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SOUTH AFRICA

Qualification Standard for Higher Certificate in Engineering for Specified Categories: NQF Level 5

E-07-SC

REVISION 2: 17 April 2019

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ECSA

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DEFINITIONS

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 disciplines of Chemical, Civil, or Electrical Engineering, 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.

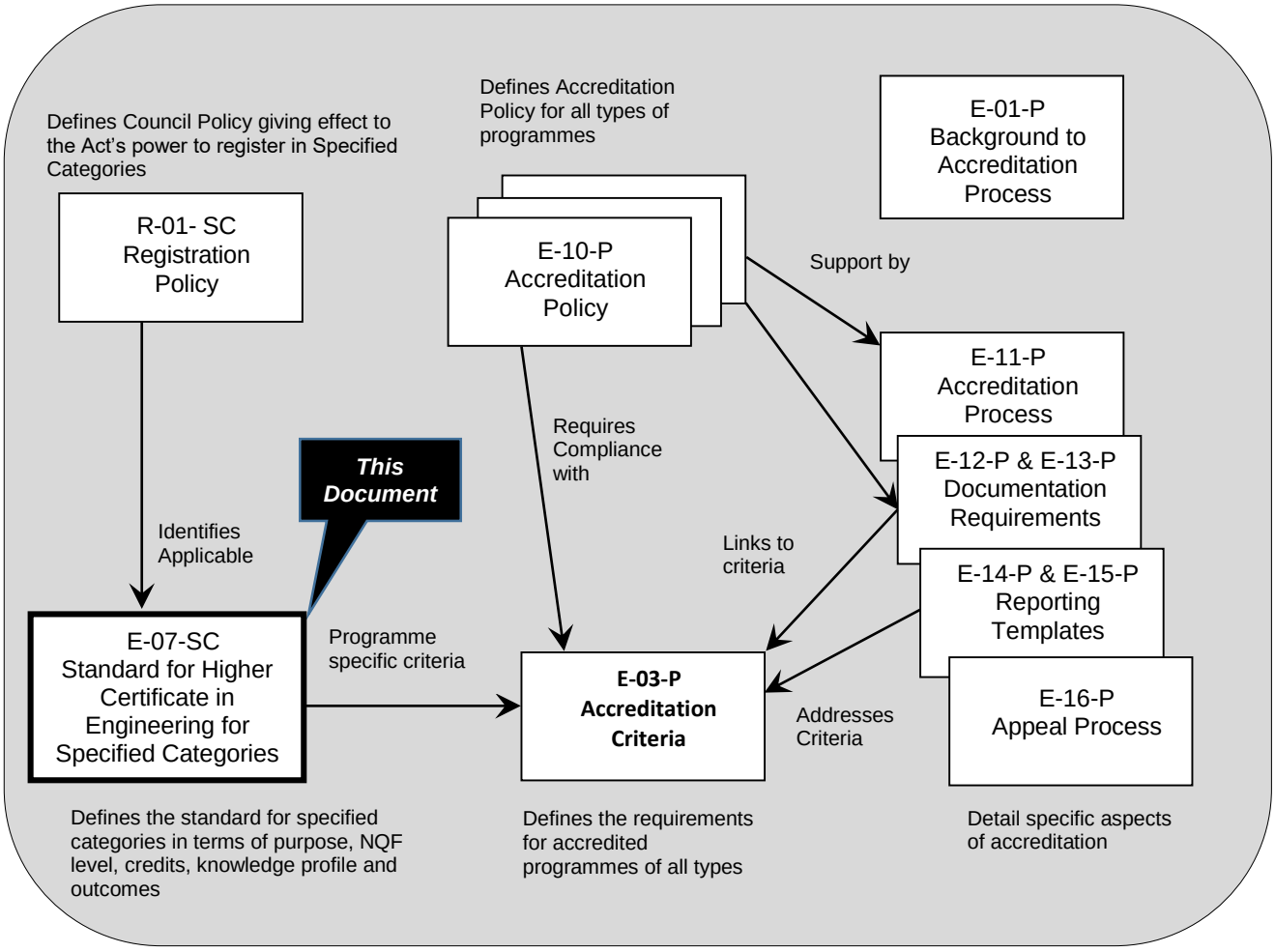

Figure 1: Documents defining the ECSA Accreditation System

1. PURPOSE OF THIS DOCUMENT

This document defines the standard for accredited Higher Certificate in Engineering-type programmes for Specified Categories 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 ECSA document **E-03-P**.

