No. 216 **6 March 2009**

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 & Technology

registered by Organising Field 06 – Manufacturing, Engineering & Technology, publishes the following Qualifications and Unit Standards for public comment.

This notice contains the titles, fields, sub-fields, NQF levels, credits, and purpose of the Qualifications and Unit Standards. The full Qualifications 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 Qualifications and Unit Standards should reach SAQA at the address below and ***no later than 6 April 2009.*** All correspondence should be marked **Standards Setting – SGB for Generic Manufacturing, Engineering and Technology** and addressed to

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ACTING DIRECTOR: STANDARDS SETTING AND DEVELOPMENT

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:
National Certificate: Measurement, Control and Instrumentation

SAQA QUAL ID	*QUALIFICATION TITLE*		
65629	National Certificate: Measurement, Control and Instrumentation		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
QUALIFICATION TYPE	*FIELD*	*SUBFIELD*	
National Certificate	6 - Manufacturing, Engineering and Technology	Engineering and Related Design	
ABET BAND	*MINIMUM CREDITS*	*NQF LEVEL*	*QUAL CLASS*
Undefined	133	Level 2	Regular-Unit Stds Based

This qualification replaces:

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
48695	National Certificate: Measurement, Control and Instrumentation	Level 2	137	Will occur as soon as 65629 is registered

PURPOSE AND RATIONALE OF THE QUALIFICATION
Purpose:

The purpose of this qualification is to provide learners with the necessary applied competence to function effectively in the Measurement, Control and Instrumentation field at an entry level.

Qualifying learners will gain competencies that will promote professionalism in this sub field of Measurement, Control and Instrumentation by demonstrating competence against the following exit level outcomes:

> Understand the fundamentals of field process instrumentation.
> Conduct basic maintenance and calibration of field instrumentation and equipment.
> Demonstrate knowledge of relevant organizational standards, policies and procedures. [Range: legislative health, safety, environmental and maintenance].

This qualification provides for instrumentation competence and specialization in analytical equipment by means of elective unit standards.

Rationale:

Measurement, Control and Instrumentation is complex and sophisticated and regarded as a critical and scarce skill. Its importance spans across industries of manufacturing, engineering and technology and competence is important since the implications of malfunctioning instrumentation could cause the loss of life, finances and infrastructure in industry.

Health, safety, risks and environmental knowledge forms an integral part of the learning covered in the unit standards associated with this qualification. Concepts and technology covered by this qualification are written in a generic manner in order to provide for the portability of skill across

generic manufacturing, engineering and technology industries. The qualification thus contributes to a national skills pool in a meaningful and proactive manner. The qualification provides for the pipelining of a scarce skill for the sustainable growth of the industries it supports.

Typical entrants:

This qualification is aimed at learners (employed and unemployed) who wish to enter this field of economic activity as well as learners who are already in this field and have gained experience in this sub field and wish to receive formal recognition of experience. This qualification serves as an entry level for learners who wish to articulate through this career path and forms the basis for further development by advancing from this NQF Level 2 certificate to the NQF Level 3 and NQF Level 4 qualifications and eventual summative assessment through a nationally centralized trade test for red seal certification.

Hence, the range of typical learners at entry level could be:

> Assistants to qualified artisans with exposure resulting in unstructured experience, and who now seek to formalize their learning experience.
> School leavers who have not yet had any experience or vocational learning but have the potential to achieve this qualification.
> People working in other industry fields, but who now choose this field of work and have the potential to complete this qualification successfully.

Through its design this qualification will provide enhanced opportunity for employment within the Measurement, Control and Instrumentation industry.

Qualifying learners:

After qualifying with this certificate learners will be able to provide meaningful foundational skills to a range of industries and will contribute to the maintenance function of instrumentation by delivering skills and knowledge commensurate with the exit level outcomes of this certificate.

RECOGNIZE PREVIOUS LEARNING?
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LEARNING ASSUMED IN PLACE
It is assumed that learners are already competent in:

> Communication and Mathematical Literacy at NQF Level 1.

Recognition of Prior Learning:

This qualification may be obtained through Recognition of Prior Learning (RPL). The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the RPL option towards gaining the qualification.

Access to the Qualification:

Access to this qualification is open. However, it is preferred that learners have completed a National Certificate at NQF Level 1 in a trade-related sub-field or an equivalent qualification.

The learner must be physically able to perform the outcomes as specified in the unit standards and be able to differentiate between various colours applicable to the industry.

QUALIFICATION RULES
In the compulsory Fundamental Component of the qualification, learners must demonstrate their competence in the 20 credits in the field of Communication at NQF Level 2 and 16 credits in the field of Mathematical Literacy NQF Level 2.

The unit standards in the compulsory Core Component of this qualification reflect the generic competencies required in the Measurement, Control and Instrumentation discipline for the applicable industrial environments. The learner must demonstrate competence in the Core Component for the total of 84 credits.

Learners have to complete a minimum of 13 credits in the Elective Component. A minimum of 133 credits is required for certification purposes.

This qualification provides for a specialization in analytical equipment through the selection of the following elective unit standards:

> ID 244062: Demonstrate an understanding of elementary chemical principles and their application in process industries, 8 credits.
> ID 244071: Apply sampling theory and practice, 5 credits.

The above specializations apply to the following process industries in South Africa:

> Pulp and Paper.
> Metals Manufacturing and related process industries.
> Chemicals including Petrochemical.
> Mining and Minerals.
> All industries dealing with lifting machinery.
> Food and Beverages.
> Power Plant.

EXIT LEVEL OUTCOMES
1. Understand the fundamentals of field process instrumentation.

2. Conduct basic maintenance and calibration of field instrumentation and equipment.

3. Demonstrate knowledge of organizational standards, policies and procedures.
> Range: legislative health, safety, environmental and maintenance.

4. Solve problems and communicate with peers, supervisors and others.
> Range: Communication includes verbal and written form.

Critical Cross Field Outcomes:

> The learner is capable of identifying deviations related to equipment and procedures and creatively finding solutions through clearly defined methods and techniques.
> Work effectively with others as a member of a team on a daily basis to effectively provide maintenance and related services to process plants.
> Organise and manage oneself and one's activities responsibly and effectively by proactively handling and maintaining instrumentation equipment and tools.
> Communicate effectively using appropriate verbal and nonverbal skills to ensure a smooth shift take-over and hand-over and reporting all work related issues.
> Demonstrate an understanding of the world, as a set of related systems by recognising that problem solving in the context of Instrumentation and Analytical equipment does not happen in isolation.

> Use science and technology to show responsibility towards the environment and health of the broader community by complying with health, safety and environmental policies and procedures as dictated by legislation.

ASSOCIATED ASSESSMENT CRITERIA

Associated Assessment Criteria for Exit Level Outcome 1:

1.1 Basic Measurement, Control and Instrumentation drawings, sketches and material lists are identified and described in terms of their function.
1.2 The purpose of field instruments and equipment is explained in terms of a control loop within a process.
1.3 The fundamentals of electricity are described in accordance with accepted theoretical principles.
1.4 The methods and reasons for sampling instrumentation are given in accordance with organizational policy and procedure.
1.5 Methods and reasons for calibrating instrumentation are described using appropriate terminology and meet organizational standards.

Associated Assessment Criteria for Exit Level Outcome 2:

2.1 Maintenance of field instruments and equipment is planned for in accordance with sound Measurement, Control and Instrumentation principles and organisational requirements.
2.2 All appropriate engineering tools are used and maintained according to standard operating procedures.
2.3 Safe working conditions are applied when working with field instruments and equipment.
2.4 Field instruments and equipment are installed and removed in accordance with industry accepted procedures.
2.5 Basic Measurement, Control and Instrumentation drawings, sketches and material lists are used according to their purpose.
2.6 Instruments are calibrated as per specifications and associated ranges.

Associated Assessment Criteria for Exit Level Outcome 3:

3.1 Field instruments and equipment are used in accordance with safe working practices and manufacturer specifications.
3.2 Quality, safety and environmental procedures are followed, with specific reference to regulatory and legislative requirements.
3.3 Safety requirements in an electrical environment are described in terms of meeting legislative and organisational specific standards.

Associated Assessment Criteria for Exit Level Outcome 4:

4.1 Communication is maintained and adapted as required to promote effective interaction in the work context.
4.2 Terminology used is appropriate to the situation and in accordance with normal workplace usage.
4.3 Information related to work tasks is accessed and interpreted from a range of written and oral sources that ensure work requirements are understood.
4.4 Communication is clear and unambiguous and at an appropriate level for designated target audiences.
4.5 Information communicated is accurate and conveyed in accordance with acceptable timeframes.
4.6 Communication is effective, regular and ongoing.

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.

Some assessment aspects will demand practical demonstration while others may not. In some cases inference will be necessary to determine competence depending on the nature and context within which performance takes place.

Since this is a foundational qualification, 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 further learning. The assessment should also ensure that all the critical cross-field outcomes have been achieved.

INTERNATIONAL COMPARABILITY

This qualification was compared with a host of countries internationally including Zimbabwe, Kenya, Tanzania, Zambia, New Zealand, Australia, USA, European Union, India and Canada.

International qualifications were examined to ensure that the qualification model and associated unit standards proposed are comparable in terms of technical and learning best practice. However, the core and elective components have been developed and/or revised taking into account South Africa's unique context. The Working group for Instrumentation and Analyser mechanician is satisfied that this newly revised qualification is comparable to the best in the world.

Introduction:

The dual function of learning and training is a central feature of education and training policy in many countries, for example in Egypt, Mexico, Tunisia and South Africa. In Egypt, proactive training that assists enterprises to adjust to the needs of new skills, technology and work organization goes hand in hand with active labour market policy, including training for the unemployed, as well as measures that encourage income-generating and training activities for poorer groups of the population. The European Union exemplifies a regional dimension of such developments. Bi- and tripartite agreements on lifelong learning and training have multiplied recently, particularly in industrialized countries, as governments, employers' and workers' organisations have engaged in collective bargaining at the enterprise, sector or national level. The agreements stipulate workers' rights and certain regulatory conditions. They have also contributed to institutional frameworks at sector or national levels, often with the financial partnership of the government. Collective bargaining and dialogue with governments have, in many countries, led to the establishment of training funds that finance lifelong learning and training, for example in France, Spain, Netherlands, Denmark, and Sweden, and also in developing countries such as Benin, Senegal and Mali. Other arrangements provide for national qualification frameworks and skills recognition and certification, for instance, the United Kingdom, South Africa, Australia and New Zealand. Hence, training clauses of collective agreements tend to provide a good basis for establishing and sharing responsibilities, for building different types of partnerships, and for promoting equity in training.

