No. 7 **9 January 2009**

SAQA

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

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

Engineering

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

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

Comment on the Qualification should reach SAQA at the address below and ***no later than*** *9 February 2009* All correspondence should be marked **Standards Setting** – **SGB for Engineering** and addressed to

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SAQA

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:
Bachelor of Engineering

SAQA QUAL ID	***QUALIFICATION TITLE***		
64429	Bachelor of Engineering		
ORIGINATOR		***PROVIDER***	
SGB Engineering			
QUALIFICATION TYPE	***FIELD***	***SUBFIELD***	
National First Degree	6 - Manufacturing, Engineering and Technology	Engineering and Related Design	
ABET BAND	***MINIMUM CREDITS***	***NQF LEVEL***	***QUAL CLASS***
Undefined	560	Level 7	Regular-ELOAC

This qualification replaces:

Qual ID	Qualification Title	NQF Level	Min Credits	Replacement Status
48694	Bachelor of Science: Engineering	Level 7	560	Will occur as soon as 64429 is registered

PURPOSE AND RATIONALE OF THE QUALIFICATION
Purpose:

The purpose of the qualification is to build the necessary knowledge, understanding, abilities and skills required for further learning towards becoming a competent practicing engineer. The recognized purpose of this bachelor's degree in engineering will be to provide graduates with:

> A thorough grounding in mathematics, basic sciences, engineering sciences, engineering modeling, engineering design and the abilities to enable applications in fields of emerging knowledge together with an appreciation for the world and society in which engineering is practiced.
> Preparation for careers in engineering itself and related areas, for achieving technological leadership and to make a contribution to the economy and national development.
> The educational requirement towards registration as a Professional Engineer with the Engineering Council of South Africa, as well as to allow the graduate to make careers in engineering and related fields.
> The ability to proceed to postgraduate studies in both course-based and research masters programmes for graduates with an appropriate level of achievement in the programme.

The particular engineering learner completing this qualification will be competent and able to display the following learning outcomes on:

> Solving complex problems.
> Applying of scientific and engineering knowledge.
> Performing Engineering designs.
> Conduct investigations, experiments and collate data analysis.
> Using appropriate Engineering methods, skills and tools, including the use of Information Technology equipment.
> Communicating technical information in a professional manner.
> Demonstrating critical awareness of the impact of the engineering activity.

> Effectively working with individuals and teams in a multi-disciplinary working environment.
> Engaging in independent learning.
> Acting professionally and ethically at all times.

Rationale:

Engineering is an activity that is best defined by five distinguishing characteristics. First, it encompasses initiatives, services and the solution of problems that are of importance to society and the economy.

Second, engineering activity brings benefits through exploiting natural resources, harnessing energy, using materials with beneficial properties, using machinery and equipment, transferring, storing and processing information, constructing, operating and maintaining infrastructure and plant, and the organisation and control of systems or processes. These actions involve risks, requiring engineering activity to be conducted with due regard to safety, health, environmental and sustainability considerations.

Third, engineering functions include: designing materials, components, systems or processes; planning the capacity and location of infrastructure; investigating, advising and reporting on engineering problems; improvement of materials, components, systems or processes; managing or operating plant and processes; managing implementation or construction projects; implementing designs or solutions; research, development and commercialization of products.

Fourth, engineering activity requires a body of knowledge and distinctive competencies. The body of knowledge is based on mathematics, basic sciences, engineering sciences, information technology and contextual knowledge including legal, financial and regulatory aspects. Distinctive competencies include identifying problems and designing solutions, managing activities, addressing impacts of solutions and activities and acting ethically, applying judgement and taking responsibility.

Fifth, the practice of Engineering activities at professional level involves a number of roles, recognized in categories of registration under the Engineering Profession Act: Professional Engineer, Professional Engineering Technologist, Professional Engineering Technician, and Professional Certificated Engineer. This qualification is intended to provide the educational base for the development of a Professional Engineer with the following profile.

Professional Engineers are characterised by the ability to solve problems, develop components, systems, services and processes through creativity, innovation and the application of fundamental and engineering principles. They provide technical and commercial leadership through well-developed interpersonal skills. They work independently and responsibly, applying original thought and judgement to technical and risk-based decisions in complex situations. Professional Engineers must therefore have a broad, fundamentals-based appreciation of engineering sciences, with depth in specific areas, together with knowledge of financial, commercial, legal, social and health, safety and environmental matters.

The process of professional development of a Professional Engineer starts with the attainment of a qualification that meets this standard. After graduation a programme of training and experience is completed to attain the competencies for Stage 2, namely professional registration. The programme defined in this standard therefore has the following purpose.

The examples of development paths to occupations that can be supported by this qualification are as follows:

> Aeronautical Engineer.
> Agricultural Engineer.
> Chemical Engineer.

> Civil Engineer.
> Electrical Engineer.
> Industrial Engineer.
> Mechanical Engineer.
> Mining Engineer and
> Metallurgical Engineer.

It is envisaged that the Higher Education training providers will use this generic engineering qualification to develop appropriate learning programmes for the specific occupation content and skills.

RECOGNIZE PREVIOUS LEARNING?
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LEARNING ASSUMED IN PLACE
It is assumed that learners are already competent in Mathematics, Physical Science and the language of teaching and learning at NQF Level 4 at levels determined by the higher education provider.