2. HEQF and NQF SPECIFICATION

Field: Manufacturing, Engineering and Technology

Sub-Field: Engineering and Related Design

NQF Level: Level 5

Credits: 140 credits total; Not less than 120 Credits shall be at NQF level 5

Acceptable titles: Higher Certificate in Engineering

Abbreviation: H Cert (Engineering)

Qualifiers: See section 3

3. QUALIFIERS

The qualification must have a qualifier(s) defined in the provider's rules for the Higher Certificate and reflected on the academic transcript and Higher Certificate, subject to the following:

1. 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, Mechatronics, Metallurgical, Mineral(s) Processing, Physical Metallurgical and Mining. Qualifiers are not restricted to this list.
2. A second qualifier, if present, must indicate a focus area within the field of the first qualifier such as: Environmental, Information, Extractive Metallurgical, Minerals Processing and Physical Metallurgical.

The qualifier(s) must:

- clearly indicate the nature and purpose of the programme;
- be consistent with the fundamental engineering science content on the programme;

3. The target market indicated by the qualifier(s) may be a traditional discipline of engineering or a branch of engineering or a substantial industry area or in a specified area of practice. Formal education for niche markets should be satisfied by broad undergraduate programmes such as specified in this standard followed by specialized course-based programmes.

In the case of a provider offering programmes with different titles but having only minor differences in content or undifferentiated purposes, only one programme should be accredited.

Examples of acceptable qualification titles in accordance with the HEQF policy are:

- Higher Certificate in Civil Engineering, abbreviated H Cert. (Civil Engineering) In case of a second *Qualifier:*
- Higher Certificate in Civil Engineering in Environmental Engineering, abbreviated, H Cert. (Civil Engineering) (Environmental)
- Higher Certificate in Electro Mechanical Engineering in Lift Inspection, abbreviated H Cert. (Electro Mechanical Engineering) (Lift Inspection)

4. PURPOSE OF THE QUALIFICATION

The qualification is primarily vocational or occupational in nature. The qualification also serves to provide students with the basic introductory knowledge, cognitive and conceptual tools and practical skills for further higher education studies in their chosen field of study. The knowledge emphasizes general principles and application. This qualification signifies that the student has attained a basic level of higher education knowledge and competence in a particular field or occupation and is capable of applying such knowledge and competence in an occupation or role in the workplace.

This standard is designed to meet the educational requirement towards registration as a Candidate or potential for registration as a Registered Specified Category Practitioner with the Engineering Council of South Africa.

This qualification provides:

a. Preparation for careers in engineering and areas that potentially benefit from engineering skills, for achieving technical proficiency and to make a contribution to the economy and national development;
b. The educational base that may be required for registration in a Specified Category with ECSA. (refer to qualification rules).
c. Entry to programmes e.g. Advanced Certificate, Diploma or Bachelor Degree Programme

Engineering students completing this qualification will demonstrate competence in all the Graduate Attributes contained in this standard.

5. RATIONALE

Work done by practitioners in the Support Occupations is characterized by their ability to apply proven, commonly understood detailed techniques procedures, practices and codes to solve *specifically-defined*

engineering problems. They manage and supervise specific engineering operations, construction and activities. They work independently and responsibly within a specified allocated area or under supervision.

Support Occupation practitioners must therefore have a detailed understanding of engineering sciences supporting the specific techniques used, together with financial, commercial, legal, social economic, health, safety and environmental methodologies and specific best practices.

The process of professional development of Support Occupation practitioner starts with the attainment of a qualification that meets this standard. After graduation a programme of detailed training and experience is completed to attain the competencies for registration in a specified category.

6. PROGRAMME STRUCTURE

The programme leading to the qualification shall contain a minimum of 140 credits, with not less than 120 credits at NQF level 5. Credits shall be distributed in order to create a coherent progression of learning towards the exit level.

6.1 Knowledge Profile of the Graduate

The content of the educational programme when analysed by knowledge area shall not fall below the minimum credits in each knowledge area as listed below:

Table 1: Minimum credits in knowledge areas

Table 1: Minimum credits in knowledge areas	Type A	Type B
Total	140	140
Mathematical Sciences	14	7
Natural Sciences	7	7
Engineering Sciences	63	56
Engineering Design & Synthesis	14	7
Computing and IT	14	14
Complementary Studies	7	7
Specified Category Discipline	-	21
Available for re-allocation in above areas	21	21

Type A indicates the minimum credit requirement for progression to the Advanced Certificate. The reallocation credits must be assigned to the knowledge areas to form a coherent, balanced programme.

Type B indicates the minimum credits requirement for this qualification that leads to engineering support occupations. The Specified Categories Discipline credits are allocated to provide the underpinning knowledge in the specific discipline as detailed for the particular Specified Category on ECSA's website e.g. Lift Inspectors, Lifting Machinery Inspectors, Medical Equipment Maintainers, Fire Protection System Inspectors, etc. The reallocation credits may be assigned to any of the six knowledge areas to meet the specifics of an engineering support occupation.

The method of calculation of credits and allocation to knowledge area is defined in ECSA document **E-01-P** or **Appendix A**.