The South African National Skills Development Strategy (NSDS) promotes a coherent and comprehensive approach to skills development. Learnerships are used to provide a mechanism to facilitate linkages between a structured learning environment and the workplace, so that graduates who obtain a qualification are ready to enter the world of work. In support of this goal, the Instrument Mechanician Learnership as it existed, has been revised, optimized and streamlined in conjunction with professional organisations, industry and training institutions who have rolled-out the initial training, incorporating the experience gained during this process. The review and optimisation of this qualification also aligns with the governmental, business and labour organisation objectives as defined in the Joint Initiative on Priority Skills Acquisition

(JIPSA), which has defined the trade of Instrument Mechanician as one of the sixteen priority trades in South Africa.

The trade of Instrument Mechanician is overwhelmingly technology based, i.e. the 'technology of the day' dictates the work content. The benefit that international comparability can deliver to this trade is therefore best derived in the form of 'best practice' typically found in the 'high technology' societies from which the majority of the equipment and systems originate. These are primarily the USA/Canada, UK, Germany, Japan and Australia/New Zealand. Comparison with Japan and Germany is complicated because of language barriers and their preference in providing narrow band 'specialized' training, which is not as broad based as the South African approach. Good comparison is possible between the other countries mentioned. India is included in this comparison as an upwardly mobile developing nation similar to South Africa.

Comparison between the various countries mentioned shows that while differences exist in sub-skill groupings, a good correlation exists between the blend of basic and advanced skills taught in the SAQA Instrumentation Mechanician qualification series called the Further Education and Training Certificate: Measurement, Control and Instrumentation. These may be summarized into the following major skill categories:

> Electrical and Electronics.
> Sensors and measurement techniques.
> Instrumentation by functionality, including Flow, Pressure, Level, Temperature & Analysis.
> Instrument Control Loops.
> Control Systems (PLC/DCS).

This Instrument Mechanician Qualification series has been developed with the active participation of the South African Institute of Measurement and Control (SAIMC), which has a broad spectrum industry and interested party representation, which involves continental and international partnerships.

International occupational profile of Measurement, Control and Instrumentation Mechanician (including analysers).

Measurement Control and Instrumentation studies across the globe, provides Industrial Instrument Mechanics with the basic knowledge and skills (technical training) that employers are seeking in new employees.

Industrial Instrument Mechanicians install, repair, maintain, and adjust instruments used to measure and control industrial processes such as pulp and paper manufacturing and petrochemical production. These types of instruments are typically used for controlling factors such as:

> Flow of substances such as gases or liquids.
> Temperature of materials or stages of a process.
> Pressure maintained during a process.
> Level of a material used or created during a process.

Industrial Instrument and Analyser Mechanics are often employed by pulp and paper processing companies, hydroelectric power generating companies or mining, petrochemical and natural gas companies. They help these companies diagnose faults and perform preventive maintenance by inspecting and testing the instruments and systems in use. Industrial Instrument Mechanic is usually a nationally designated trade in individual countries since the skill they provide is crucial for the survival of processing plants.

Industrial Instrument Mechanics also calibrate components and instruments according to manufacturer's' specifications and troubleshoot and tune industrial processes. Many of the instruments that they maintain are key to automating part (or all) of a manufacturing process.

Because their work can affect millions of dollars of production, Industrial Instrument Mechanics are in high demand. Industrial Instrument Mechanics are sometimes placed under tight deadlines to complete work assigned.

Country Comparison:

Canada:

Courses in Canada are based on intense theory in the classroom for a concurrent total curriculum incorporating approximately 900 classroom hours. The Canadian curriculum involves industry examples but the learning itself is not work based. Theory is combined with practical examples, simulations and field trips, but there is no coordination between classroom learning and learning in the workplace. It is structured with 4 exit levels ranging from level 1 - 4. The subject content of the curriculum is identical to the South African qualifications. There are minor changes in the way sets of skills are related but the overall curriculum results in the same objectives of installation, calibration, general maintenance and breakdown maintenance of industrial instrumentation as with this qualification. The Canadian model refers to critical cross field outcomes as essential skills and demonstrates the integration of critical cross field outcomes to the fundamental knowledge of their curriculum. There was favourable comparison with regard to the latter. It is interesting to note the detailed classification and reference to "on the job" technical description in their curriculum. The Canadian curriculum classifies the complexity of the tasks according to the essential knowledge and describes the detail of the associated technical content.

The curriculum is similar to the whole qualification concept and is not outcomes based. It is similar to the apprentice system in South Africa and there is no coordinated relationship in the learning and assessment of workplace and classroom learning. However, there is summative assessment resulting in nationally recognised certification. Industrial Instrument Mechanic is a nationally designated trade under the Inter-provincial Red Seal program.

India:

In India there are two routes to industry competence in the field of Instrumentation. Route one follows the craftsman route and Route two, the apprenticeship route. The difference is essentially the fact that the craftsman is not employer supported and that the apprentice is. The two routes are also done over different time periods. The apprenticeship takes 3 years to complete and the craftsmanship takes two years since more time is spent at the training institute. The content of the first and second year syllabus of the craftsman and apprenticeship is the same. There is two year rebate for practical training before certification.

In comparing the qualifications, there is general consensus among the subject matter experts consulted that a similar standard of technology and training is applied with minor changes in semantics and the structure of the learning programmes. What the Indian curriculum refers to as preventative maintenance South African instrumentation experts refer to as routine maintenance.

In the Indian syllabus there is no fundamental education development with regards to Communication and Literacy. It is assumed that candidates have successfully completed this learning through the schooling system, which is specified as the entry requirement. It appears that social studies are combined as part of the syllabus but there was very little access to this detailed content for comparison.

Republic of Zimbabwe:

Zimbabwe prescribes to a SADC Protocol, which requires member countries to set up a National Qualification Framework and calls for well-defined Skilled Worker classes/levels. Apprenticeship programs are administered via national legislation and the Industrial Training and Trade Testing Division (IT&TT), which is represented throughout Zimbabwe via regional offices situated in Gweru, Bulawayo, Masvingo and Mutare, with the Head Office in Harare.

The formal trade of "Instrument Mechanic" exists in Zimbabwe. It appears as though their course structure is influenced by the Canadian methodology. There is also a localised German influence via the Informal Sector Training and Resources Network (ISTARN) project in the Masvingo area. The ISTARN skills project is a joint venture between the Government of Zimbabwe and the Government of the Federal Republic of Germany.

Zambia, Kenya and Tanzania:

These countries operate process industries that employ the skill of Instrument Mechanics, and train towards this profession. From information available from SAIMC, certain academics are registered who are involved in these programmes. The three countries appear to emulate the South African apprenticeship structure. A research paper investigating the viability and effectiveness of vocational training also concurs with the apprenticeship structure of training. The SAIMC has confirmed that their programme content compares very favourabley to this qualification.

New Zealand and Australia:

New Zealand and Australia have qualification frameworks and like South Africa belong to the Organisation for Economic Cooperation and Development (OECD). Their curriculum structure was most conveniently compared. In certain instances there was direct comparison of unit standards.

The main difference between our technical content is that they group their tasks and activities differently. An example of this is the analyser component of this qualification. These countries categorise the equipment differently and deal with types of analytical instruments individually. The South African unit standards categorised the principle of operation and listed all types of equipment, grouping the individual analytical instruments in a range.

The New Zealand Qualifications Authority's National Certificate in Industrial Measurement and Control, and the Australian Certificate II in Electro-technology - Instrumentation compare favorably with this qualification in terms of outcomes, assessment criteria, duration and degree of difficulty.

USA:

The inside wireman (journeyman) trade curriculum was used as a basis for comparison. There appears to be a global standard on technological content and approach to training. The tool list required for the practical training as well as subject content seems to be almost identical to the South Africa model.

Instrumentation courses in the USA differ from state to state. The New York state course in instrumentation is rolled out as an apprenticeship. The duration is 48 months for a red seal certificate. It appears that this curriculum covers the same content as this qualification series up to the Level 5 certificate. The progression of complexity and content was almost identical to what was researched in the Canadian curriculum and compares favourably to the South African qualification.

Conclusion:

As much as a thorough effort was made to compare this set of qualifications internationally, language barriers or a general lack of information regarding the content and structure of international qualifications were sometimes encountered. However the curriculum content in accessible countries was thoroughly interrogated and debated for relevance and best practice against the South African model and the Working group for Instrumentation and Analyser mechanician is satisfied that this newly revised qualification is comparable to the best in the world.

ARTICULATION OPTIONS

This is the first qualification in a series from NQF Level 2 through NQF Level 3, 4 and 5. This series of qualifications can articulate directly to learning programmes and qualifications in the Measurement, Control and Instrumentation field. It also opens the possibility for further learning in the sub-field of Engineering and related design.

Vertical Articulation:

A learner could progress from NQF Level 2 through to a Level 5 Certificate. After completion of NQF Level 5, this would serve as a bridging course for entry into Higher Education Qualifications.

Horizontal:

Horizontally this qualification provides for instrumentation or analyzer specialization by means of learning programmes based on the selected elective unit standards in the matrix below and as informed by the qualification rules. There is limited articulation possibility with other trade-related electrical engineering qualifications.

MODERATION OPTIONS

> A person assessing a learner or moderating the assessment of learners against this Qualification must be registered as an assessor with the relevant ETQA.

> Any institution offering learning that will enable the achievement if this Qualification must be accredited as a provider with the relevant ETQA.

> Assessment and moderation of assessment will be overseen by the relevant ETQA according to the ETQAs policies and guidelines for assessment and moderation; in terms of agreements reached around assessment and moderation between ETQAs (including professional bodies); and in terms of the moderation guideline.

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

CRITERIA FOR THE REGISTRATION OF ASSESSORS

All assessors need to be Subject Matter Experts, qualified one level higher than the level of this qualification and registered with the relevant ETQA.

NOTES

This qualification replaces qualification 48695, "National Certificate: Measurement, Control and Instrumentation", Level 2, 137 credits.