Note: that the qualification may have a disciplinary or cross-disciplinary qualifier (discipline, branch, option or endorsement) defined in the provider's rules for the degree that is reflected on the academic transcript and degree certificate, subject to the following:

> There must be at least one qualifier which contains the word Engineering together with a disciplinary description such as: Agricultural, Aeronautical, Chemical, Civil, Computer, Electrical, Electro-mechanical, Electronic, Environmental, Industrial, Extractive Metallurgical, Information, Materials, Mechanical, Mechatronic, Metallurgical, Mineral(s) Processing, Physical Metallurgical and Mining. Qualifiers are not restricted to this list.
> A second qualifier, if present, must indicate a focus area within the field of the first qualifier.
> The qualifier(s) must:
> Clearly indicate the purpose of the programme and the discipline or practice area served.
> Must be consistent with the fundamental engineering science content on the programme.
> Be comparable with typical programmes within Washington Accord signatories.
> The target market indicated by the qualifier(s) may be a traditional discipline or a branch of engineering or a substantial industry area. Formal education for niche markets should be satisfied by broad undergraduate programmes such as specified in this standard followed by specialized course-based programmes.

Recognition of Prior Learning:

> This qualification may be achieved in part or wholly through recognition of prior learning (RPL) processes.
> The provision that the qualification may be obtained through the recognition of prior learning, facilitates access to an education, training and career path in engineering and thus accelerates the redress of past unfair discrimination in education, training and employment opportunities.
> Evidence of prior learning must be assessed through formal RPL processes through recognized methods. Any other evidence of prior learning should be assessed through formal RPL processes to recognize achievement thereof.
> Learners submitting themselves for RPL should be thoroughly briefed prior to the assessment and will be required to submit a Portfolio of Evidence (PoE) in the prescribed format to be assessed for formal recognition. While this is primarily a workplace-based qualification, evidence from other areas of learning may be introduced if pertinent to any of the Exit Level Outcomes (ELOs).
> The structure of this non-unit standard based qualification makes RPL possible, if the learner is able to demonstrate competence in the knowledge, skills, values and attitudes implicit in this first stage engineering qualification.

> Learners who already work in the engineering industry who believe they possess competencies to enable them to meet some or all of the ELOs listed in the qualification will be able to present themselves for assessment against those of their choice.

Access to the Qualification:

> Access to the qualification is open bearing in mind learning assumed to be place.

QUALIFICATION RULES

The programme leading to the qualification shall be a four-year full-time equivalent programme with a minimum of 560 credits. Not less than 120 Credits shall be at NQF Level 7 (HEQF Level 8).

Fundamentals; Credits:

> Mathematical Sciences; 56 Credits.
> Basic Sciences; 56 Credits.
Totals: 112 Credits.

Core; Credits:

> Computing and IT; 20 Credits.
> Engineering Sciences; 168 Credits.
> Engineering Design and Synthesis; 67 Credits.
Totals: 255 Credits.

Electives; Credits:

> Complementary Studies; 56 Credits.
> Discretionary studies; 137 Credits.
Totals: 193 Credits.

The discretionary studies component shall be taken up by allocating knowledge to the six areas, to form a coherent, balanced programme. However, if the training service provider chooses to include work integrated learning in the programme, credits shall not be included in the knowledge breakdown if the work is not quality assured by the same provider or does not comprehensively assess the student's performance against defined outcomes and is not documented and presented in the accreditation process.

Core and Specialist Requirements:

The programme shall have a core of mathematics, natural sciences and fundamental engineering sciences that provides a viable platform for further studies and lifelong learning. The core must enable development in a traditional discipline or in an emerging field. The core embraces both fundamental and core elements as defined.

A programme shall contain specialist engineering study at the exit level. Specialist study may lead to elective or compulsory credits. Specialist study may take on many forms including further deepening of a theme in the core, a new sub-discipline, or a specialist topic building on the core. It is recognized that the extent of specialist study is of necessity limited in view of the need to provide a substantial coherent core. Specialist study may take the form of compulsory or elective credits.

Underpinning Complementary Studies knowledge must be sufficient and appropriate to support the student in satisfying Exit Level Outcomes 7 and 10.

Curriculum Content:

This standard does not specify detailed curriculum content and the fundamental and specialist engineering science content must be consistent with the designation of the degree. Complementary Studies are portable and cover those disciplines outside of engineering sciences which includes modules/subjects on communication skills, etc. Discretionary study credits range from 0-56 provided the total credits for the complete qualification is not less than a 560 credits.

