.

It is necessary to ensure that the fundamental part of the qualification is also targeted to ensure that while the competence may have been achieved in a particular context, learners are able to apply it in a range of other contexts and for future learning. The assessment should also ensure that all the critical cross-field outcomes have been achieved.

The learner may choose in which language s/he 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 introduced if pertinent to any of the exit-level outcomes. The assessment process should cover both the explicit tasks required for the qualification as well as the understanding of the concepts and principles that underpin the activities associated with electro-mechanical engineering.

INTERNATIONAL COMPARABILITY

This qualification has been titled "NC Electro Mechanics" and does not use the colloquial term "millwright" in its definitions. The purpose of this is on one hand *to* be more accurate in terms of the title, and on the other to prevent any confusion or restriction that may be caused by different interpretations of the term "millwright" across different industries. However, in benchmarking the proposed qualification against international ones, we refer (below) to terms such as "millwright" and "flexi-trade" as used in the international context.

The learning outcomes of the FETC Electro-Mechanics L4 compare well to the advanced requirements of similar international qualifications in terms of:

- Content: The qualifications from the various countries all address mechanical, electrical, hydraulic, pneumatic, industrial electronic (PLC) and other related competencies.
- Progression: The qualifications all address a progression of competencies, e.g. Replace components (L2), Maintain and repair (L3) and Programme systems (PLC's) (L4). At NQF Level 4 the learning outcomes compare to the final years (typically partly 3rd and 4th year)s of the apprenticeships found.

o Year Three:

- Install Equipment.
  - > Explain Leveling and Aligning Procedures

- Service Power Transmissions.
  - > Describe Power Transmission Theory.
  - > Service Couplings.
  - > Service Gear Types.
  - > Service Belt Types.
  - > Service Clutches and brakes.
  - > Service Chain Drive.

- Service Fluid Power.
  - Explain Hydraulic Theory.
  - Interpret Hydraulic Schematics.
  - Describe Hydraulic Components.
  - Identify Hydraulic Pumps.
  - Assemble Hydraulic Circuits.
  - Maintain and Troubleshoot Hydraulic Circuits.

- Service Pumps.
  - Explain Pump Theory.
  - Identify Types of Pumps.
  - Maintain and Troubleshoot Positive Displacement Pumps.
  - Maintain and Troubleshoot Non Positive Displacement Pumps.

- Year Four:

- Use Work Practices.
  - Plan Job Requirements.

- Describe Trade Science.
  - Describe Theory of Electricity and Electronics.

- Install Equipment.
  - Describe Procedures for Commissioning Equipment.

- Maintain Prime Movers.
  - Explain Prime Mover Theory.
  - Describe Electric Motors.
  - Maintain Electric Motors.
  - Describe Internal Combustion Engines.
  - Describe the Maintenance of Internal Combustion Engines.
  - Describe Turbines.
  - Describe the Maintenance of Turbines.

- Service Power Transmissions.
  - Describe Power Turbines.

- Service Fluid Power.
  - Explain Pneumatic Theory.
  - Describe Pneumatic Components.
  - Interpret Pneumatic Schematics.
  - Identify Pneumatic Pumps.
  - Assemble Pneumatic Circuits.
  - Maintain and Troubleshoot Pneumatic Circuits.
  - Explain the Theory of Vacuum Systems.
  - Interpret Vacuum Symbols.
  - Identify Vacuum System Components.
  - Describe Vacuum Systems.
  - Maintain and Troubleshoot Vacuum Systems.

- Describe Compressors.
- Explain Compressor Theory,
- Identify Types of Compressors.
- Describe Positive Displacement Compressor Theory.

- Describe Non-Positive Displacement Compressor theory.

- Service Material Handling Systems.
  > Maintain Fans and Blowers.

- Service HVAC and Pollution Control Equipment.
  > Describe Theory of Pollution Control.
  > Describe the Different Methods of Pollution Control.
  > Maintain Pollution Control Equipment.
  > Describe Methods of Heating Ventilation and Air Conditioning (HVAC).

