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SOUTH AFRICA

Qualification Standard for Bachelor of Engineering Technology Honours: NQF Level 8

E-09-PT

Revision No.: 6 29 Jan 2019

ENGINEERING COUNCIL OF SOUTH AFRICA
Tel: 011 6079500 | Fax: 011 6229295
Email: engineer@ecsa.co.za | Website: www.ecsa.co.za

ECSA

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DEFINITION OF TERMS

Complementary studies: cover those disciplines outside of engineering sciences, natural sciences and mathematics which are relevant to the practice of engineering including but not limited to engineering economics, management, the impact of technology on society, effective communication, and the humanities, social sciences or other areas that support an understanding of the world in which engineering is practised.

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 fundamentals: engineering sciences that embody a systematic formulation of engineering concepts and principles based on mathematical and natural sciences to support applications.

Engineering management: the generic management functions of planning, organising, leading and controlling, applied together with engineering knowledge in contexts including the management of projects, construction, operations, maintenance, quality, risk, change and business.

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.

Engineering discipline (a branch of engineering): a generally-recognised, major subdivision of engineering such as the traditional chemical, civil, or electrical engineering disciplines, or a cross-disciplinary field of comparable breadth including combinations of engineering fields, for example Mechatronics, and the application of engineering in other fields, for example Bio-Medical Engineering.

Engineering sub-discipline (an engineering speciality): a generally-recognised practice area or major subdivision within an engineering discipline, for example Structural and Geotechnical Engineering within Civil Engineering.

Engineering sciences: have roots in the mathematical and physical sciences, and where applicable, in other natural sciences but extend knowledge and develop models and methods in order to lead to engineering applications and solve engineering problems.

Engineering speciality: the extension of engineering fundamentals to create theoretical frameworks and bodies of knowledge for engineering practice areas.

Mathematical sciences: an umbrella term embracing the techniques of mathematics, numerical analysis, statistics and aspects of computer science cast in an appropriate mathematical formalism.

Natural 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.

BACKGROUND

The documents that define the Engineering Council of South Africa (ECSA) system for accreditation of programmes meeting educational requirements for professional categories are shown in Figure 1 which also locates the current document.