Knowledge Area Definitions:

> Natural (Basic) Sciences: Physics (including mechanics), chemistry, earth sciences and the biological sciences which focus on understanding the physical world, as applicable in each engineering disciplinary context.
> Complementary Studies: Cover those disciplines outside of engineering sciences, basic sciences and mathematics which are relevant to the practice of engineering in 2 ways: (a) principles, results and methods are applied in the practice of engineering, including engineering economics, the impact of technology on society and effective communication and (b) (for Levels 7 and above) study broadens the student's perspective in the humanities or social sciences to support an understanding of the world.
> Computing and Information Technologies: Encompasses the use of computers, networking and software to support engineering activity and as an engineering activity in itself as appropriate to the discipline.
> Engineering Sciences: Have roots in the mathematical and physical sciences, and where applicable, in other basic sciences but extend knowledge and develop models and methods in order to lead to engineering applications and solve engineering problems.
> Mathematical Sciences: An umbrella term embracing the techniques of mathematics, numerical analysis, statistics and aspects of computer science cast in an appropriate mathematical formalism.
> Engineering Design and Synthesis: Is the systematic process of conceiving and developing materials, components, systems and processes to serve useful purposes. Design may be procedural, creative or open-ended and requires application of engineering sciences, working under constraints, and taking into account economic, health and safety, social and environmental factors, codes of practice and applicable laws.

Designers of specific qualifications may build on this generic base by specifying occupation-related content and specific skills required. The particular occupation may also require other qualifications, learnerships, skills programmes or further learning.

EXIT LEVEL OUTCOMES

Exit Level Outcomes defined below are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment. Words shown in italics have specific meanings as defined in ECSA documentation that training providers must take cognizance of:

General Range Statement: The competencies defined in the ten exit level outcomes may be demonstrated in a university-based, simulated workplace context. Competencies stated generically may be assessed in various engineering disciplinary or cross-disciplinary contexts.

1. Problem solving:

Learning Outcome: Formulate and solve complex engineering problems creatively and innovatively.

Range Statement: Complex engineering problems are characterized by some or all of the following attributes:

> Problems require identification and analysis, and may be concrete or abstract, may be divergent and may involve significant uncertainty.
> Problems may be infrequently encountered types and occur in unfamiliar contexts.
> Approach to problem solving needs to be found, is creative and innovative.
> Information is complex and possibly incomplete, requiring validation and critical analysis.
> Solutions are based on theory, use of first-principles and evidence, (which may be incomplete) together with judgement where necessary.
> Involves a variety of interactions which may impose conflicting constraints.

2. Application of scientific and engineering knowledge.

Learning Outcome: Demonstrate competence to apply knowledge of mathematics, basic science and engineering sciences from first principles to solve complex engineering problems.

Range Statement: Knowledge of mathematics, basic science and engineering sciences is characterized by:

> Knowledge of mathematics using formalism, and oriented toward engineering analysis and modeling.deep knowledge of basic sciences: both as relevant to discipline.
> Deep knowledge of broad, range of fundamental principles and engineering sciences of an engineering discipline or cross-disciplinary field that is coherently and systematically organized.
> In-depth, theoretically based knowledge in limited specialist area(s), informed by current developments, and emerging issues.
> Use Mathematics, basics science and engineering sciences in formal analysis and modeling of engineering situations, for reasoning about and conceptualizing engineering problems.

Note: Problems used for assessment may provide evidence in the application of one, two or all three categories of knowledge listed above.

3. Engineering Design.

Learning Outcome: Demonstrate competence to perform creative, procedural and non-procedural design and synthesis of components, systems, engineering works, products or processes of a complex nature.

Range Statement: Design problems used in assessment must conform to the definition of a complex engineering problem. A major design problem should be used to provide evidence. The problem would be typical of that which the graduate would participate in a typical employment situation shortly after graduation. The selection of components, systems, engineering works, products or processes to be designed is dependent on the discipline or sub-discipline.

4. Investigations, experiments and data analysis.

Learning Outcome: Demonstrate competence to conduct investigations of complex engineering problems including engagement with the research literature and use of research methods including of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

Range Statement: The balance of investigation and experiment should be appropriate to the discipline. An investigation or experimental study should be typical of those in which the graduate would participate in an employment situation shortly after graduation.

Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon.

5. Engineering methods, skills and tools, including Information Technology.

Learning Outcome: Demonstrate competence to use appropriate techniques, resources and modern engineering tools, including information technology, prediction and modeling for the solution of complex engineering activities, with an understanding of the limitations, restrictions, premises, assumptions and constraints.

Range Statement: A range of methods, skills and tools appropriate to the disciplinary designation of the program including:

> Discipline-specific tools, processes or procedures.
> Computer packages for computation, modeling, simulation, and information handling.
> Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork.
> Techniques from socio-economic, management, health and safety, and environmental protection.

6. Professional and technical communication.

Learning Outcome: Demonstrate competence to communicate effectively, both orally and in writing, with engineering audiences and the community at large.

Range Statement: Material to be communicated is in an academic or simulated professional context. Audiences range from engineering peers, academic personnel and lay persons. Appropriate academic or professional discourse is used. Written reports range from short (300-1000 word plus tables and diagrams) to research, design or investigative reports (10 000 to 15 000 words plus tables, diagrams and appendices), covering material at the exit level. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject-specific methods.

7. Impact of Engineering activity.

Learning Outcome: Demonstrate critical awareness of the impact of engineering activity on the socio-economic, industrial and physical environment and of the need to act professionally within own limits of competence.

Range Statement: The combination of social, workplace (industrial) and physical environmental factor must be appropriate to the discipline or other designation of the qualification. Evidence may include case studies typical of engineering practice situations in which the graduate is likely to participate. The range of the candidates activity:

> Is generally outside of standards and codes of practice.
> Involves a diverse group of stakeholders with widely varying needs.
> Has significant consequences that are far ranging.
> Is complex, possibly including many component parts or sub-systems.