- Describe Operational Equipment Effectiveness.
  > Describe Operational Equipment Effectiveness Processes.
  > Create Problem Solving Flow Charts.
  > Describe Theory of Maintenance Procedures.
  > Describe Types of maintenance.
  > Describe Use of Predictive Maintenance Tools.
  > Identify Equipment and Process Deficiencies.
  > Perform Vibration Analysis and Rotating equipment Balancing.

- Duration: Depending on entry requirements, the various apprenticeships/learnerships for the relevant outcomes span a period of 3-4 years.
- Learning delivery: The learning delivery process in all the examples included on-the-job (practical) and off-the-job (theoretical) components.
- Outcomes-Based: All the examples found either directly or indirectly comply with principles of outcomes-based learning, particularly in terms of outcomes (modules) representing meaningful units of learning and assessment being conducted continuously. There is generally a final integrated assessment, typically called a trade test, where the candidate is required to demonstrate specific and core (cross-field) knowledge and skills. While the **U.S.** example does not specifically refer to outcomes-based learning, this should be seen in the context of the USA being at the forefront of Competency-based training since the 1970's. The term "competency-based" is often used interchangeably with "outcomes-based" or "standards-based".
- Apprenticeship/Learnership: In all the examples found, learning is vocational-based. In some countries (Scotland, New Zealand) these are called "modern apprenticeships". Learners are engaged in a formal contract of learning and most learning is workplace-based. In most cases learners "earn while they learn".
- Application (Purpose): As is the intention with the South African qualifications, the international qualifications all prepare learners for working in process or manufacturing oriented industries where they contribute to the effective and efficient maintenance of plant and equipment.
- Status: In all countries researched "millwrights" are sought after individuals and their skills are highly rated.

In benchmarking the proposed Electro-Mechanical Qualifications against international qualifications, we looked for examples in different parts of the world:

- Canada was chosen in as much it represents a multicultural society (French and British) and its proximity and similarity to the United States of America.
- The United States was chosen because it has one of the largest economies of the world.
- Botswana was chosen because it is a neighbouring country (part of the SADEC community) with a stable socio-economical system.
- South Africa - We also looked at a variety of millwright applications from the era before the current skills development dispensation.

Canada:

The following information was obtained on the website: http://www.logos-net.net/Skills with regards to "flexi training" programmes.

Niagara College, the Lincoln County Board of Education and the Ontario Training and Adjustment Board trained learners for work as millwrights in pipefitting, electrical trades, instrumentation, machining and welding. The concept of "Flex-Trades" was intended to train workers to perform tasks to agreed levels within their associated trade area. For example, a trained millwright would be able to carry out welding and pipefitting tasks up to the agreed level, depending on the individual's competence. The Flex-Trades concept will allow for more efficient use of personnel within the mechanical and electrical (maintenance) areas. In addition, each tradesperson will gain a higher skill level and an understanding of interdisciplinary relations.

Information regarding training was also found on the website of the British Columbia Institute of Technology (www.bcit.ca). The full millwright qualification is obtained over a four-year period. The "job description" of the millwright is in essence similar to the basic purpose of the proposed Electro-Mechanical qualifications:

- "Millwrights are often described as masters of all trades as they are expected to install, maintain and repair all types of machinery in almost any industry. Millwrights install, repair, overhaul and maintain all types of machinery and heavy mechanical equipment".

Conclusion: The term "Flexi-trades" can be used interchangeably with the term "millwright" as intended in the proposed Electro-Mechanic qualifications. The qualifications developed for the South African industries serve a similar purpose.

United States:

The millwright trade is very strong in the USA and highly organized in terms of union representation. The site of Union Millwrights (www.unionmillwright.com) describes the function and training (apprenticeship) of millwrights in similar vein to the purpose of the Electro-Mechanical qualifications, i.e. multi-skilled artisans receiving their training by means of apprenticeships which include on-the-job and off-the-job (theoretical) components.