For the purposes of this qualification, Instrumentation refers to Industrial instrumentation and control as applied on process plants.

Measurement, Control and Instrumentation equipment refers to flow, temperature, level and pressure field instrumentation. In order to demonstrate an understanding, the learner is given an application, which, if successfully carried out will demonstrate the knowledge component. This application must include the safe handling of the above-mentioned equipment.

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119463	Access and use information from texts	Level 2	5
Fundamental	9009	Apply basic knowledge of statistics and probability to influence the use of data and procedures in order to investigate life related problems	Level 2	3
Fundamental	7480	Demonstrate understanding of rational and irrational numbers and number systems	Level 2	3
Fundamental	9008	Identify, describe, compare, classify, explore shape and motion in 2-and 3-dimensional shapes in different contexts	Level 2	3
Fundamental	119454	Maintain and adapt oral/signed communication	Level 2	5
Fundamental	119460	Use language and communication in occupational learning programmes	Level 2	5
Fundamental	7469	Use mathematics to investigate and monitor the financial aspects of personal and community life	Level 2	2
Fundamental	9007	Work with a range of patterns and functions and solve problems	Level 2	5
Fundamental	119456	Write/present for a defined context	Level 2	5
Core	117867	Managing files in a Graphical User Interface (GUI) environment	Level 1	3
Core	258925	Apply and maintain safety in a working environment	Level 2	5
Core	114605	Carry out soldering and de-soldering procedures	Level 2	3
Core	114621	Demonstrate an understanding of and install Instrument impulse lines	Level 2	6
Core	114608	Demonstrate an understanding of and maintain equipment associated with final control elements	Level 2	6
Core	114622	Demonstrate an understanding of and maintain flow equipment	Level 2	6
Core	114609	Demonstrate an understanding of and maintain level equipment	Level 2	6
Core	114611	Demonstrate an understanding of and maintain pressure equipment	Level 2	6
Core	114614	Demonstrate an understanding of and maintain temperature equipment	Level 2	6
Core	262489	Demonstrate an understanding of instrumentation calibration, terminology and standards	Level 2	6
Core	258957	Identify, inspect, use, maintain and care for engineering hand tools	Level 2	6
Core	10255	Select, use and care for power tools	Level 2	5
Core	113877	Understand fundamentals of electricity	Level 2	8
Core	114623	Select, inspect, use and maintain measurement, test and calibration equipment	Level 3	8
Core	114406	Understand basic electronic theory and components	Level 3	4
Elective	244062	Demonstrate understanding of elementary chemical principles and their applications in process industries	Level 1	8
Elective	244071	Apply sampling theory and practice	Level 2	5
Elective	258939	Carry out basic electric arc welding in an electrical environment	Level 2	8
Elective	258920	Carry out basic gas welding, brazing and cutting in an electrical environment	Level 2	8
Elective	12484	Perform basic fire fighting	Level 2	4
Elective	9882	Read and interpret basic engineering drawings	Level 2	8
Elective	12481	Sling loads	Level 2	4
Elective	116534	Carry out basic first aid treatment in the workplace	Level 3	2

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION
None

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:
National Certificate: Measurement, Control and Instrumentation

SAQA QUAL ID	*QUALIFICATION TITLE*		
65631	National Certificate: Measurement, Control and Instrumentation		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
QUALIFICATION TYPE	*FIELD*	*SUBFIELD*	
National Certificate	6 - Manufacturing, Engineering and Technology	Engineering and Related Design	
ABET BAND	*MINIMUM CREDITS*	*NQF LEVEL*	*QUAL CLASS*
Undefined	120	Level 3	Regular-Unit Stds Based

This qualification replaces:

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
48696	National Certificate: Measurement, Control and Instrumentation	Level 3	163	Will occur as soon as 65631 is registered

PURPOSE AND RATIONALE OF THE QUALIFICATION
Purpose:

The purpose of this qualification is to provide learners with the necessary applied competence to function professionally in the Measurement, Control and Instrumentation field.

Qualifying learners will gain competencies that will promote professionalism in this sub field by being able to:

> Maintain programmable field instrumentation.
> Demonstrate knowledge of the principles of field instrumentation.
> Comply with manufacturer's specifications, organizational policies, procedures, standards and applicable legislative requirements.

Learner achievement in this qualification sets the platform for further learning at a more complex level involving troubleshooting, repair and maintenance. The qualification provides for specialization in analytical equipment.

Typical entrants to this qualification:

This qualification is aimed at learners who have completed the NQF Level 2 certificate preceding this qualification, as well as learners who are already active in this field and wish to receive formal recognition of their knowledge, skill and experience. This qualification serves as a learning pathway toward the NQF Level 4 Further Education and Training Certificate: Measurement, Control and Instrumentation.

Qualifying learners:

After qualifying in this certificate learners are able to provide meaningful skills to a range of industries and will contribute to the maintenance function of instrumentation by delivering skills and knowledge commensurate with the exit level outcomes of this certificate.

Rationale:

Measurement, Control and Instrumentation is complex and sophisticated and regarded as a critical and scarce skill. Its importance spans across various industries of manufacturing engineering and technology. Competence is important since the implications of malfunctioning instrumentation could cause the loss of life, finances and infrastructure in industry.

Health, safety, risks and environmental knowledge forms an integral part of the learning covered in the unit standards associated with this qualification. Concepts and technology covered by this qualification are written in a generic manner in order to provide for the portability of skill across various industries. The qualification thus contributes to a national skills pool in a meaningful and proactive manner.

This qualification responds to a critical, core and scarce skill as identified by the energy sector skills plan and provides an opportunity for qualifying learners to access employment in the Measurement, Control and Instrumentation field.

RECOGNIZE PREVIOUS LEARNING?
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LEARNING ASSUMED IN PLACE
This qualification assumes that the candidate has acquired the competencies associated with the NQF Level 2 Certificate in Measurement Control and Instrumentation.

Learning in preparation for this qualification should include the aspects of:

> Language, Mathematical Literacy and Numeracy.
> Science, Measurement, Control and Instrumentation technology or equivalent.

Recognition of Prior Learning:

This qualification may be obtained through a process of RPL assessment. The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided on the criteria required to be declared competent. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the RPL option towards gaining a qualification.

The guidelines for integrated assessment should be used to develop the RPL assessment process. As with integrated assessment, while this is primarily a workplace based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the exit level outcomes.

Access to the Qualification:

Access to this qualification is open. It is however necessary to obtain relevant work experience in order to produce the evidence required to assess the Exit Level Outcomes.

The learner must be physically able to perform the outcomes as specified in the unit standards and be able to differentiate between various colours applicable to the industry.

QUALIFICATION RULES
Fundamental Component:

This section consists of Unit Standards in:

> Communication at NQF Level 3 to the value of 20 credits.
> Mathematical Literacy at NQF Level 3 to the value of 16 credits.
> All unit standards in the fundamental component are compulsory.

Core Component:

This section consists of unit standards to the value of 64 Credits, all of which are compulsory.

Elective Component:

This section consists of two specializations. A learner may nominate to specialize in Instrumentation or Analytical equipment according to the following rules:

Instrumentation:

> Unit standards chosen from the Elective Component should amount to a minimum of 20 Credits.

Analyzer:

Unit standards chosen from the Elective component should amount to a minimum of 20 Credits made up of the following:

> ID 262485: Demonstrate an understanding of analytical measurement systems, NQF Level 3, 12 Credits.
> ID 244241: Apply knowledge of chemical reactions in a processing environment, NQF Level 3, 6 Credits.
> ID 10630: Maintain intrinsically safe apparatus, NQF Level 3, 2 Credits.

A minimum of 120 credits is required for certification purposes.

The above specializations apply to the following process industries in South Africa:

> Pulp and Paper.
> Metals Manufacturing and related process industries.
> Chemicals including Petrochemical.
> Mining and Minerals.
> All industries dealing with lifting machinery.
> Food and Beverages.
> Power Plant.

EXIT LEVEL OUTCOMES

1. Maintain programmable field instruments.

2. Demonstrate knowledge of the principles of field instrumentation.

3. Comply with relevant specifications, policies, procedures and legislative requirements.

4. Solve problems and communicate with peers, supervisors and others.
> Range: Communication includes verbal and written form.

Critical Cross Field Outcomes:

> The learner is capable of identifying deviations related to equipment and procedures and creatively finding solutions through clearly defined methods and techniques.
> Work effectively with others as a member of a team on a daily basis to effectively provide maintenance and related services to process plants.
> Organise and manage oneself and one's activities responsibly and effectively by proactively handling and maintaining instrumentation equipment and tools.
> Communicate effectively using appropriate verbal and nonverbal skills to ensure a smooth shift take-over and hand-over and reporting all work related issues.
> Demonstrate an understanding of the world, as a set of related systems by recognising that problem solving in the context of Instrumentation and Analytical equipment does not happen in isolation.
> Use science and technology to show responsibility towards the environment and health of the broader community by complying with health, safety and environmental policies and procedures as dictated by legislation.

ASSOCIATED ASSESSMENT CRITERIA
Associated Assessment Criteria for Exit Level Outcome 1:

1.1 Maintenance of field instruments and equipment is planned for in accordance with sound Measurement, Control and Instrumentation principles and organisational requirements.
1.2 Fault finding techniques are applied in accordance with organisational standards, procedures and manufacturer's specifications.
1.3 Engineering tools are used and maintained according to standard operating procedures.
1.4 Programmable field instruments and controllers are maintained in accordance with organizational standards, procedures and manufacturer's specifications.
1.5 Relay Logic Circuits are designed and constructed in accordance with plant process loop requirements and plant specifications within equipment specification guidelines.
1.6 Instruments are calibrated as per specifications and associated ranges.
1.7 Field instruments are removed and installed in accordance with maintenance and occupational health, safety and environmental policies and procedures.

Associated Assessment Criteria for Exit Level Outcome 2:

2.1 Electronic circuits are constructed as per design requirements in accordance with sound theoretical principles.
2.2 The fundamental knowledge of PLC's is demonstrated in accordance with sound theoretical principles.
2.3 The principles of Process Control Loops are described in accordance with generally accepted instrumentation philosophy.