8. Individual, team and multidisciplinary working.

Learning Outcome: Demonstrate competence to work effectively as an individual, as a member or leader in diverse teams and in multidisciplinary environments.

Range Statement: Tasks require co-operation across at least one disciplinary boundary. Co-operating disciplines may be engineering disciplines other than that of the programme or may be outside engineering.

9. Independent learning ability.

Learning Outcome: Demonstrate competence to engage in independent learning through well developed learning skills.

Range Statement: The learning context is complex and ill defined. Some information is drawn from the research literature.

10. Engineering Professionalism.

Learning Outcome: Comprehend and apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

Range Statement: Evidence includes case studies typical of engineering practice situations in which the graduate is likely to participate. The range of the learners activity:

> Is generally outside of standards and codes of practice.
> Involves a diverse group of stakeholders with widely varying needs.
> Has significant consequences that are far ranging.
> Is complex, possibly including many component parts or sub-systems.

Critical Cross-Field Outcomes:

This qualification promotes, in particular, the following Critical Cross-Field Outcomes:

Identifying and solving problems in which responses indicate that responsible decisions using critical and creative thinking have been made when:

> Identifying potential risks in the workplace and implementing appropriate solutions to maintain a safe and secure working environment.
> Identifying and resolving general client queries and deviations from regulatory requirements.
> Identifying and pro-actively reporting on non-availability of resources and materials.

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

> Directing appropriate colleagues to attend to client queries.
> Understanding the impact of service delivery to the client.
> Activities involving clients, co-workers and suppliers.
> Communicating and receiving advice from supervisors.

Organizing and managing oneself and one's activities responsibly and effectively when:

> Identifying, minimizing and reporting potential occupational health and safety hazards and risks in the workplace.
> Performing work activities in accordance with industry standard operating procedures.
> Safety equipment and clothing is selected and prepared in accordance with legislative requirements.

Collecting, analyzing, organizing and critically evaluating information to better understand and explain by:

> Carrying out written instructions issued by the clients and supervisors, correctly and efficiently.
> Interpreting and recording correct client contact details.

Communicating effectively using visual, mathematical and/or language skills in the modes of oral and/or written persuasion when:

> Issuing clear verbal instructions to team members, other colleagues and clients.
> Actively listening to feedback received from team members, other colleagues and clients.
> Evaluating and reporting problem situations to team members, other colleagues and clients.

Using science and technology effectively and critically, showing responsibility towards the environment and health of others when:

> Interpreting various gauge settings, readings and recording the impact on the business.
> Understanding and interpreting the various gauge reading equipment.

Demonstrating and understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation when:

> Applying the inter-relatedness of the engineering industry as a set of related systems.
> Recognizing the inter-relatedness between the various business units within the organization.

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

1.1 The problem is analysed and defined in terms of criteria for an acceptable solution.
1.2 Relevant information and engineering knowledge and skills are identified in formulating the problem.
1.3 Possible approaches are generated and formulated that would lead to a workable solution for the problem.
1.4 Solutions provided are creative and innovative, but clearly focused on the problem at hand.
1.5 Possible solutions are modelled and analysed in terms of strengths and weaknesses for the overall solution.
1.6 Possible solutions are prioritised in order of suitability to the overall problem and budget constraints.
1.7 The solution is formulated and presented in an appropriate form to final decision makers.

Associated Assessment Criteria for Exit Level Outcome 2:

2.1 Analysis and modelling of problems includes mathematical, numerical analysis and statistical knowledge within the principles of the basic sciences.
2.2 Concepts, ideas and theories are communicated with the aid of mathematics.
2.3 Mathematical concepts are implemented in reasoning about and conceptualising engineering components, systems or processes.
2.4 Uncertainty and risk is described through the use of probability and statistics.
2.5 Physical laws and knowledge of the physical world are used as a foundation for the solution of engineering problems.
2.6 Principles of the basic sciences are adhered to in reasoning about and conceptualising engineering problems, components, systems or processes.
2.7 Open-ended engineering problems are identified and solved using techniques, principles and laws of engineering science at a fundamental level in at least one specialist area.
2.8 Engineering applications are identified and pursued using techniques, principles and laws of engineering science at a fundamental level in at least one specialist area.
2.9 Work is conducted across engineering disciplinary boundaries through cross disciplinary literacy and shared fundamental knowledge using techniques, principles and laws of engineering science.

Associated Assessment Criteria for Exit Level Outcome 3:

3.1 The design problem is formulated to satisfy user needs, applicable standards, codes of practice and legislation.

3.2 The design process focuses on important issues, recognises and deals with relevant constraints.
3.3 Knowledge, information and resources are acquired and evaluated in order to apply appropriate principles and design tools to provide a workable solution.
3.4 Design tasks performed include analysis, quantitative modelling and optimisation of the product, system or process.
3.5 Alternatives are evaluated for implementation and a preferred solution is selected based on techno-economic analysis.
3.6 The selected design is assessed in terms of the impact and benefits.
> Range: Social, economic, legal, health, safety, and environmental.
3.7 The design logic and relevant information is communicated to relevant personnel in accordance with organisational requirements.