The site of the University of Virginia (www.ccps.virginia.edu) also gives good descriptions of the tasks performed by millwrights, knowledge and skills required:

- "They fit bearings, align gears and wheels, attach motors and connect belts according to the manufacturer's specifications. Precision levelling and alignment are important to getting the job right. As the machinery is put into use, millwrights perform preventive maintenance and fix broken or malfunctioning parts.

- This type of work requires many different skills. Millwrights need to understand how machines work, be able to follow drawings and blueprints, use precision assembly equipment, and calculate angles and measurement.

- They also need to know how to use power tools, cutting torches, welding machines, and soldering guns. In addition to old-fashioned tools, they must know something about computers since more machinery, controls and equipment-testing has become computerized. Much of their work is performed under pressure, since a machine or the entire production process may have to be halted to complete installation, repairs or maintenance.

Conclusion: The proposed Electro-Mechanical qualifications are in line with the US examples.

Botswana:

In Botswana Millwrights are trained through the apprenticeship system. The length and duration of the practical and theoretical components differ slightly to the South African apprenticeship system, but the learning outcomes are similar for example millwrights with fitting and electrical competences are trained as they is a great need for them in the country.

South Africa:

The term "millwright" in the former Skills Development dispensation in South Africa had different meanings in different contexts, which is why this term is not being used in the proposed qualifications.

Formerly, millwrights were trained by larger industrial organisations such as:

- Iscor - typical heavy industrial application.
- SATS (Railways) - petrol and diesel.
- SASOL - process application.
- Unilever - manufacturing plant application.

With the decline in the training of artisans over the past decade or so, there has been a drastic decline in the training of millwrights and one of the objectives of this qualification is to reintroducethe training of this valuable trade albeit in the guise of Electro-Mechanics.

Generic conclusions:

While there are different definitions referring to millwrights and their "job descriptions" all over the world, there is sufficient consensus that it refers to a multi-skilled artisan responsible for installation, maintenance and repair of plant and equipment typically in an industrial or process environment.

In terms of training and qualification, it is clear that a learner will obtain a specific qualification (Millwright) after a vocational learning process (apprenticeship or learnership) of 3-4 years.

Typical outcomes of the various Millwright training programmes are:

- Maintain and repair production or processing machines and equipment with minimal downtime.
- Check, set up and operate various types of production tools and equipment prior to approving for production use.
- Report any information that may impede the operation of the plant as soon as it becomes known.
- Practice safe work habits.
- Basic training and skills in Industrial Electronics and application of those skills to plant electronic problems or demonstrate industrial electronic ability.
- Understand and apply knowledge about most commonly used programmable controllers or demonstrate ability to work with programmable controllers.
- Thoroughly understand and apply knowledge to troubleshoot all types of AC and DC.
- Control Systems or demonstrate electrical troubleshooting abilities.
- Troubleshoot all types of DC drives.

Conclusion: These outcomes are covered within the L2, L3 and L4 certificates developed for South Africa.

Millwrights are highly sought after individuals who make valuable contributions to the industries in which they work, as effective and efficient maintenance is important to the safe and efficient operation of plant and equipment. A trained millwright is not restricted to working in a particular

industry or environment only, but can easily adapt to different working environments. Some "conversion learning" may be required e.g. when moving from one process to another, but the core competencies will largely be the same across different industries.

ARTICULATION OPTIONS
This qualification allows for both vertical and horizontal articulation.

Horizontal articulation exists with:

o ID 23256: FETC: Mechanical Engineering: Fitting and Machining, NQF Level 4.
o ID 48474: FETC: Electrical Engineering, NQF Level 4.

Vertical articulation exists with:

o National Diploma Mechanical Engineering NQF Level 5.
o ID 49061: National Certificate: Master Craftsmanship (Electrical), NQF Level 5.