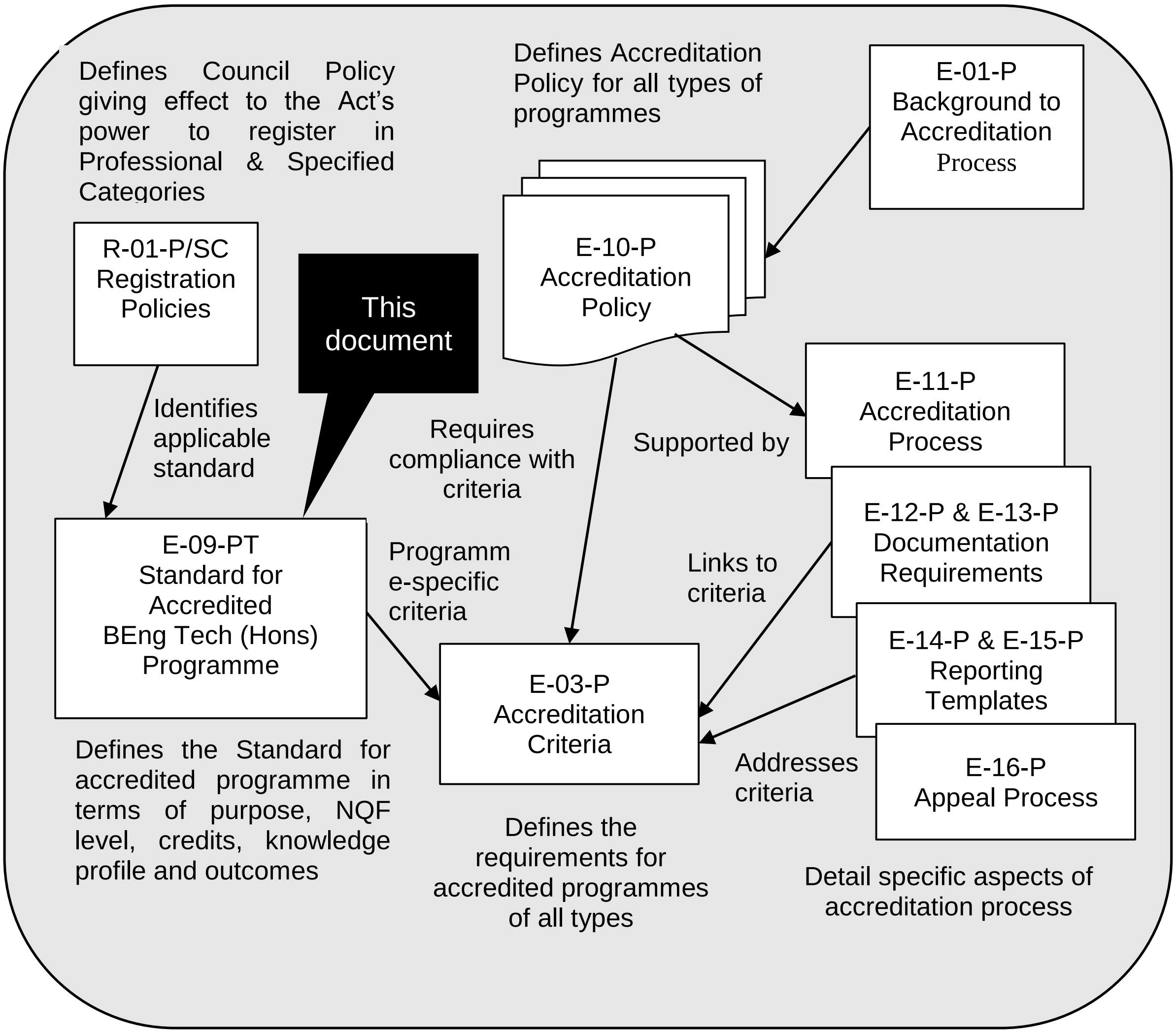

Figure 1: Documents defining the ECSA Accreditation System

1. PURPOSE OF THIS DOCUMENT

This document defines the standard for accredited Bachelor of Engineering Technology Honours-type programmes in terms of programme design criteria, a knowledge profile and a set of graduate attributes. This standard is referred to in the Accreditation Criteria defined in the ECSA document **E-03-P**.

2. QUALIFICATION TYPE AND VARIANT

Bachelor of Engineering Technology Honours

3. GENERAL CHARACTERISTICS

“The Bachelor Honours Degree is a postgraduate qualification, characterised by the fact that it prepares students for research-based postgraduate study. This qualification typically follows a Batchelor’s Degree, and serves to consolidate and deepen the student’s expertise in a particular discipline, and to develop research capacity in the methodology and techniques of that discipline. This qualification demands a high level of theoretical engagement and intellectual independence. In some cases, a Bachelor Honours Degree carries recognition by an appropriate professional or statutory body.

“Bachelor Honours Degree programmes must include conducting and reporting research under supervision, worth at least 30 credits, in the form of a discrete research component that is appropriate to the discipline or field of study” (The Higher Education Qualifications Sub-Framework, CHE, 2013).

4. PREAMBLE

The Bachelor of Engineering Technology Honours Degree enhances the application of research and development as well as contextual knowledge to meet the minimum entry requirement for admission to a cognate master’s degree. The master's degree programme is usually in the area of specialisation of the bachelor honours degree.

Characteristic Profile of the Graduate:

- Consolidates and deepens the graduate’s expertise in a particular discipline and develops research capacity in the methodology and techniques of that discipline;
- Work independently and responsibly, applying original thought and judgment to technical and risk-based decisions in complex situations; and

- Have a broad, fundamentals-based appreciation of engineering sciences, with depth in specific areas, together with knowledge of financial, commercial, legal, social and economic, health, safety and environmental matters.

Note

Words and phrases with specific meaning are defined in Section 16 of this document or in the Engineering Council of South Africa (ECSA) Document **E-01-P**. The method required for calculating credits is detailed in the ECSA Document **E-01-P** available at www.ecsa.co.za.