Associated Assessment Criteria for Exit Level Outcome 4:

4.1 Investigations and experiments are planned and conducted within an appropriate discipline.
4.2 Available literature and material is critically evaluated for suitability to the investigation or experiment.
4.3 Analysis is performed as necessary to ensure suitability of the investigation or experiment.
4.4 Equipment or software is selected and used as appropriate for the relevant application in the investigations and experiments.
4.5 Information is analysed, interpreted and derived from available data.
4.6 Conclusions are drawn from an analysis of all available evidence.
4.7 The purpose, process and outcomes of the investigation and experiment are recorded in a technical report and distributed to relevant personnel in accordance with organisational procedures.

Associated Assessment Criteria for Exit Level Outcome 5:

5.1 The method, skill or tool is assessed for applicability and limitations against the required result.
5.2 The method, skill or tool is applied correctly to achieve the required result.
5.3 Results produced by the method, skill or tool are tested and assessed against required results.
5.4 Computer applications are created as required by the discipline.

Associated Assessment Criteria for Exit Level Outcome 6:

6.1 The structure, style and language of written and oral communication is appropriate for the purpose of the communication and the target audience.
6.2 Graphics used are effective in enhancing the meaning of the text.
6.3 Visual materials used enhance oral communications.
6.4 Information is provided in a format that can be used by others involved in the engineering activity.
6.5 Oral communication is delivered fluently with the intended meaning being apparent.

Associated Assessment Criteria for Exit Level Outcome 7:

7.1 The impact of technology is explained in terms of the benefits and limitations to society.
7.2 The engineering activity is analysed in terms of the impact on occupational and public health and safety.
7.3 The engineering activity is analysed in terms of the impact on the physical environment.
7.4 Personal, social, economic, cultural values and requirements are taken into consideration for those who are affected by the engineering activity.

Associated Assessment Criteria for Exit Level Outcome 8:

8.1 Individual objectives are identified and focused on in conducting work tasks.
8.2 Work is conducted strategically to ensure quality outputs.
8.3 Individual work tasks are executed effectively to meet organisational requirements.
8.4 Work conducted is of an acceptable quality and is delivered in an acceptable time frame.
8.5 Individual contributions made to team activities support the output of the team as a whole.
8.6 Critical functions are performed to facilitate effective team work.
8.7 Activities are conducted to enhance the work efforts of fellow team members.
8.8 Support of team members is capitalised on to obtain maximum benefit within the team.
8.9 Working knowledge of other team members' disciplines is acquired in order to capitalise on strengths of the workforce.
8.10 A systems approach is used to streamline work activities.
8.11 Communication is effective across disciplinary boundaries and enhances team output.

Associated Assessment Criteria for Exit Level Outcome 9:

9.1 Learning undertaken is reflected on and own learning requirements and strategies are determined to suit personal learning style and preferences.
9.2 Relevant information is sourced and evaluated in terms of applicability to the learning context.
9.3 Knowledge acquired from outside of formal instruction is applied in relevant learning contexts as necessary.
9.4 Assumptions proposed are critically challenged and learning activities embrace new thinking styles.

Associated Assessment Criteria for Exit Level Outcome 10:

10.1 The nature and complexity of ethical dilemmas is described in terms of required practices and limitations of authority.
10.2 The ethical implications of decisions made are described in terms of the impact on the business and trustworthiness.
10.3 Engineering solutions are evaluated in terms of ethical and financial aspects.
10.4 The approach to dealing with ethical problems is developed and justified in terms of legislation and costs.
10.5 Continued competence is maintained through keeping abreast of up-to-date tools and techniques available in the workplace.
10.6 The system of continuing professional development is embraced and endorsed as an ongoing process.
10.7 Responsibility is accepted for consequences stemming from own actions or inaction.
10.8 Judgements in decision making during problem solving and design are ethical and within acceptable boundaries of competence.
10.9 Decision making is limited to area of current competence.

Integrated Assessment:

The applied competence (practical, foundational and reflective competencies) of this qualification will be achieved if a learner is able to achieve the Exit Level Outcomes of the qualification as per the rules specified. Applicable Critical Cross-Field Outcomes must be assessed during any combination of practical, foundational and reflexive competencies assessment methods and tools to determine the whole person development and integration of applied knowledge and skills.

Certain Exit Level Outcomes are measurable and verifiable through assessment criteria assessed in one application. Applicable assessment tools to assess the foundational, reflective and practical competencies within the regulatory environment.

A detailed portfolio of evidence is required of the practical, foundational and reflective competencies of the learner. Assessors and moderators should develop and conduct integrated assessment by making use of a range of formative and summative methods.
Assessors should assess and give credit for the evidence of learning that has already been acquired (RPL) through any form of learning. Unit standards associated with this qualification must be used to assess Specific and Critical Cross-Field Outcomes.

During integrated assessment, the assessor should make use of formative and summative assessment methods and should assess combinations of practical, foundational and reflective competencies. Because assessment practices must be open, transparent, fair, valid, and reliable and ensure that no learner is disadvantaged in any way whatsoever, the qualification applies in an integrated assessment approach.