Associated Assessment Criteria for Exit Level Outcome 3:

3.1 Programmable field instruments and equipment are used in accordance with safe working practices and manufacturer specifications.
3.2 Quality, safety and environmental procedures are followed, with specific reference to regulatory and legislative requirements.
3.3 Safety requirements in an electrical environment are described in terms of meeting legislative and organisational specific standards.

Associated Assessment Criteria for Exit Level Outcome 4:

4.1 Communication is maintained and adapted as required to promote effective interaction in the work context.
4.2 Terminology used is appropriate to the situation and in accordance with normal workplace usage.

4.3 Information related to work tasks is accessed and interpreted from a range of written and oral sources that ensure work requirements are understood.
4.4 Communication is clear and unambiguous and at an appropriate level for designated target audiences.
4.5 Information communicated is accurate and conveyed in accordance with acceptable timeframes.
4.6 Communication is effective, regular and ongoing.

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.

The assessment criteria of the qualification are embodied in the Unit Standards. The depths of technical expertise that will be assessed across the various specialist contexts are clearly articulated in the relevant specific outcomes, assessment criteria and range statements within these unit standards.

Some assessment aspects will demand practical demonstration while others may not. In some case inference will be necessary to determine competence depending on the nature and context within which performance takes place.

Since this is a foundational qualification, 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 further learning. The assessment should also ensure that all the critical cross-field outcomes have been achieved.

INTERNATIONAL COMPARABILITY
This qualification was compared with a host of countries internationally including Zimbabwe, Kenya, Tanzania, Zambia, New Zealand, Australia, USA, European Union, India and Canada.

International qualifications were examined to ensure that the qualification model and associated unit standards proposed are comparable in terms of technical and learning best practice. However, the core and elective components have been developed and/or revised taking into account South Africa's unique context. The Working group for Instrumentation and Analyser mechanician is satisfied that this newly revised qualification is comparable to the best in the world.

Introduction:

The dual function of learning and training is a central feature of education and training policy in many countries, for example in Egypt, Mexico, Tunisia and South Africa. In Egypt, proactive training that assists enterprises to adjust to the needs of new skills, technology and work organization goes hand in hand with active labour market policy, including training for the unemployed, as well as measures that encourage income-generating and training activities for poorer groups of the population. The European Union exemplifies a regional dimension of such developments. Bi- and tripartite agreements on lifelong learning and training have multiplied recently, particularly in industrialized countries, as governments, employers' and workers' organisations have engaged in collective bargaining at the enterprise, sector or national level. The agreements stipulate workers' rights and certain regulatory conditions. They have also contributed to institutional frameworks at sector or national levels, often with the financial partnership of the government. Collective bargaining and dialogue with governments have, in many countries, led to the establishment of training funds that finance lifelong learning and

training, for example in France, Spain, Netherlands, Denmark, and Sweden, and also in developing countries such as Benin, Senegal and Mali. Other arrangements provide for national qualification frameworks and skills recognition and certification, for instance, the United Kingdom, South Africa, Australia and New Zealand. Hence, training clauses of collective agreements tend to provide a good basis for establishing and sharing responsibilities, for building different types of partnerships, and for promoting equity in training.

The South African National Skills Development Strategy (NSDS) promotes a coherent and comprehensive approach to skills development. Learnerships are used to provide a mechanism to facilitate linkages between a structured learning environment and the workplace, so that graduates who obtain a qualification are ready to enter the world of work. In support of this goal, the Instrument Mechanician Learnership as it existed, has been revised, optimized and streamlined in conjunction with professional organisations, industry and training institutions who have rolled-out the initial training, incorporating the experience gained during this process. The review and optimisation of this qualification also aligns with the governmental, business and labour organisation objectives as defined in the Joint Initiative on Priority Skills Acquisition (JIPSA), which has defined the trade of Instrument Mechanician as one of the sixteen priority trades in South Africa.

The trade of Instrument Mechanician is overwhelmingly technology based, i.e. the 'technology of the day' dictates the work content. The benefit that international comparability can deliver to this trade is therefore best derived in the form of 'best practice' typically found in the 'high technology' societies from which the majority of the equipment and systems originate. These are primarily the USA/Canada, UK, Germany, Japan and Australia/New Zealand. Comparison with Japan and Germany is complicated because of language barriers and their preference in providing narrow band 'specialized' training, which is not as broad based as the South African approach. Good comparison is possible between the other countries mentioned. India is included in this comparison as an upwardly mobile developing nation similar to South Africa.

Comparison between the various countries mentioned shows that while differences exist in sub-skill groupings, a good correlation exists between the blend of basic and advanced skills taught in the SAQA Instrumentation Mechanician qualification series called the Further Education and Training Certificate: Measurement, Control and Instrumentation. These may be summarized into the following major skill categories:

> Electrical and Electronics.
> Sensors and measurement techniques.
> Instrumentation by functionality, including Flow, Pressure, Level, Temperature & Analysis.
> Instrument Control Loops.
> Control Systems (PLC/DCS).

This Instrument Mechanician Qualification series has been developed with the active participation of the South African Institute of Measurement and Control (SAIMC), which has a broad spectrum industry and interested party representation, which involves continental and international partnerships.

International occupational profile of Measurement, Control and Instrumentation Mechanician (including analysers):

Measurement Control and Instrumentation studies across the globe, provides Industrial Instrument Mechanics with the basic knowledge and skills (technical training) that employers are seeking in new employees.

Industrial Instrument Mechanicians install, repair, maintain, and adjust instruments used to measure and control industrial processes such as pulp and paper manufacturing and

petrochemical production. These types of instruments are typically used for controlling factors such as:

> Flow of substances such as gases or liquids.
> Temperature of materials or stages of a process.
> Pressure maintained during a process.
> Level of a material used or created during a process.

Industrial Instrument and Analyser Mechanics are often employed by pulp and paper processing companies, hydroelectric power generating companies or mining, petrochemical and natural gas companies. They help these companies diagnose faults and perform preventive maintenance by inspecting and testing the instruments and systems in use. Industrial Instrument Mechanic is usually a nationally designated trade in individual countries since the skill they provide is crucial for the survival of processing plants.

Industrial Instrument Mechanics also calibrate components and instruments according to manufacturer's' specifications and troubleshoot and tune industrial processes. Many of the instruments that they maintain are key to automating part (or all) of a manufacturing process.

Because their work can affect millions of dollars of production, Industrial Instrument Mechanics are in high demand. Industrial Instrument Mechanics are sometimes placed under tight deadlines to complete work assigned.

Country Comparison:

Canada:

Courses in Canada are based on intense theory in the classroom for a concurrent total curriculum incorporating approximately 900 classroom hours. The Canadian curriculum involves industry examples but the learning itself is not work based. Theory is combined with practical examples, simulations and field trips, but there is no coordination between classroom learning and learning in the workplace. It is structured with 4 exit levels ranging from level 1 - 4. The subject content of the curriculum is identical to the South African qualifications. There are minor changes in the way sets of skills are related but the overall curriculum results in the same objectives of installation, calibration, general maintenance and breakdown maintenance of industrial instrumentation as with this qualification. The Canadian model refers to critical cross field outcomes as essential skills and demonstrates the integration of critical cross field outcomes to the fundamental knowledge of their curriculum. There was favourable comparison with regard to the latter. It is interesting to note the detailed classification and reference to "on the job" technical description in their curriculum. The Canadian curriculum classifies the complexity of the tasks according to the essential knowledge and describes the detail of the associated technical content.

The curriculum is similar to the whole qualification concept and is not outcomes based. It is similar to the apprentice system in South Africa and there is no coordinated relationship in the learning and assessment of workplace and classroom learning. However, there is summative assessment resulting in nationally recognised certification. Industrial Instrument Mechanic is a nationally designated trade under the Inter-provincial Red Seal program.

India:

In India there are two routes to industry competence in the field of Instrumentation. Route one follows the craftsman route and Route two, the apprenticeship route. The difference is essentially the fact that the craftsman is not employer supported and that the apprentice is. The two routes are also done over different time periods. The apprenticeship takes 3 years to complete and the craftsmanship takes two years since more time is spent at the training

institute. The content of the first and second year syllabus of the craftsman and apprenticeship is the same. There is two year rebate for practical training before certification.

In comparing the qualifications, there is general consensus among the subject matter experts consulted that a similar standard of technology and training is applied with minor changes in semantics and the structure of the learning programmes. What the Indian curriculum refers to as preventative maintenance South African instrumentation experts refer to as routine maintenance.

In the Indian syllabus there is no fundamental education development with regards to Communication and Literacy. It is assumed that candidates have successfully completed this learning through the schooling system, which is specified as the entry requirement. It appears that social studies are combined as part of the syllabus but there was very little access to this detailed content for comparison.

Republic of Zimbabwe:

Zimbabwe prescribes to a SADC Protocol, which requires member countries to set up a National Qualification Framework and calls for well-defined Skilled Worker classes/levels. Apprenticeship programs are administered via national legislation and the Industrial Training and Trade Testing Division (IT&TT), which is represented throughout Zimbabwe via regional offices situated in Gweru, Bulawayo, Masvingo and Mutare, with the Head Office in Harare.

The formal trade of "Instrument Mechanic" exists in Zimbabwe. It appears as though their course structure is influenced by the Canadian methodology. There is also a localised German influence via the Informal Sector Training and Resources Network (ISTARN) project in the Masvingo area. The ISTARN skills project is a joint venture between the Government of Zimbabwe and the Government of the Federal Republic of Germany.

Zambia, Kenya and Tanzania:

These countries operate process industries that employ the skill of Instrument Mechanics, and train towards this profession. From information available from SAIMC, certain academics are registered who are involved in these programmes. The three countries appear to emulate the South African apprenticeship structure. A research paper investigating the viability and effectiveness of vocational training also concurs with the apprenticeship structure of training. The SAIMC has confirmed that their programme content compares very favourabley to this qualification.

New Zealand and Australia:

New Zealand and Australia have qualification frameworks and like South Africa belong to the Organisation for Economic Cooperation and Development (OECD). Their curriculum structure was most conveniently compared. In certain instances there was direct comparison of unit standards.

The main difference between our technical content is that they group their tasks and activities differently. An example of this is the analyser component of this qualification. These countries categorise the equipment differently and deal with types of analytical instruments individually. The South African unit standards categorised the principle of operation and listed all types of equipment, grouping the individual analytical instruments in a range.