5. HEQSF AND NQF SPECIFICATION

HEQSF Qualification Type: Bachelor Honours Degree

Variant: Professionally-oriented

NQF Level: Level 8

Credits: 140 credits total: Not less than 120 Credits shall be at NQF level 8

6. QUALIFICATION TITLE

Designator: Bachelor of Engineering Technology Honours

Qualifiers: The qualifier(s) must contain the word engineering and be consistent with the engineering science content of the programme. Disciplinary or cross-disciplinary identifiers include but are not limited to: Agricultural, Aeronautical, Chemical, Civil, Computer, Electrical, Electro- mechanical, Electronic, Environmental, Industrial, Extractive Metallurgical, Information, Materials, Mechanical, Mechatronic, Metallurgical, Mineral(s) Process, Physical Metallurgical and Mining.

7. PURPOSE STATEMENT

The Bachelor of Engineering Technology Honours Degree is a postgraduate qualification, characterised by the fact that it prepares students for industry and research. This qualification typically follows a bachelor's degree, advanced diploma or relevant level 7 qualification and serves to consolidate and deepen the student's expertise in a particular discipline and to develop research capacity in the methodology and techniques of that discipline.

In some cases, a Bachelor of Engineering Technology Honours Degree carries recognition by an appropriate professional or statutory body. This qualification demands a high level of theoretical engagement and intellectual independence.

A provider my elect to offer the Bachelor of Engineering Technology Honours Degree as part of a carefully curriculated combination of qualifications that when offered as a structured whole could be determined through a process of accreditation to meet the educational requirements for registration in the category candidate engineer. This pathway is described fully in E-23-P. A provider adopting this approach for their suite of qualifications on this pathway would need to ensure that the necessary knowledge content areas – specifically mathematical and natural sciences, discipline specific advanced engineering sciences, and engineering design and synthesis – have been curriculated in such a way that on completion of this pathway, both the knowledge content areas and the developed graduate attributes meet or exceed the requirements of a bachelor of engineering qualification.

This qualification provides:

- Preparation for careers in engineering itself and areas that potentially benefit from engineering skills, for achieving technological proficiency and to make a contribution to the economy and national development;
- Entry to NQF level 9 Master's programmes e.g. MSc/MEng; and
- Access to the relevant pathways described in **E-23-P**.

Engineering students completing this qualification will demonstrate competence in all the graduate attributes contained in this standard.

8. NORMAL DURATION OF STUDY

Programmes have normal duration of one year with not less than 140 credits.

9. STANDARD FOR THE AWARD OF THE QUALIFICATION

The purpose and level of the qualification will have been achieved when the student has demonstrated:

- the knowledge defined in Section 10; and
- the skills and applied competence defined in Section 11.

10. KNOWLEDGE

Knowledge demonstrated by the graduate has the following characteristics:

10.1 The content of the educational programme when analysed by knowledge area shall not fall below the minimum credits in each knowledge area listed in Table 1.

Table 1: Minimum credits in knowledge areas

Knowledge area	Minimum Credits
Mathematical sciences	8
Natural sciences	15
Engineering sciences	45
Engineering design and synthesis	30
Complementary studies	7
Subtotal	105
For reallocation	≥35
Total credits	≥140

Note 1: These credits total 105. Credits in selected knowledge areas must be increased to satisfy the 140 minimum total credits.

Note 2: The programme leading to the qualification shall contain a minimum of 140 credits including a research project of no less than 30 credits. No less than 120 credits shall be at NQF level 8. Credits shall be distributed in order to create a coherent progression of learning toward the exit level.

10.2 The programme shall have a coherent core of mathematics, basic sciences and fundamental engineering sciences that provides a viable platform for research and development, further studies and lifelong learning. The coherent core must enable development in a traditional discipline or in an emerging field. The coherent core includes fundamental elements. The provider may allow elective credits, subject to the minimum credits in each knowledge area and the exit level outcomes being satisfied for all choices. The level of knowledge of mathematics, natural sciences and engineering sciences is characterised by:

- A knowledge of mathematics using formalism, and oriented toward engineering analysis and modelling; deep knowledge of natural sciences: both as relevant to discipline;
- A deep knowledge of a broad range of fundamental principles of an engineering discipline or cross-disciplinary field that is coherently and systematically organised;
- In-depth, theoretically based knowledge in limited specialist area(s), informed by current developments, and emerging issues; and
- The use of mathematics, naturals science and engineering sciences in formal analysis and modelling of engineering situations, for reasoning about and conceptualising complex engineering problems.