Learning, teaching and assessment are inextricably linked. Whenever possible, the assessment of knowledge, skills, attitudes and values shown in the unit standards should be integrated. Assessment of the fundamental unit standards should be conducted in conjunction with the core and elective unit standards where applicable.
A variety of methods must be used in assessment, and tools and activities must be appropriate to the context in which the learner is working. Where it is not possible to assess the learner in the workplace or on-the-job, simulations, case studies, role-plays and other similar techniques should be used to provide a context appropriate to the assessment.

Assessors and moderators should use a range of formative and summative assessment methods. Assessors should assess and give credit for the evidence of learning that has already been acquired through formal, informal and non-formal learning and work experience.
Assessment should ensure that all specific outcomes, embedded knowledge and critical cross-field outcomes are evaluated.
The assessment of the critical cross-field outcomes should be integrated with the assessment of specific outcomes and embedded knowledge.

Formative Assessment:

Assessment criteria for formative assessment will typically take place during training and serves to guide the learner towards full competence and is described in the various unit standards. Formative assessment takes place during the process of learning and assessors can use a range of appropriate assessment methods and tools or in any agreed-upon method of assessment of the knowledge required to perform the various competencies in a holistic manner. To be allowed access to the final qualifying assessment, a learner must show that he/she has reached a level of overall integrated competence.

The methods of assessment could include but not limited to the following:

> On-the-job Observations.
> Role-play and/or Simulations.
> Knowledge tests, exams, case studies, projects, logbooks, workbooks.
> Verbal report backs (presentations).
> Portfolios of Evidence (RPL).
> Working in teams (360 degrees evaluations).
> Scenario sketching Incident reports.

The assessment tools and methods used by the assessor must be:

> Fair, not to hinder or disadvantage the learner in any way.
> Valid, to measure what is intended to measure.
> Reliable, consistent and delivers the same output across a range of learners and assessors.

Summative Assessment:

For the learner to be certified competent against the qualification, he/she must prove overall competence through the integration of the competencies expressed in the unit standards. The elements of importance here are overall abilities, problem-solving capability and safe working. In addition, assessors should be satisfied that the learner has achieved a level of competence to be able to take charge of any aspect of the regulatory operations.

The learner's ability to demonstrate competence against a particular unit standard, under real-life working conditions and in the presence of an assessor, will be assessed. The summative assessment can also be used as a diagnostic assessment tool aimed at identifying the learner's skills gaps.

Workplace Assessment:

Workplaces can be used for assessment purposes provided that the appropriate facilities, tools, equipment, and support systems are available and accessible to both the assessor and the learner. The regulatory operations industry agreed on the following requirements for workplace assessment:

> Assessment needs to occur in a familiar environment at the time of assessment.
> Assessment needs to take place at a time and venue mutually agreed to by the assessor and the learner.

Methods of Assessment:

The following methods of assessment have been identified as the preferred measurement and assessment of learner competence in the assessment criteria:

> Portfolio of Evidence.
> Written tests.
> Practical tests.
> Oral assessment methods.
> In-situ (on-the-job) observations.
> Simulation.
> Structured classroom discussions and oral tests.

These methods will be selected carefully based on the purpose of the assessment. For example, the written method will be used to assess knowledge and on-the-job demonstration for practical competence. The assessment must integrate a number of different methods (no less than two of those detailed above) in order to give the assessor reliable and valid proof of competence and evidence of required attitudes.

INTERNATIONAL COMPARABILITY

Introduction:

International comparability of the whole qualification standard is ensured through the Washington Accord. The standards are comparable with those for professionally-oriented bachelor's degrees in engineering in countries having comparable engineering education systems to South Africa:

Australia, Canada, Chinese Taipei, Hong Kong, Ireland, Japan, Korea, New Zealand, India, Malaysia, Germany, Russia, Sri Lanka, Singapore, United Kingdom, and the United States of America. Comparability is audited on a six yearly cycle by a visiting Washington Accord team.

International comparability of this qualification and standards was done against qualifications that is offered in the various countries and particularly to those that are signatories to the various international agreements, like the Washington, Sydney and Dublin Accords. These 3 International Accords places recognition of the equivalence of Accredited Engineering Education Programmes which articulates to the Engineering Degrees, Diplomas, Certificates and beyond. It is an essential quality assurance process and is based on world best practice. Hence, these standards are comparable with those for professionally-oriented degrees, diplomas and certificates' in engineering in countries having comparable engineering education systems to South Africa of 2-4 years duration with no work-integrated learning.

Hence, there are six international agreements governing mutual recognition of engineering qualifications and professional competence. In each of these agreements countries/economies who wish to participate may apply for membership, and if accepted become members or signatories to the agreement. In broad principle, each country/economy must meet its own costs, and the body making application must verify that it is the appropriate representative body for that country/economy.

Agreements covering tertiary qualifications in Engineering:

There are three agreements covering mutual recognition in respect of tertiary-level qualifications and standards in engineering:

The Washington Accord signed in 1989 was the first and it recognizes substantial equivalence in the accreditation of qualifications in professional engineering, normally of four years duration. It recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. The national engineering organizations Australia, Canada, Ireland, New Zealand, South Africa, United Kingdom, United States, Chinese Taipei represented by Institute of Engineering Education Taiwan, Korea represented by Accreditation Board for Engineering Education of Korea, Singapore represented by Institution of Engineers Singapore and Hong Kong represented by The Hong Kong Institution of Engineers signed an agreement mutually recognizing the qualifications which underpin the granting of Professional Engineer titles in the eleven countries.