The New Zealand Qualifications Authority's National Certificate in Industrial Measurement and Control, and the Australian Certificate II in Electro-technology - Instrumentation compare favourably with this qualification in terms of outcomes, assessment criteria, duration and degree of difficulty.

USA:

The inside wireman (journeyman) trade curriculum was used as a basis for comparison. There appears to be a global standard on technological content and approach to training. The tool list required for the practical training as well as subject content seems to be almost identical to the South Africa model.

Instrumentation courses in the USA differ from state to state. The New York state course in instrumentation is rolled out as an apprenticeship. The duration is 48 months for a red seal certificate. It appears that this curriculum covers the same content as this qualification series up to the Level 5 certificate. The progression of complexity and content was almost identical to what was researched in the Canadian curriculum and compares favourably to the South African qualification.

Conclusion:

As much as a thorough effort was made to compare this set of qualifications internationally, language barriers or a general lack of information regarding the content and structure of international qualifications were sometimes encountered. However the curriculum content in accessible countries was thoroughly interrogated and debated for relevance and best practice against the South African model and the Working group for Instrumentation and Analyser mechanician is satisfied that this newly revised qualification is comparable to the best in the world.

ARTICULATION OPTIONS

This is the second qualification in a series from NQF Level 2 through NQF Level 3, 4 and 5. This series of qualifications can articulate directly to learning programmes and qualifications in the Measurement, Control and Instrumentation field. It also opens the possibility for further learning in the sub-field of Engineering and related design.

Vertical Articulation:

> A learner could progress from NQF Level 2 through to a National Certificate: Measurement Control and Instrumentation, NQF Level 5. After completion of NQF Level 5, this would serve as a bridging course for entry into Higher Education Qualifications. A learner could also enter a National Diploma in Electronics Engineering with a specialization in Instrumentation or A Bachelor of Science Degree: Electronics.

Horizontal:

> Fundamental learning at this level applies to equivalent credit accrual for engineering-related qualifications at NQF Level 3.

> Core learning at this level applies to equivalent credit accrual for some unit standards applicable to a range of engineering qualifications. Horizontal articulation is applicable between the different specialization areas of this qualification.

MODERATION OPTIONS

> A person assessing a learner or moderating the assessment of a learner against this qualification must be registered as an assessor with the relevant ETQA.

> Any institution offering learning that will enable the achievement if this qualification must be accredited as a provider with the relevant ETQA.

> Assessment and moderation of assessment will be overseen by the relevant ETQA according to the ETQAs policies and guidelines for assessment and moderation; in terms of agreements reached around assessment and moderation between ETQAs (including professional bodies); and in terms of the moderation guideline.

> Moderation must include both internal and external moderation of assessments at exit points of the qualification, unless ETQA policies specify otherwise. Moderation should also encompass achievement of the competence described both in individual unit standards, exit level outcomes as well as the integrated competence described in the associated assessment criteria of the exit level outcomes of this qualification.

CRITERIA FOR THE REGISTRATION OF ASSESSORS
The following criteria should be applied by a relevant ETQA as a minimum requirement:

Assessors should be in possession of an appropriate qualification:
> Measurement, Control and Instrumentation at NQF Level 4 and a minimum period of 5 years related experience as specified by the relevant ETQA.

OR

> An artisan qualification in Measurement, Control and Instrumentation (trade test certificate or completed contract of apprenticeship) with a minimum of 5 years of related experience as specified by the relevant ETQA.

OR

> Subject matter experience, which may be established through recognition of prior learning (RPL).
> Registration as an assessor with the relevant Education and Training Quality Assurance Body.

Proven inter-personal skills and the ability to:

> Maintain national and local industry standards.
> Act in the interest of the learner.
> Understand the need for transformation to redress the legacies of the past, and respect the cultural background and language of the learner.

NOTES
This qualification replaces qualification 48696, "National Certificate: Measurement, Control and Instrumentation", Level 3, 163 credits.

Preamble:

> For the purposes of this qualification, Instrumentation refers to Industrial instrumentation and control as applied on process plants.

> Measurement, Control and Instrumentation equipment refers to flow, temperature, level and pressure field instrumentation. In order to demonstrate an understanding, the learner is given an application, which, if successfully carried out will demonstrate the knowledge component. This application must include the safe handling of the above-mentioned equipment.

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	119472	Accommodate audience and context needs in oral/signed communication	Level 3	5

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Fundamental	9010	Demonstrate an understanding of the use of different number bases and measurement units and an awareness of error in the context of relevant calculations	Level 3	2
Fundamental	9013	Describe, apply, analyse and calculate shape and motion in 2-and 3-dimensional space in different contexts	Level 3	4
Fundamental	119457	Interpret and use information from texts	Level 3	5
Fundamental	9012	Investigate life and work related problems using data and probabilities	Level 3	5
Fundamental	119467	Use language and communication in occupational learning programmes	Level 3	5
Fundamental	7456	Use mathematics to investigate and monitor the financial aspects of personal, business and national issues	Level 3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	5
Core	10270	Construct Basic Electronic Circuits	Level 3	4
Core	113899	Demonstrate an understanding of basic programmable logic controllers	Level 3	6
Core	114620	Demonstrate fault finding techniques on field instrumentation	Level 3	8
Core	262486	Design and construct relay logic circuits	Level 3	6
Core	114615	Maintain analytical equipment	Level 3	7
Core	114603	Maintain controllers	Level 3	7
Core	262482	Maintain programmable field instruments	Level 3	12
Core	114624	Read and interpret instrumentation drawings	Level 3	4
Core	116084	Demonstrate an understanding of the Principles of Process Control Loops	Level 4	10
Elective	10630	Maintain intrinsically safe apparatus	Level 2	2
Elective	262485	Demonstrate an understanding of analytical measurement systems	Level 3	12
Elective	260723	Install, test and maintain a basic fluid power system	Level 3	8
Elective	13139	Install, test and maintain a basic pneumatic system	Level 3	10

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION
None

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:
Further Education and Training Certificate: Measurement, Control and Instrumentation

SAQA QUAL ID	*QUALIFICATION TITLE*		
65630	Further Education and Training Certificate: Measurement, Control and Instrumentation		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
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	134	Level 4	Regular-Unit Stds Based

This qualification replaces:

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
48919	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4	160	Will occur as soon as 65630 is registered

PURPOSE AND RATIONALE OF THE QUALIFICATION
Purpose:

The purpose of this qualification is to provide learners with the necessary applied competence to function professionally in the Measurement, Control and Instrumentation field.

Qualifying learners will gain competencies that will promote professionalism in this sub field by being able to:

> Maintain process control systems.
> Maintain Programmable Logic Controllers (PLC).
> Demonstrate understanding of the principles of process communication systems.
> Maintain and support policies and procedures to solve a variety of problems within a Measurement, Control and Instrumentation field.

The elective component of this qualification provides for specialization in analytical equipment.

This qualification is the final in a series of three towards the Further Education and Training Certificate: Measurement, Control and Instrumentation. It serves as a prerequisite for entry into the certificate at NQF Level 5. After completion of this certificate a learner could be summatively assessed towards the red seal certification by the Department of Labour.

Typical entrants to this qualification:

> A learner whom has completed the NQF Level 3 Qualification in Measurement, Control and Instrumentation and is progressing towards the completion of this Further Education and Training Certificate.
> Whilst work experience during this learning is important and advisable, an institutional provider with the necessary simulator equipment and plant that is accredited by the relevant ETQA, would suffice for providing this learning.
> A Recognition of Prior Learning (RPL) candidate (an individual whom has developed specific on the job knowledge and skills in a non-formal manner outside of a structured learning programme and volunteers to be assessed for competence in a structured manner).

Qualifying learners:

After qualifying with this certificate learners will be able to provide meaningful foundational skills to a range of industries and will contribute to the maintenance function of instrumentation by delivering skills and knowledge commensurate with the exit level outcomes of this certificate.

Completion of this qualification is a pre-requisite for a trade test towards the red seal certification for artisanship.

Rationale:

The need for this qualification has been established by the Measurement, Control and Instrumentation profession and informed by the energy sector skill plan. This qualification serves as a basis for learners who are already in this field, have gained experience in this industry and wishe to receive formal recognition for their current experience, and for learners who wish to follow this career path for further development.

Measurement, Control and Instrumentation is complex and sophisticated and regarded as a critical and scarce skill. Its importance spans across various industries of manufacturing engineering and technology. Competence is important since the implications of malfunctioning instrumentation could cause the loss of life, finances and infrastructure in industry. One of its primary purposes in industry, and particularly process plants, is to ensure correct measurement and control for the purpose of contributing to the safe and efficient operation of plants. Secondly, competence in Measurement, Control and Instrumentation is important since it is a significant contributor to innovation. Throughput and quality is driven by instrumentation processes directly contributing to the revenue of businesses. Ensuring competence against this qualification is important since it forms the basis for ongoing learning in order to keep track of changing technology and advances in the field. This qualification provides for the channelling of a scarce skill for the sustainable growth of the industries it supports.

Health, safety, risks and environmental knowledge forms an integral part of the learning covered in the unit standards associated with this qualification. Concepts and equipment covered by this qualification are written in a generic manner in order to provide for the portability of skill across industries. The qualification thus contributes to a national skills pool in a meaningful and proactive manner.

RECOGNIZE PREVIOUS LEARNING?
Y

LEARNING ASSUMED IN PLACE
This qualification assumes that the candidate has acquired the competencies associated with the NQF Level 3 Certificate in Measurement Control and Instrumentation.

Learning in preparation for this qualification should include the aspects of:

> Communication and Mathematical Literacy at NQF Level 3.

> Natural Science Technology.
> Measurement Control and Instrumentation principles and technology.

Recognition of Prior Learning:

This qualification may be obtained through RPL. The learner should be thoroughly briefed on the mechanism to be used and support and guidance should be provided. Care should be taken that the mechanism used provides the learner with an opportunity to demonstrate competence and is not so onerous as to prevent learners from taking up the RPL option towards gaining a qualification. As with integrated assessment, whilst this is primarily a workplace-based qualification, evidence from other areas of endeavour may be introduced if pertinent to any of the outcomes assessed against.

Access to the Qualification:

There is open access to this qualification, however it is necessary to obtain relevant task experience at the NQF Level 3, National Certificate: Measurement, Control and Instrumentation in order to produce the evidence required for competence against the exit level outcomes.