10.3 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 recognised 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.

10.4 In the area of complementary studies, the programme covers those disciplines outside of engineering sciences, basic sciences and mathematics which are relevant to the practice of engineering in two ways: (a) principles, results and method are applied in the practice of engineering, including engineering economics, the impact of technology on society and effective communication; and (b) study broadens the student's perspective in the humanities or social sciences to support an understanding of the world. Underpinning knowledge gained from complementary studies must be sufficient and appropriate to support the student in satisfying Graduate Attributes 7 and 10 in the graduates practice area.

10.5 This standard does not specify detailed curriculum content. The engineering fundamentals and specialist engineering science content must be consistent with the designation of the degree.

11. SKILLS AND APPLIED COMPETENCE

The graduate is able to demonstrate competence in the graduate attributes 1 to 11. The Graduate Attributes are stated generically and may be assessed in various engineering disciplinary or cross- disciplinary contexts in a provider-based or simulated practice environment. Words and phrases with specific meaning are defined in this document or in the ECSA document **E-01-P**.

Note:

General Range Statement: The competencies defined in the eleven graduate attributes may be demonstrated in a provider-based and / or simulated workplace context.

Graduate Attribute 1: Problem solving

Identify, formulate, analyse and solve *complex problems* creatively and innovatively.

Level Descriptor: *Complex problems*

(a) require in-depth fundamental and specialised knowledge;

and have one or more of the characteristics:

(b) are ill-posed, under- or over specified, or require identification and refinement;

(c) are high-level problems including component parts or sub-problems;

(d) are unfamiliar or involve infrequently encountered issues;

and their solutions have one or more of the characteristics:

(e) are not obvious, require originality or analysis based on fundamentals;

(f) may be outside the scope of standards and codes;

(g) require information from variety of sources that is complex, abstract or incomplete;

(h) involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

Range Statement: *Complex problems* are characterised 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 judgment where necessary; and
- Involves a variety of interactions which may impose conflicting constraints, premises, assumptions and / or restrictions.

Graduate Attribute 2: Application of Scientific and Engineering Knowledge

Demonstrate competence to apply knowledge of mathematics, natural science and engineering sciences to the conceptualisation of engineering models and to solve *complex problems*.

Range Statement: Mathematics, natural science and engineering sciences are applied in formal analysis and modelling of engineering situations, and for reasoning about and conceptualising engineering problems. Characteristics of knowledge in different areas are defined in Section 10.2

Note: Problems used for assessment may provide evidence in the application of one, two or all three categories of knowledge listed in Section 10.2. It also requires working across engineering disciplinary boundaries through cross disciplinary literacy and shared fundamental knowledge.

Graduate Attribute 3: Engineering Design

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* problem.

- A major design problem should be used to provide a body of evidence that demonstrates this outcome; and

- 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.

Graduate Attribute 4: Investigations, Experiments and Data Analysis

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

Range Statement: This qualification includes conducting and reporting research under supervision, worth at least 30 credits, in the form of a discrete research component that is appropriate to the discipline or field of study. The following needs to be noted:

- The balance of investigation and experiment should be appropriate to the discipline; and
- 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.

Graduate Attribute 5: Engineering Methods, Skills and Tools, Including Information Technology

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

Range Statement: A range of methods, skills and tools appropriate to the discipline of the programme including:

- Discipline-specific tools, processes or procedures;

- Computer packages for computation, modelling, simulation, and information handling; and
- Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork.

Graduate Attribute 6 Professional and Technical Communication

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 con- text; and

- Audiences range from engineering peers, related engineering personnel and lay persons.
- Appropriate academic or professional discourse is used.

Methods of providing information include the conventional methods of the discipline, for example engineering drawings, as well as subject-specific methods

Graduate Attribute 7: Sustainability and Impact of Engineering Activity

Demonstrate knowledge and understanding of the impact of engineering activities on society, economy, industrial and physical environment.

Range Statement: The combination of social, workplace (industrial) and physical environmental factors must be appropriate to the discipline or other designation of the qualification. Comprehension of the role of engineering in society and identified issues in engineering practice in the discipline: health, safety and environmental protection; risk assessment and management and the impacts of engineering activity: economic, social, cultural, environmental and sustainability.