Since then, five further economies have attained provisional membership, and are working towards signatory status and they are Germany represented by German Accreditation Agency for Study Programme and Informatics, India represented by National Board of Accreditation of all India Council for Education, Malaysia represented by Board of Engineers Malaysia, Russia represented by Russian Association for Engineering Education and Sri Lanka represented by Institution of Engineers Sri Lanka.

The Sydney Accord commenced in 2001 and recognizes substantial equivalence in the accreditation of qualifications in engineering technology, normally of three years duration. Flowing from the Washington Accord, a similar Agreement was developed for Engineering Technologists or Incorporated Engineers, called the Sydney Accord (SA), which was signed in June 2001. It also recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. The national engineering organizations of Australia, Canada, Ireland, New Zealand, South Africa, United Kingdom and Hong Kong signed an agreement mutually recognizing the qualifications which underpin the granting of Engineering Technologist titles in the seven countries. Since then, another economy has attained provisional membership, and are working towards signatory status and they are the United States.

The Dublin Accord is an agreement for substantial equivalence in the accreditation of tertiary qualifications in technician engineering, normally of two years duration and it commenced in

2002. The Dublin Accord is an agreement for the international recognition of Engineering Technician qualifications and in May 2002 the national engineering organizations of the United Kingdom represented by Engineering Council UK, Republic of Ireland represented by Engineers Ireland, South Africa represented by Engineering Council of South Africa and Canada represented by Canadian Council of Technicians and Technologists signed an agreement mutually recognizing the qualifications which underpin the granting of Engineering Technician titles in the four countries. Since then, two further economies have attained provisional membership, and are working towards signatory status and they are New Zealand represented by Institution of Professional Engineers NZ and the United States represented by Accreditation Board for Engineering and Technicians.

Agreements covering competence standards and qualifications for practicing engineers:

The other three agreements cover recognition of equivalence at the practicing engineer level i.e. it is individual people, not qualifications that are seen to meet the comparable and benchmark standard. The concept of these agreements is that a person recognized in one country as reaching the agreed international standard of competence should only be minimally assessed (primarily for local knowledge) prior to obtaining registration in another country that is party to the agreement.

The oldest such agreement is the Asia-Pacific Economic Cooperation (APEC) APEC Engineer agreement which commenced in 1999. This has Government support in the participating APEC economies. The representative organization in each economy creates a "register" of those engineers wishing to be recognized as meeting the generic international standard. Other economies should give credit when such an engineer seeks to have his or her competence recognized. The Agreement is largely administered between engineering bodies, but there can be Government representation and substantive changes need to be signed off at governmental APEC Agreement level.

The Engineers Mobility Forum (EMF) agreement commenced in 2001. It operates the same competence standard as the APEC Engineer agreement but any country/economy may join. The parties to the recognition of the qualification and standards agreement are largely engineering bodies and there are intentions to draw EMF and APEC closer together.

The Engineering Technologist Mobility Forum agreement was signed by participating economies/countries in 2003. The parties to the Agreement have agreed to commence establishing a mutual qualification and standards recognition scheme for engineering technologists.

SADC Nations:

International Comparability with qualifications of countries within the SADC region proved to be difficult, as in most SADC Countries no similar qualifications could be found and thus they use the Engineering Council of South Africa (ECSA) qualifications as a point of comparing standards. Only Namibia, who has previously been a part of South Africa, has similar qualifications, but does not necessarily practice exactly the same standards as in South Africa.

South African companies also have a strong and respected tradition of training in engineering. Prior to the development of this qualification, training has been company based, in-house and on-the-job, but to international standards, using internationally recognized American or British generated materials.

South African companies provide training to other African countries such as Botswana and Zambia, as well as further-a-field in a range of other countries, including the Middle East.

In the early 2000's the South African engineering industries identified a need to develop qualifications that align with the principles of the National Qualifications Framework. Such qualifications would provide a national standard for training and would support the need to maintain and improve standards of safety and quality in this important industry sector. There was also considerable pressure from industry stakeholders for quality learning to be developed and implemented.

Emerging Economies:

In an attempt to do a comparison with countries with an emerging economy, the following websites were searched:

www.lan.gov.my:

> This site directs searches to the Malaysian Accreditation Body: Lenbaga Akcreditasi Negara, but only gives details of engineering qualifications that could be compared with Washington Accord signatory countries, although there is an Institution of Engineers in Malaysia (IEM) and a Board of Engineers in Malaysia (BEM).

www.naac-india.com:

> This site directs searches to the National Assessment and Accreditation Council (India), but only gives details of engineering qualifications that could be compared with Washington Accord signatory countries, although there is an Institution of Engineers in India (IEI) and a National Board of Accreditation of All India Council for Technical Education (NBA-AICTE).

www.nigeria.com:

> Provides links and access to the Federal Ministry of Education in Nigeria, but does not give any details of any engineering qualifications that could be compared with those in South Africa.