The learner must be physically able to perform the outcomes as specified in the unit standards and be able to differentiate between various colours applicable to the industry.

QUALIFICATION RULES
Fundamental Component:

> The Fundamental Component consists of Unit Standards in:
> Communications in a first language at NQF Level 4 to the value of 20 credits.
> Communications in a second language at NQF Level 3 to the value of 20 credits.
> Mathematical Literacy at NQF Level 4 to the value of 16 credits.
All Unit Standards in the Fundamental Component are compulsory.

Core Component:

The Core Component consists of unit standards to the value of 51 Credits, all of which are compulsory.

Elective Component:

The elective component consists of two specializations. A learner may nominate to specialize in Instrumentation or Analytical equipment according to the following rules:
Unit standards chosen from the Elective Component should amount to a minimum of 27 Credits.

Analyzer stream:

> Perform routine maintenance on analysers, 12 Credits.
> Fault find and repair analysers, 15 Credits.

The afore-mentioned rules apply to the following industries:

> Pulp and Paper.
> Metals Manufacturing and related process industries.
> Chemicals including Petrochemical.
> Mining and Minerals.
> All industries dealing with lifting machinery.
> Food and Beverages.

> Power Plant.

EXIT LEVEL OUTCOMES

1. Maintain process control systems.

2. Maintain Programmable Logic Controllers (PLC).

3. Demonstrate understanding of the principles of Process Communication Systems.

4. Maintain and support policies and procedures to solve a variety of problems within a Measurement, Control and Instrumentation field.
> Range: Problems include both familiar and unfamiliar.

Critical Cross Field Outcomes:

> The learner is capable of identifying deviations related to equipment and procedures and creatively finding solutions through clearly defined methods and techniques.
> Work effectively with others as a member of a team on a daily basis to effectively provide maintenance and related services to process control systems.
> Organise and manage oneself and one's activities responsibly and effectively by proactively handling and maintaining instrumentation, equipment and tools.
> Communicate effectively using appropriate verbal and nonverbal skills to ensure a smooth shift take-over and hand-over and reporting all work related issues.
> Demonstrate an understanding of the world, as a set of related systems by recognising that problem solving in the context of Instrumentation and Analytical equipment does not happen in isolation.
> Use science and technology to show responsibility towards the environment and health of the broader community by complying with health, safety and environmental policies and procedures as dictated by legislation.

ASSOCIATED ASSESSMENT CRITERIA

Associated Assessment Criteria for Exit Level Outcome 1:

1.1 Preparations for maintaining process control systems are done in accordance with workplace policies and procedures.
1.2 Faults in process control systems are diagnosed in accordance with sound troubleshooting philosophies.
1.3 Equipment in process control system is repaired in accordance with manufacturer's specifications.
1.4 Equipment is calibrated in accordance with calibration standards and specified ranges.

Associated Assessment Criteria for Exit Level Outcome 2:

2.1 PLC hardware is diagnosed for faults, in accordance with sound diagnostic techniques.
2.2 PLC hardware is repaired in accordance with manufacturer's specifications.
2.3 Normal conditions are established after completion in accordance with organizational procedure.

Associated Assessment Criteria for Exit Level Outcome 3:

3.1 The fundamentals of the hierarchical industrial network structure are explained.
> Range: Diagrams, description, equipment handling.
3.2 Process Communication protocols, interfaces and mediums are conducted in accordance with workplace procedures.
3.3 Network addressing is conducted in accordance with manufacturer specifications.

Associated Assessment Criteria for Exit Level Outcome 4:

4.1 Solutions to problems are based on a clear analysis of information gathered through accepted diagnostic procedures.
4.2 Policies and procedures are reviewed in responding to unfamiliar problems to ensure suitability of the solution to the situation.
4.3 Answers given to problems arising in the Measurement, Control and Instrumentation field show insight and understanding. Where answers are not known, the process of researching information is appropriate to the situation.
4.4 Actions taken to solve problems are accurately recorded for future reference.

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.
> The assessment criteria of the qualification are embodied in the Unit Standards. The depths of technical expertise that will be assessed across the various specialist contexts are clearly articulated in the relevant specific outcomes, assessment criteria and range statements within these unit standards.
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petrochemical production. These types of instruments are typically used for controlling factors such as:

> Flow of substances such as gases or liquids.
> Temperature of materials or stages of a process.
> Pressure maintained during a process.
> Level of a material used or created during a process.

Industrial Instrument and Analyser Mechanics are often employed by pulp and paper processing companies, hydroelectric power generating companies or mining, petrochemical and natural gas companies. They help these companies diagnose faults and perform preventive maintenance by inspecting and testing the instruments and systems in use. Industrial Instrument Mechanic is usually a nationally designated trade in individual countries since the skill they provide is crucial for the survival of processing plants.

Industrial Instrument Mechanics also calibrate components and instruments according to manufacturer's' specifications and troubleshoot and tune industrial processes. Many of the instruments that they maintain are key to automating part (or all) of a manufacturing process.

Because their work can affect millions of dollars of production, Industrial Instrument Mechanics are in high demand. Industrial Instrument Mechanics are sometimes placed under tight deadlines to complete work assigned.

Country Comparison:

Canada:

Courses in Canada are based on intense theory in the classroom for a concurrent total curriculum incorporating approximately 900 classroom hours. The Canadian curriculum involves industry examples but the learning itself is not work based. Theory is combined with practical examples, simulations and field trips, but there is no coordination between classroom learning and learning in the workplace. It is structured with 4 exit levels ranging from level 1 - 4. The subject content of the curriculum is identical to the South African qualifications. There are minor changes in the way sets of skills are related but the overall curriculum results in the same objectives of installation, calibration, general maintenance and breakdown maintenance of industrial instrumentation as with this qualification. The Canadian model refers to critical cross field outcomes as essential skills and demonstrates the integration of critical cross field outcomes to the fundamental knowledge of their curriculum. There was favourable comparison with regard to the latter. It is interesting to note the detailed classification and reference to "on the job" technical description in their curriculum. The Canadian curriculum classifies the complexity of the tasks according to the essential knowledge and describes the detail of the associated technical content.

The curriculum is similar to the whole qualification concept and is not outcomes based. It is similar to the apprentice system in South Africa and there is no coordinated relationship in the learning and assessment of workplace and classroom learning. However, there is summative assessment resulting in nationally recognised certification. Industrial Instrument Mechanic is a nationally designated trade under the Inter-provincial Red Seal program.

India:

In India there are two routes to industry competence in the field of Instrumentation. Route one follows the craftsman route and Route two, the apprenticeship route. The difference is essentially the fact that the craftsman is not employer supported and that the apprentice is. The two routes are also done over different time periods. The apprenticeship takes 3 years to complete and the craftsmanship takes two years since more time is spent at the training

institute. The content of the first and second year syllabus of the craftsman and apprenticeship is the same. There is two year rebate for practical training before certification.

In comparing the qualifications, there is general consensus among the subject matter experts consulted that a similar standard of technology and training is applied with minor changes in semantics and the structure of the learning programmes. What the Indian curriculum refers to as preventative maintenance South African instrumentation experts refer to as routine maintenance.

In the Indian syllabus there is no fundamental education development with regards to Communication and Literacy. It is assumed that candidates have successfully completed this learning through the schooling system, which is specified as the entry requirement. It appears that social studies are combined as part of the syllabus but there was very little access to this detailed content for comparison.

Republic of Zimbabwe:

Zimbabwe prescribes to a SADC Protocol, which requires member countries to set up a National Qualification Framework and calls for well-defined Skilled Worker classes/levels. Apprenticeship programs are administered via national legislation and the Industrial Training and Trade Testing Division (IT&TT), which is represented throughout Zimbabwe via regional offices situated in Gweru, Bulawayo, Masvingo and Mutare, with the Head Office in Harare.

The formal trade of "Instrument Mechanic" exists in Zimbabwe. It appears as though their course structure is influenced by the Canadian methodology. There is also a localised German influence via the Informal Sector Training and Resources Network (ISTARN) project in the Masvingo area. The ISTARN skills project is a joint venture between the Government of Zimbabwe and the Government of the Federal Republic of Germany.

Zambia, Kenya and Tanzania:

These countries operate process industries that employ the skill of Instrument Mechanics, and train towards this profession. From information available from SAIMC, certain academics are registered who are involved in these programmes. The three countries appear to emulate the South African apprenticeship structure. A research paper investigating the viability and effectiveness of vocational training also concurs with the apprenticeship structure of training. The SAIMC has confirmed that their programme content compares very favourabley to this qualification.

New Zealand and Australia:

New Zealand and Australia have qualification frameworks and like South Africa belong to the Organisation for Economic Cooperation and Development (OECD). Their curriculum structure was most conveniently compared. In certain instances there was direct comparison of unit standards.

The main difference between our technical content is that they group their tasks and activities differently. An example of this is the analyser component of this qualification. These countries categorise the equipment differently and deal with types of analytical instruments individually. The South African unit standards categorised the principle of operation and listed all types of equipment, grouping the individual analytical instruments in a range.

The New Zealand Qualifications Authority's National Certificate in Industrial Measurement and Control, and the Australian Certificate II in Electro-technology-Instrumentation compare favorably with this qualification in terms of outcomes, assessment criteria, duration and degree of difficulty.

USA:

The inside wireman (journeyman) trade curriculum was used as a basis for comparison. There appears to be a global standard on technological content and approach to training. The tool list required for the practical training as well as subject content seems to be almost identical to the South Africa model.

Instrumentation courses in the USA differ from state to state. The New York state course in instrumentation is rolled out as an apprenticeship. The duration is 48 months for a red seal certificate. It appears that this curriculum covers the same content as this qualification series up to the Level 5 certificate. The progression of complexity and content was almost identical to what was researched in the Canadian curriculum and compares favourably to the South African qualification.

Conclusion:

As much as a thorough effort was made to compare this set of qualifications internationally, language barriers or a general lack of information regarding the content and structure of international qualifications were sometimes encountered. However the curriculum content in accessible countries was thoroughly interrogated and debated for relevance and best practice against the South African model and the Working group for Instrumentation and Analyser mechanician is satisfied that this newly revised qualification is comparable to the best in the world.