MODERATION OPTIONS
o Anyone assessing a learner or moderating the assessment of a learner against the qualification must be registered as an assessor with the relevant 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 Education, Training, Quality, Assurance (ETQA) Body, or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

o Assessment and moderation of assessment will be overseen by the relevant Education, Training, Quality, Assurance (ETQA) Body, 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.

o Moderation must include both internal and external moderation of assessments, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described in the associated unit standards

• Anyone wishing to be assessed against this qualification may apply to be assessed by any assessment agency, assessor or provider institution that is accredited by the relevant ETQA.

CRITERIA FOR THE REGISTRATION OF ASSESSORS
Assessors should be in possession of:

o An appropriate qualification at or above the level of the qualification and preferably relevant workplace practical experience.
• Registration as an assessor with the relevant ETQA.

NOTES
N/A

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	116046	Fault find and repair Equipment associated with Final Control Elements	Level 4	10
Core	13327	Diagnose and repair faults on equipment and machinery during production/operation	Level 4	24
Core	13321	Maintain fluid power / pneumatic systems	Level 4	16

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	113899	Demonstrate an understanding of basic programmable logic controllers	Level 3	6
Core	12414	Diagnose and repair faults on low voltage transformers and equipment	Level 4	6
Core	10259	Fault find, repair and maintain three phase voltage electrical circuits	Level 4	8
Core	113897	Troubleshoot on programmable logic controllers	Level 4	5
Core	13328	Refurbish machines	Level 4	24
Core	13818	Maintain low voltage switchgear	Level 4	4
Elective	13303	Align machines and equipment using laser technology	Level 4	6
Elective	13326	Maintain safety valves	Level 4	4
Elective	243773	Repair an air compressor	Level 3	10
Elective	13325	Maintain gearboxes	Level 4	10
Elective	113880	Inspect, test and maintain Medium / High Voltage transformers	Level 4	6
Elective	113969	Inspect, record and report condition of Medium / High Voltage station apparatus and related equipment	Level 4	6
Elective	10621	Identify the correct phase sequence on high voltage transformers and cables	Level 3	3
Fundamental	119462	Engage in sustained oral/signed communication and evaluate spoken/signed texts	Level 4	5
Fundamental	119469	Read/view, analyse and respond to a variety of texts	Level 4	5
Fundamental	119459	Write/present/sign for a wide range of contexts	Level 4	5
Fundamental	119471	Use language and communication in occupational learning programmes	Level 4	5
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	5
Fundamental	119457	Interpret and use information from texts	Level 3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	5
Fundamental	7468	Use mathematics to investigate and monitor the financial aspects of personal, business, national and international issues	Level 4	6
Fundamental	9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	Level 4	6
Fundamental	9016	Represent analyse and calculate shape and motion in 2- and 3-dimensional space in different contexts	Level 4	4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Demonstrate knowledge of the principles of the transfer of mechanical power

SAQA US ID	***UNIT STANDARD TITLE***		
243762	Demonstrate knowledge of the principles of the transfer of mechanical power		
SGB		***PROVIDER***	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		***SUBFIELD***	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	***UNIT STANDARD TYPE***	***NQF LEVEL***	***CREDITS***
Undefined	Regular	Level 1	2
REGISTRATION STATUS	***REGISTRATION START DATE***	***REGISTRATION END DATE***	***SAQA DECISION NUMBER***
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Demonstrate knowledge of hydraulics and pneumatics.

SPECIFIC OUTCOME 2
Demonstrate knowledge of mechanical drives.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Demonstrate knowledge of lubrication

SAQA US ID	*UNIT STANDARD TITLE*		
243769	Demonstrate knowledge of lubrication		
SGB		*PROVIDER*	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 2	2
REGISTRATION STATUS	*REGISTRATION START DATE*	*REGISTRATION END DATE*	*SAQA DECISION NUMBER*
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Demonstrate knowledge of lubrication.