Conclusion:

This qualification has generic competencies equivalent to a Professional Engineer, industry-specific contextual knowledge and practices and knowledge of South African health and safety legislation relevant to the particular industry. The generic competencies are compared and benchmarked by ECSA against those of international signatories to the Washington, Sydney, and Dublin Accords and the Engineers Mobility Forum (EMF) agreement, Engineering Technologist Mobility Forum and the Asia-Pacific Economic Cooperation (APEC) Engineer agreement. Engineering Industry specific practices and standards are internationally compared and benchmarked by the various employers to these international accords, agreements and forums.

ARTICULATION OPTIONS

The Exit Level Outcomes ensure that a graduate of a programme meeting these standards would meet requirements for entry to a number of programmes including:

> A candidacy programme toward registration as a Professional Engineer.
> A Learnership programme directed at becoming registered as a Professional Engineer or meeting other industry requirements.
> Formal specialist study toward the Postgraduate Diplomas.
> A postgraduate Bachelor of Laws (LLB) programme.
> Specialist coursework masters programmes, for example M.Eng.
> Research masters programmes leading to the M.Sc(Eng), with or without coursework Components.
> With appropriate work experience, the Master of Business Administration or similar.

> In certain disciplines, progression toward the Government Certificate of Competency.

However, this qualification also provides for both horizontal and vertical articulation.

Horizontal Articulation is possible with:

> Bachelors Degree in Technology (B.Tech): Engineering, NQF Level 7.

Vertical Articulation is possible with:

> Bachelor of Honours Degree in Science (BSc): Engineering, NQF Level 8.

MODERATION OPTIONS

It is likely that candidates will offer a single body of work-based evidence for assessment against the ten outcomes. Assessors must therefore examine the evidence holistically, recognizing that a given body of work-based evidence may demonstrate performance against several outcomes.

> Anyone assessing a learner or moderating the assessment of a learner against this Qualification must be registered as an assessor with a relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.

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

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

> A learner wishing to be assessed for this qualification can only be assessed through an accredited assessment provider/centre.

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

CRITERIA FOR THE REGISTRATION OF ASSESSORS

Assessors must be Professional Engineers registered with ECSA and fully trained in the methods of assessment.

The assessor for this qualification must:

Have a similar qualification that is at least one level higher than this qualification.

> Meet the requirements of National Assessor Unit Standards.
> Be registered as an assessor with the relevant ETQA or with an ETQA that has a Memorandum of Understanding with the relevant ETQA.
> Have a minimum of 1 year on the job relevant experience.

NOTES

This qualification replaces qualification 48694, "Bachelor of Science: Engineering", Level 7, 560 credits.

Abbreviations:

BSc (Eng), BScEng, BEng, BIng.

BSc(Eng)/BEng/BIng Qualification:

In the case of a provider offering programmes with the same first-level qualifier and different second-level qualifiers but with insufficiently differentiated purpose or content, only one programme should be accredited.

Examples of acceptable designations in accordance with HEQF policy are:

> Bachelor of Engineering in Civil Engineering, abbreviated BEng (Civil Engineering).
> Bachelor of Engineering in Civil Engineering, Environmental Engineering Option abbreviated BEng (Civil Engineering)(Environmental).

This qualification has been revised, with its previous identity number being 48694 and had an estimated learner uptake of 70 candidates for the 7 engineering universities per annum of the 4 year duration of the degree programme. The changes made to the qualification were primarily concerned with enhancing the Purpose, Rationale, RPL, Qualification Rules, some of the ELOs and AACs and Range Statements, International Comparability, CCFOs, etc in order to comply with SAQA requirements for qualification format.

Method of Calculation of SAQA Credits and Allocation to Knowledge Area.

The method of calculation assumes that certain activities are scheduled on a regular weekly basis while others can only be quantified as a total activity over the duration of a course or module. This calculation makes the following assumptions:

> Classroom or other scheduled contact activity generates notional hours of the student's own time for each hour of scheduled contact. The total is given by a multiplier applied to the contact time.
> Two weeks of full-time activity accounts for assessment in a semester.
> Assigned work generates only the notional hours judged to be necessary for completion of the work and is not multiplied.

Define for each course or module identified in the rules for the degree:

Type of Activity Time Unit in Hours Contact Time Multiplier:

> L = Number of lectures per week.
> TL = Duration of a lecture period.
> ML= Total work per lecture period.
> T = Number of tutorial per week.
> TT = Duration of a tutorial period.
> MT=Total work per tutorial period
> P = Total practical periods.
> TP = Duration of a practical period.
> MP= Total work per practical period.
> X = Total other contact periods.
> TX = Duration of other period.
> MX = Total work per other period.
> A = Total assignment non-contact Hours.
> TA = 1 hour.
> W = Number of weeks the course lasts (actual + 2 week per semester for examinations, if applicable to the course or module).
> The credit for the course is: C = {W (LTL ML + TTT MT) + PTP MP + XTX MX + ATA }/10.

The resulting credit for a course or value may be divided between more than one knowledge area. In allocating the credit for a course to multiple knowledge areas, only new knowledge or skills in a particular area may be counted. Knowledge and skills developed in other courses and used in the course in question shall not be counted. Such knowledge is classified by the nature of the area in which it is applied. In summary, no knowledge is counted more than once as being new.

UNIT STANDARDS
This qualification is not based on Unit Standards.

LEARNING PROGRAMMES RECORDED AGAINST THIS QUALIFICATION
None

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