ARTICULATION OPTIONS

Vertical Articulation:

A learner could progress from the National Certificate: Measurement, control and Instrumentation, NQF Level 2 through to NQF Level 5. After completion of NQF Level 5, this would serve as a bridging course for entry into a National Diploma: Electrical Engineering and opt for a specialization in Instrumentation or A Bachelor of Science Degree: Electrical Engineering Light Current with a specialization in Instrumentation.

Qualifying candidates will have the ability to articulate to the NQF Level 5 qualification or/and opt to go for a summative assessment Trade Test with the Department of Labour (DoL) towards the red seal certification for artisanship.

Horizontal Articulation:

Horizontal articulation is applicable between the different specialization areas of this qualification in accordance with qualification rules above.

MODERATION OPTIONS

> A person assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with the relevant ETQA.

> Any institution offering learning that will enable the achievement if this Qualification must be accredited as a provider with the relevant ETQA.

> Assessment and moderation of assessment will be overseen by the relevant ETQA according to the ETQAs policies and guidelines for assessment and moderation; in terms of agreements reached around assessment and moderation between ETQAs (including professional bodies); and in terms of the moderation guideline.

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

CRITERIA FOR THE REGISTRATION OF ASSESSORS

All assessors need to be Subject Matter Experts, qualified one level or higher and be registered with the relevant ETQA.

The following criteria should be applied by a relevant ETQA as a minimum requirement:

> Assessors should be in possession of a qualification (or equivalent) in the Measurement, Control and Instrumentation discipline and at least 5 years experience in the relevant subject area.
> Registration as an assessor with the relevant Education and Training Quality Assurance Body.
> Proven inter-personal skills and the ability to:
> Maintain national and local industry standards.
> Act in the interest of the learner.
> Understand the need for transformation to redress the legacies of the past, and respect the cultural background and language of the learner.

NOTES

This qualification replaces qualification 48919, "Further Education and Training Certificate: Measurement, Control and Instrumentation", Level 4, 160 credits.

> For the purposes of this qualification, Instrumentation refers to Industrial instrumentation and control as applied on process plants.

> Measurement, Control and Instrumentation equipment will refer to flow, temperature, level and pressure field instrumentation. In order to demonstrate an understanding, the learner is given an application, which, if successfully carried out will demonstrate the knowledge component. This application must include the safe handling of the above-mentioned equipment.

> For the purposes of progression to NQF Level 5, the unit standard "Construct and test advanced electronic circuits" shall be nominated from the elective component.

UNIT STANDARDS

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
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	119467	Use language and communication in occupational learning programmes	Level 3	5
Fundamental	119465	Write/present/sign texts for a range of communicative contexts	Level 3	5
Fundamental	9015	Apply knowledge of statistics and probability to critically interrogate and effectively communicate findings on life related problems	Level 4	6
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	9016	Represent analyse and calculate shape and motion in 2- and 3-dimensional space in different contexts	Level 4	4
Fundamental	119471	Use language and communication in occupational learning programmes	Level 4	5
Fundamental	7468	Use mathematics to investigate and monitor the financial aspects of personal, business, national and international issues	Level 4	6
Fundamental	119459	Write/present/sign for a wide range of contexts	Level 4	5

	ID	UNIT STANDARD TITLE	LEVEL	CREDITS
Core	113901	Demonstrate an understanding of process communication systems	Level 4	8
Core	116086	Demonstrate an understanding of the factors influencing the quality of measurement	Level 4	3
Core	262483	Fault find and repair Process control loops	Level 4	15
Core	116056	Fault find and repair Programmable Logic Controllers (PLC's)	Level 4	10
Core	262488	Perform routine maintenance on integrated process control loops	Level 4	15
Elective	262481	Demonstrate an understanding of detection equipment	Level 3	4
Elective	12225	Construct and test advanced electronic circuits	Level 4	16
Elective	262487	Fault find and repair Analytical Equipment	Level 4	15
Elective	116059	Maintain Specialized Sensing Devices	Level 4	15
Elective	262484	Perform routine maintenance on analysers	Level 4	12

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION
None

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Demonstrate an understanding of detection equipment

SAQA US ID	*UNIT STANDARD TITLE*		
262481	Demonstrate an understanding of detection equipment		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 3	4

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Demonstrate an understanding of flame detectors.

SPECIFIC OUTCOME 2
Demonstrate an understanding of gas detectors.

SPECIFIC OUTCOME 3
Demonstrate an understanding of smoke detectors.

SPECIFIC OUTCOME 4
Demonstrate an understanding of heat detectors.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Elective	65630	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Maintain programmable field instruments

SAQA US ID	***UNIT STANDARD TITLE***		
262482	Maintain programmable field instruments		
ORIGINATOR		***PROVIDER***	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		***SUBFIELD***	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	***UNIT STANDARD TYPE***	***NQF LEVEL***	***CREDITS***
Undefined	Regular	Level 3	12

This unit standard replaces:

US ID	Unit Standard Title	NQF Level	Credits	Replacement Status
114612	Maintain pressure equipment	Level 3	7	Will occur as soon as 262482 is registered

SPECIFIC OUTCOME 1
Plan and prepare to isolate and de-isolate programmable field instruments.

SPECIFIC OUTCOME 2
Isolate and remove programmable field instruments.

SPECIFIC OUTCOME 3
Calibrate programmable field instruments.

SPECIFIC OUTCOME 4
Install and commission programmable field instrumentation.

SPECIFIC OUTCOME 5
Establish normal conditions after maintenance of programmable field instrumentation.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Core	65631	National Certificate: Measurement, Control and Instrumentation	Level 3

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Fault find and repair Process control loops

SAQA US ID	*UNIT STANDARD TITLE*		
262483	Fault find and repair Process control loops		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 4	15

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Establish conditions for fault finding and repairing Process Control Loops.

SPECIFIC OUTCOME 2
Diagnose faults in Process Control Loops.

SPECIFIC OUTCOME 3
Repair Process Control Loops.

SPECIFIC OUTCOME 4
Establish normal operating conditions after completion of repairs.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Core	65630	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Perform routine maintenance on analysers

SAQA US ID	*UNIT STANDARD TITLE*		
262484	Perform routine maintenance on analysers		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 4	12

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Plan and prepare to isolate and de-isolate analytical equipment.

SPECIFIC OUTCOME 2
Isolate and remove the analyser.

SPECIFIC OUTCOME 3
Calibrate analysers.

SPECIFIC OUTCOME 4
Install and commission the analyser.

SPECIFIC OUTCOME 5
Establish normal operating conditions.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Elective	65630	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Demonstrate an understanding of analytical measurement systems

SAQA US ID	*UNIT STANDARD TITLE*		
262485	Demonstrate an understanding of analytical measurement systems		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 3	12

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Demonstrate an understanding of the principles of analytical measurement.

SPECIFIC OUTCOME 2
Describe the application of analytical measurement in a process plant.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Elective	65631	National Certificate: Measurement, Control and Instrumentation	Level 3

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Design and construct relay logic circuits

SAQA US ID	***UNIT STANDARD TITLE***		
262486	Design and construct relay logic circuits		
ORIGINATOR		***PROVIDER***	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		***SUBFIELD***	
6 - Manufacturing, Engineering and Technology		Manufacturing and Assembly	
ABET BAND	***UNIT STANDARD TYPE***	***NQF LEVEL***	***CREDITS***
Undefined	Regular	Level 3	6

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Draw Relay Logic Circuits.

SPECIFIC OUTCOME 2
Construct relay logic circuits.

SPECIFIC OUTCOME 3
Test Relay Logic Circuit.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Core	65631	National Certificate: Measurement, Control and Instrumentation	Level 3

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Fault find and repair Analytical Equipment

SAQA US ID	*UNIT STANDARD TITLE*		
262487	Fault find and repair Analytical Equipment		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 4	15

This unit standard replaces:

US ID	Unit Standard Title	NQF Level	Credits	Replacement Status
116061	Fault find and repair Analytical Equipment	Level 4	10	Will occur as soon as 262487 is registered

SPECIFIC OUTCOME 1
Establish conditions for fault finding and repairing Analytical Equipment.

SPECIFIC OUTCOME 2
Diagnose faults in Analytical Equipment.

SPECIFIC OUTCOME 3
Repair Analytical Equipment.

SPECIFIC OUTCOME 4
Establish normal conditions after completion.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Elective	65630	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Perform routine maintenance on integrated process control loops

SAQA US ID	*UNIT STANDARD TITLE*		
262488	Perform routine maintenance on integrated process control loops		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 4	15

This unit standard replaces:

US ID	Unit Standard Title	NQF Level	Credits	Replacement Status
116042	Maintain process control loops	Level 4	10	Will occur as soon as 262488 is registered

SPECIFIC OUTCOME 1
Establish conditions for maintaining Integrated Process Control Loops.

SPECIFIC OUTCOME 2
Diagnose faults in Integrated Process Control Loops.

SPECIFIC OUTCOME 3
Repair equipment in an Integrated Process Control Loop.

SPECIFIC OUTCOME 4
Establish normal operating conditions after completion.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Core	65630	Further Education and Training Certificate: Measurement, Control and Instrumentation	Level 4

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:

Demonstrate an understanding of instrumentation calibration, terminology and standards

SAQA US ID	***UNIT STANDARD TITLE***		
262489	Demonstrate an understanding of instrumentation calibration, terminology and standards		
ORIGINATOR		***PROVIDER***	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		***SUBFIELD***	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	***UNIT STANDARD TYPE***	***NQF LEVEL***	***CREDITS***
Undefined	Regular	Level 2	6

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

SPECIFIC OUTCOME 1
Define terms used in instrument calibration.

SPECIFIC OUTCOME 2
Define and explain calibration standards.

QUALIFICATIONS UTILISING THIS UNIT STANDARD

	ID	QUALIFICATION TITLE	LEVEL
Core	65629	National Certificate: Measurement, Control and Instrumentation	Level 2

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

UNIT STANDARD:
Use and care for medium voltage electrical test instruments

SAQA US ID	*UNIT STANDARD TITLE*		
262924	Use and care for medium voltage electrical test instruments		
ORIGINATOR		*PROVIDER*	
SGB Generic Manufacturing, Engineering& Technology			
FIELD		*SUBFIELD*	
6 - Manufacturing, Engineering and Technology		Engineering and Related Design	
ABET BAND	*UNIT STANDARD TYPE*	*NQF LEVEL*	*CREDITS*
Undefined	Regular	Level 3	4

This unit standard does not replace any other unit standard and is not replaced by another unit standard.