SPECIFIC OUTCOME 2
Lubricate machines and equipment.

SPECIFIC OUTCOME 3
Demonstrate knowledge of the importance of the correct handling and storage of lubricants.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Repair an air compressor

SAQA US ID	*UNIT STANDARD TITLE*		
243773	Repair an air compressor		
SGB		*PROVIDER*	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 3	10
REGISTRATION STATUS	*REGISTRATION START DATE*	*REGISTRATION END DATE*	*SAQA DECISION NUMBER*
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Explain the factors critical to repairing an air compressor.

SPECIFIC OUTCOME 2
Prepare to repair an air compressor.

SPECIFIC OUTCOME 3
Repair the air compressor.

SPECIFIC OUTCOME 4
Test the air compressor and prepare for operation and/or production.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Monitor bearing performance and conduct routine bearing maintenance

SAQA US ID	***UNIT STANDARD TITLE***		
243780	Monitor bearing performance and conduct routine bearing maintenance		
SGB		***PROVIDER***	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		***SUBFIELD***	
6 - Manufacturing, Engineering and Technology		Manufacturing and Assembly	
ABET BAND	***UNIT STANDARD TYPE***	***NQF LEVEL***	***CREDITS***
Undefined	Regular	Level 2	8
REGISTRATION STATUS	***REGISTRATION START DATE***	***REGISTRATION END DATE***	***SAQA DECISION NUMBER***
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Demonstrate a basic understanding of bearings in terms of engineering principles and manufacturers' specifications.

SPECIFIC OUTCOME 2
Monitor bearing performance in accordance with maintenance requirements and manufacturers specifications.

SPECIFIC OUTCOME 3
Conduct basic bearing maintenance (lubrication) in accordance with maintenance requirements and manufacturers specifications.

SPECIFIC OUTCOME 4
Complete the monitoring and lubrication process.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Identify, select and examine different types of bearings

SAQA US ID	*UNIT STANDARD TITLE*		
243781	Identify, select and examine different types of bearings		
SGB		*PROVIDER*	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 1	1
REGISTRATION STATUS	*REGISTRATION START DATE*	*REGISTRATION END DATE*	*SAQA DECISION NUMBER*
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Demonstrate knowledge of different types of bearings and describe their application.

SPECIFIC OUTCOME 2
Select and examine different types of bearings for defects.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Identify, select and apply mechanical fasteners

SAQA US ID	UNIT STANDARD TITLE		
243782	Identify, select and apply mechanical fasteners		
SGB		PROVIDER	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		SUBFIELD	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	UNIT STANDARD TYPE	NQF LEVEL	CREDITS
Undefined	Regular	Level 2	4
REGISTRATION STATUS	REGISTRATION START DATE	REGISTRATION END DATE	SAQA DECISION NUMBER
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Demonstrate an understanding of mechanical fasteners used in engineering.

SPECIFIC OUTCOME 2
Prepare to apply mechanical fasteners.

SPECIFIC OUTCOME 3
Apply mechanical fasteners.

SPECIFIC OUTCOME 4
Complete the fastening process.

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Identify and select engineering equipment and materials

SAQA US ID	*UNIT STANDARD TITLE*		
243783	Identify and select engineering equipment and materials		
SGB		*PROVIDER*	
SGB Generic Manufacturing, Engineering & Technolog			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Fabrication and Extraction	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 1	4
REGISTRATION STATUS	*REGISTRATION START DATE*	*REGISTRATION END DATE*	*SAQA DECISION NUMBER*
Draft - Prep for P Comment			

SPECIFIC OUTCOME 1
Identify and select equipment commonly used in engineering applications.

SPECIFIC OUTCOME 2
Identify and select equipment commonly used in rigging applications.

SPECIFIC OUTCOME 3
Identify and select materials used in common engineering applications.

SPECIFIC OUTCOME 4
Identify and select different metals and profiles.