Graduate Attribute 8: Individual, Team and Multidisciplinary Working

Demonstrate competence to work effectively as an individual, in teams and in multidisciplinary environments.

Range Statement:

- May apply to one's own work, as a member or leader in a multidisciplinary project;
- The ability to manage a project should be demonstrated in the form of project indicated in Graduate Attributes 3 and 4; and
- Tasks may require co-operation across at least one disciplinary boundary.

Co-operating disciplines may be engineering disciplines with different fundamental bases or may be outside engineering.

Graduate Attribute 9: Independent Learning

Demonstrate competence to engage in independent and life-long learning through well-developed learning skills.

Range Statement: The learning context is complex and ill defined. Information is also drawn from research literature.

Graduate Attribute 10: Engineering Professionalism

Comprehend and apply ethical principles and commit to professional ethics, 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.

Graduate Attribute 11: Engineering Management

Demonstrate knowledge and understanding of engineering management principles and economic decision-making.

Range Statement: Basic techniques from economics, business management; project management applied to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

12. CONTEXTS AND CONDITIONS FOR ASSESSMENT

Graduate Attributes defined in Section 11 are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment.

Providers of programmes shall in the quality assurance process demonstrate that an effective integrated assessment strategy is used. Clearly identified components of assessment must address summative assessment of graduate attributes. Evidence should be derived from major work or multiple instances of limited scale work.

13. AWARD OF THE QUALIFICATION

The qualification may be awarded when the qualification standard has been **met or exceeded**.

14. PROGRESSION

A bachelor honours degree is a requirement for admission to a master's degree or postgraduate diploma.

A qualification may not be awarded for early exit from a bachelor honour's degree.

15. GUIDELINES

15.1 Pathway

This qualification lies on a HEQSF Professional Pathway. See also **E-23-P.**

15.2 International Comparability

International comparability of engineering education qualifications is ensured through the Washington, Sydney and Dublin Accords, all being members of the International Engineering Alliance (IEA).

The graduate attributes and level descriptors defined in this qualification are aligned with the International Engineering Alliance's Graduate Attributes and Professional Competencies (See www.ieagreements.org).

REVISION HISTORY

Revision Number	Revision Date	Revision Details	Approved By
Revision 1	12 September 2012	Reconfiguration of document approved by Council to align with E-02-PE.	Technology SGG Working Group
Revision 2	14 March 2013	Editorial Improvements.	ECSA Council
Revision 3 Draft A	27 November 2015	Revision 2 converted to new CHE format.	SGG Draft for submission to EPAC and ESGB
Revision 4 Draft A	23 January 2016	Revision 3 revised (in red underlined) and CHE objection against the use of their logo and ECSA using the wrong procedure to register the standard addressed.	Revised SGG draft for submission to the ESGB
Revision 4 Draft A	2 March 2016	Minor Editing. Final submission to Council.	Amended and approved by ESGB
Revision 4	24 March 2016	No amendments.	Approved by Council
Revision 5	21 October 2018	Revised to provide clarity on the possible contribution that this standard provides to the pathway toward registration as a candidate engineer. Addition of GA 11 in line with the BEng standard.	PDSG Working Group
Revision 6	29 January 2019	Approval	RPSC

The Qualification Standard for:

Bachelor of Engineering Technology Honours: NQF Level 8:

Revision 6 dated 29 January 2019 and consisting of 18 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards **(RPS).**

.... 01/08/2019

Business Unit Manager Date

.... 05/08/2019

Executive: **RPS** Date

This definitive version of this policy is available on our website

APPENDIX A: NQF LEVEL DESCRIPTORS

The qualification is awarded at level 8 on the National Qualifications Framework (NQF) and therefore meets the following level descriptors:

- *Scope of knowledge*, in respect of which a learner is able to demonstrate knowledge of and engagement in an area at the forefront of a field, discipline or practice; an understanding of the theories, research methodologies, methods and techniques relevant to the field, discipline or practice; and an understanding of how to apply such knowledge in a particular context.
- *Knowledge literacy*, in respect of which a learner is able to demonstrate the ability to interrogate multiple sources of knowledge in an area of specialisation and to evaluate knowledge and processes of knowledge production.
- *Method and procedure*, in respect of which a learner is able to demonstrate an understanding of the complexities and uncertainties of selecting, applying or transferring appropriate standard procedures, processes or techniques to unfamiliar problems in a specialised field, discipline or practice.
- *Problem solving*, in respect of which a learner is able to demonstrate the ability to use a range of specialised skills to identify, analyse and address complex or abstract problems drawing systematically on the body of knowledge and methods appropriate to a field, discipline or practice.
- *Ethics and professional practice*, in respect of which a learner is able to demonstrate the ability to identify and address ethical issues based on critical reflection on the suitability of different ethical value systems to specific contexts.
- *Accessing, processing and managing information*, in respect of which a learner is able to demonstrate the ability to critically review information gathering, synthesis of data, evaluation and management processes in specialised contexts in order to develop creative responses to problems and issues.
- *Producing and communicating information*, in respect of which a learner is able to demonstrate the ability to present and communicate academic, professional or occupational ideas and texts effectively to a range of audiences, offering creative

insights, rigorous interpretations and solutions to problems and issues appropriate to the context.

- *Context and systems*, in respect of which a learner is able to demonstrate the ability to operate effectively within a system, or manage a system based on an understanding of the roles and relationships between elements within the system.
- *Management of learning*, in respect of which a learner is able to demonstrate the ability to apply, in a self-critical manner, learning strategies which effectively address his or her professional and ongoing learning needs and the professional and ongoing learning needs of others.
- *Accountability*, in respect of which a learner is able to demonstrate the ability to take full responsibility for his or her work, decision-making and use of resources, and full accountability for the decisions and actions of others where appropriate.

HIGHER EDUCATION QUALIFICATIONS SUB-FRAMEWORK

STANDARDS DEVELOPMENT: POLICY AND PROCESS

Explanatory Notes

In terms of the National Qualifications Framework (NQF) Act, 67 of 2008, the Council on Higher Education (CHE) is the Quality Council (QC) for Higher Education. The CHE is responsible for quality assurance of higher education qualifications.

Part of the implementation of the Higher Education Qualifications Sub-Framework (HEQSF) is the development of qualification standards. Standards development is aligned with the *nested approach* incorporated in the HEQSF. In this approach, the outer layer providing the context for qualification standards are the NQF level descriptors developed by the South African Qualifications Authority (SAQA) in agreement with the relevant QC. One of the functions of the QC (in the case of higher education, the CHE) is to ensure that the NQF level descriptors 'remain current and appropriate'. The development of qualification standards for higher education therefore needs to take the NQF level descriptors, as the outer layer in the *nested approach*, into account. An ancillary function is to ensure that they 'remain current and appropriate' in respect of qualifications awarded by higher education institutions.

A secondary layer for the context in which qualification standards are developed is the HEQSF. This framework specifies the types of qualification that may be awarded and, in some cases, the allowable variants of the qualification type. An example of variants is the provision for two variants of the Master's degree (including the 'professional' variant).

Another example is the distinction, in the bachelor's degree type, between the 'general' and 'professionally-oriented' variants. The HEQSF also specifies the purpose and characteristics of each qualification type. However, as indicated in the *Framework for Qualification Standards in Higher Education* (CHE, 2013), neither the NQF level descriptors nor the HEQSF are intended to address, or indeed capable of addressing, fully the relationship between generic qualification-type purpose and the specific characteristics of that qualification type in a particular field of study. One of the tasks of standards development is to reconcile the broad, generic description of a qualification type according to the HEQSF and the particular characteristics of qualifications awarded in diverse fields of study and disciplines, as defined by various descriptors and qualifiers.

Development of qualification standards is guided by the principles, protocols and methodology outlined in the *Framework*, approved by the Council in March 2013. The focus of a standards statement is the relationship between the purpose of the qualification, the attributes of a graduate that manifest the purpose, and the contexts and conditions for assessment of those attributes. A standard establishes a threshold. However, on the grounds that a standard also plays a developmental role, the statement may include, as appropriate, elaboration of terms specific to the statement, guidelines for achievement of the graduate attributes, and recommendations for above-threshold practice.