PURPOSE OF THE UNIT STANDARD
This unit standard will be useful to people who are required to use and care for high voltage electrical test instruments.

People credited with this unit standard are able to:

> Explain the factors critical to using and caring for high voltage electrical test instruments.
> Prepare to use and care for high voltage electrical test instruments.
> Use high voltage electrical test instruments.
> Care for high voltage electrical test instruments and prepare for operation.

LEARNING ASSUMED TO BE IN PLACE
The credit calculation is based on the assumption that learners are already competent in terms of the following outcomes or areas of learning when starting to learn towards this unit standard:

> Mathematical literacy NQF Level 2.
> Communication NQF Level 2.
> Use hand held test instruments.
> Use relevant hand tools.
> Read and interpret electrical diagrams.
> Read and interpret manufacturers instructions.
> Know the dangers associated with working in close proximity of electricity.
> Know the treatment for electrical shock.

UNIT STANDARD RANGE
The following scope and context applies to the whole unit standard and must include instruments designed for testing electrical installations operating at a voltage exceeding a 1000 Volt:

> Insulation tester.
> Phasing sticks.
> Voltage detectors.

Specific range statements are provided in the body of the unit standard where they apply to particular specific outcomes or assessment criteria.

SPECIFIC OUTCOMES AND ASSESSMENT CRITERIA:

SPECIFIC OUTCOME 1
Explain the factors critical to using and caring for high voltage electrical test instruments.

Associated Assessment Criterion 1
The purpose of using and caring for high voltage electrical test instruments are explained in accordance with specified requirements.

Associated Assessment Criterion 2
The application and function of high voltage electrical test instruments is explained with reference to type of instrument and specified requirements.

Associated Assessment Criterion 3
The care and maintenance of the high voltage electrical test instruments is explained in accordance with the specified requirements.

Associated Assessment Criterion 4
The importance of using correct electrical test instruments for high voltage applications is explained with reference to safety, to person, equipment and loss of time.

Associated Assessment Criterion 5
The methods that are applied to determine if the high voltage electrical test instruments are safe for use are explained in terms of inspections, pre-tests and specified requirements.

Associated Assessment Criterion 6
Hazards and associated risks that are identified through specified risk assessment procedures and the actions to be taken should they be encountered are explained with reference to using high voltage electrical test instruments.

SPECIFIC OUTCOME 2
Prepare to use and care for high voltage electrical test instruments.

Associated Assessment Criterion 1
Permission is obtained in accordance with specified requirements.

Range
Permission refers to:

- Permit.
- Logbook entries.

Associated Assessment Criterion 2
The required personal protective equipment is selected, examined and used in a manner that protects the individual in accordance with specified requirements.

Associated Assessment Criterion 3
Tools, material and equipment required are selected, examined and transported in accordance with specified requirements.

Associated Assessment Criterion 4
The worksite is made safe for testing purposes in accordance with specified requirements.

Associated Assessment Criterion 5
Workplace hazards and associated risks are identified and dealt with in accordance with specified requirements.

Associated Assessment Criterion 6
The consequences of inadequate preparation are explained in terms of potential effect on the macro environment, occupational health, safety and production.

Range
Consequences must include:

- Permission.
- Personal protective equipment.
- Tools, material and equipment.
- Making safe of worksite.

SPECIFIC OUTCOME 3
Use high voltage electrical test instruments.

Associated Assessment Criterion 1
Personal protective equipment is used in a manner that protects the individual in accordance with specified requirements.

Associated Assessment Criterion 2
The correct test instrument is selected in accordance with the task and specified requirements.

Associated Assessment Criterion 3
A pre-use inspection and test is carried out on the instrument in accordance with specified requirements.

Associated Assessment Criterion 4

Test instruments, which are unsafe or defective, are addressed in accordance with specified requirements.

Associated Assessment Criterion 5
The test is conducted according to specified requirements.

Associated Assessment Criterion 6
Hazards and associated risks directly related to the use of high voltage electrical test instruments are identified and addressed in accordance with specified requirements.

Associated Assessment Criterion 7
Interpersonal interaction is positive, consistent with specified requirements, promotes effective teamwork and avoids dysfunctional conflict.

Associated Assessment Criterion 8
The consequences of not using high voltage electrical test instruments in line with specified requirements are explained in terms of potential effect on the macro environment, occupational health, safety and production.

Range
Consequences must include:

- Use of personal protective equipment.
- Selecting correct test instrument.
- Inspecting and testing the selected instrument.
- Dealing with unsafe or defective instruments.
- Conducting the test.
- Identification and control of work related hazards.
- Interpersonal interaction.

SPECIFIC OUTCOME 4
Care for high voltage electrical test instruments and prepare for operation.

Associated Assessment Criterion 1
The worksite is restored to normal operating state as per specified requirements.

Associated Assessment Criterion 2
High voltage electrical test instruments are cleaned, examined and stored in accordance with specified requirements.

Associated Assessment Criterion 3
Logbook entries and permits are completed in accordance with specified requirements.

Associated Assessment Criterion 4
The consequences of not caring for high voltage electrical test instruments and not

preparing for operation in line with specified requirements are explained in terms of potential effect on the macro environment, occupational health, safety and production.

Range
Consequences must include:

- Restoring the worksite.

UNIT STANDARD ACCREDITATION AND MODERATION OPTIONS
> Anyone assessing a learner against this unit standard must be registered as an assessor with the relevant ETQA.

> Any institution offering learning that will enable achievement of this unit standard must be accredited as a provider through the relevant ETQA by SAQA.

> Moderation of assessment will be overseen by the relevant ETQA according to the moderation guidelines and the agreed ETQA procedures.

UNIT STANDARD ESSENTIAL EMBEDDED KNOWLEDGE
Essential embedded knowledge will be assessed through assessment of the specific outcomes in terms of the stipulated assessment criteria. Candidates are unlikely to achieve all the specific outcomes, to the standards described in the assessment criteria, without knowledge of the listed embedded knowledge. This means that for the most part, the possession or lack of the knowledge can be directly inferred from the quality of the candidate's performance. Where direct assessment of knowledge is required, assessment criteria have been included in the body of the unit standard.

The following embedded knowledge is addressed in an integrated way in the unit standard:

> Report writing.
> Health and safety knowledge.
> Legal and site-specific requirements.

UNIT STANDARD DEVELOPMENTAL OUTCOME
N/A

UNIT STANDARD LINKAGES
N/A

Critical Cross-field Outcomes (CCFO):

UNIT STANDARD CCFO IDENTIFYING
Identify and solve problems and make decisions using critical and creative thinking.

Note: The ability of the candidate to identify sub-standard and hazardous conditions, assess and take appropriate action.

UNIT STANDARD CCFO WORKING
Work effectively with others as members of a team, group, organisation or community.

Note: The ability and willingness of the candidate to accept and interpret work instructions correctly.

UNIT STANDARD CCFO ORGANIZING
Organise and manage themselves and their activities responsibly and effectively.

Note: The ability of the candidate to indicate what methods, tools and personal protective equipment is required and communicate to fellow workers his/her intentions and assistance required.

UNIT STANDARD CCFO COLLECTING
Collect, analyse, organise and critically evaluate information.

Note: The ability of the candidate to reconcile the information from visual and physical examinations and constantly evaluate the changing situation.

UNIT STANDARD CCFO COMMUNICATING
Communicate effectively, using visual, mathematical and/or language skills in the modes of oral and/or written presentations.

Note: The appropriate communication with the relevant personnel with regard to the reporting of hazards and sub-standard conditions will indicate his/her proficiency in effective communication.

UNIT STANDARD CCFO SCIENCE
Use science and technology effectively and critically showing responsibility towards the environment and health of others.

Note: The ability of the candidate to use test equipment illustrates his/her capability to use science and technology.

UNIT STANDARD CCFO DEMONSTRATING
Demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Note: The ability of the candidate to identify and refer anomalous behaviour to a specialist confirms understanding that a specific observation, inference, action or decision can have a devastating effect.

UNIT STANDARD ASSESSOR CRITERIA
N/A

UNIT STANDARD NOTES
Notes to Assessors:

Assessors should keep the following principles in mind when designing and conducting assessments against this unit standard:

> Focus the assessment activities on gathering evidence in terms of the main outcome expressed in the title to ensure assessment is integrated rather than fragmented. Remember we want to declare the person competent in terms of the title. Where assessment at title level is unmanageable, then focus assessment around each specific outcome, or groups of specific outcomes.

> Make sure evidence is gathered across the entire range, wherever it applies. Assessment activities should be as close to the real performance as possible, and where simulations or role-plays are used, there should be supporting evidence to show the candidate is able to perform in the real situation.

> Do not focus the assessment activities on each assessment criterion. Rather make sure the assessment activities focus on outcomes and are sufficient to enable evidence to be gathered around all the assessment criteria.

> The assessment criteria provide the specifications against which assessment judgements should be made. In most cases, knowledge can be inferred from the quality of the performances, but in other cases, knowledge and understanding will have to be tested through questioning techniques. Where this is required, there will be assessment criteria to specify the standard required.

> The task of the assessor is to gather sufficient evidence, of the prescribed type and quality, as specified in this unit standard, that the candidate can achieve the outcomes again and again and again. This means assessors will have to judge how many repeat performances are required before they believe the performance is reproducible.

> All assessments should be conducted in line with the following well documented principles of assessment: appropriateness, fairness, manageability, integration into work or learning, validity, direct, authentic, sufficient, systematic, open and consistent.

Terminology:

Specified Requirements:

Specified requirements include legal and site-specific requirements and are contained in one or more of the following documents:

Legal:

> Relevant Acts: e.g. Mine Health & Safety Act, 1996 (Act no 29/1996).
> Minerals Act, Regulations, 1991 (Act no 50/1991).
> Mandatory Codes of Practice.
> SANS and other relevant Standards.
> Chief Inspector of Mines' Directives and instructions.

Site Specific:

> Hazard Identification and Risk Assessments (HIRA).
> Occupational Health and Safety Risk Management Programme.
> Managerial Instructions.
> Mine Standard Procedures.
> List of Recorded OH&S Risks.
> Working Guides.
> Equipment and Materials Specifications.

QUALIFICATIONS UTILISING THIS UNIT STANDARD
None