6.2 Core and Specialist Requirements

The programme shall have a coherent core of mathematics, natural sciences and engineering sciences totaling not less than 50% of the total credits that provide a viable platform for further studies and lifelong learning. The coherent core must enable development in a traditional discipline, sub-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 graduate attributes being satisfied for all choices.

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.

In the Complementary Studies area, it covers those disciplines outside of engineering sciences, natural sciences and mathematics which are relevant to the practice of engineering in two ways: principles, results and method are applied in the practice of engineering, including engineering economics, the impact of technology on society and effective communication; and study broadens the student's perspective in the humanities or social sciences to support an understanding of the world. Underpinning Complementary Studies knowledge of type (b) must be sufficient and appropriate to support the student in satisfying Graduate Attributes 6, 7 and 10 in the graduates specialized practice area.

6.3 Curriculum Content

This qualification does not specify detailed curriculum content. The fundamental and specialist engineering science content must be consistent with the designation of the qualification.

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, learner ships, skills programmes or further learning.

6.4 Work Integrated Learning

Should a provider elect to include work integrated learning (WIL) credits in the programme, the provider must ensure that all students must undertake work-integrated learning.

7. ACCESS TO QUALIFICATION

This standard is specified as a set of Graduate Attributes and overall distribution of credits. Providers therefore have the freedom to construct programmes geared to different levels of preparedness of learners, including:

- Use of access programmes for learners who do not meet the minimum requirements;
- Creating articulation paths from other qualifications.

8. MINIMUM LEARNING ASSUMED TO BE IN PLACE

The minimum entry requirement is the National Senior Certificate or the National Certificate (Vocational) (level 4) or the N6 certificate (NATED) with appropriate subject combinations and levels of achievement, as defined in the Government Gazette, Vol 751, No 32131 of 11 July 2008, and in the *Government Gazette,* Vol. 533, No. 32743, November 2009. Alternatively, a Higher Certificate or an Advanced Certificate or Diploma in a cognate field may satisfy the minimum admission requirements.

Note: Appropriate Language, Mathematics and Physical Science are required at NQF level 4.

9. GRADUATE ATTRIBUTES

Graduate Attributes 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 and phrases having specific meaning are defined in this document or in the ECSA document **E-01-P**.

Notes:

1. For Critical Cross-filed Attributes linked to Graduate Attributes refer to normative information in

Appendix B.

2. For exemplified informative associated assessment criteria, refer to **Appendix C**.

3. The Level Descriptor: Specifically-defined engineering problems applicable to this Qualification Standard are characterised by the following:

a. can be solved mainly by specific practical engineering knowledge, underpinned by related theory;

and one or two of:

b. are fully defined but require feedback;

c. are discrete, specifically focused tasks within engineering systems;

d. are routine, frequently encountered and in familiar specified context;

and one or more of:

e. can be solved in standardized or prescribed ways;

f. are encompassed by specific standards, codes and documented procedures; requires authorization to work outside limits;

g. information is concrete, specific and largely complete, but requires checking and possible supplementation;

h. involve specific issues but few of these imposing conflicting constraints and a specific range of interested and affected parties.

General Range Statement: The competencies defined in the ten Graduate Attributes may be demonstrated in a provider-based and / or simulated workplace context.

Graduate Attribute 1: Problem solving

Apply engineering principles to systematically diagnose and solve *specifically-defined* engineering problems.

Graduate Attribute 2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural science and engineering sciences to wide practical procedures and practices to solve *specifically-defined* engineering problems.

***Range Statement*:** Knowledge of mathematics, natural science and engineering science is characterized by:

1. A coherent range of fundamental principles in mathematics and natural science underlying a sub-discipline or recognised practice area.

2. A coherent range of fundamental principles in engineering science and technology underlying an engineering sub-discipline or recognised practice area.
3. A codified practical knowledge in recognised practice area.
4. The use of mathematics, natural sciences and engineering sciences, supported by established mathematical formulas, codified engineering analysis, methods and procedures to solve *specifically-defined* engineering problems.

Graduate Attribute 3: Engineering Design

Perform procedural design of *specifically-defined* components or processes to meet desired needs within applicable standards, codes of practice and legislation.

***Range Statement*:** Design problems used in assessment must conform to the definition of *specifically-defined* engineering problems.

Graduate Attribute 4: Investigation

Conduct tests, experiments and measurements of *specifically-defined* engineering problems by applying relevant codes and manufacturer guidelines.

***Range Statement*:** The task should be appropriate to the discipline.

Graduate Attribute 5: Engineering methods, skills, tools, including Information technology

Use appropriate established techniques, resources, and modern engineering tools including information technology for the solution of *specifically-defined* engineering problems, with an awareness of the limitations.

***Range Statement*:** A range of established methods, skills and tools appropriate to the sub- discipline of the program including:

1. Sub-discipline-specific tools, processes or procedures.
2. Computer packages for computation and information handling;
3. Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
4. Basic techniques from economics, management, and health, safety and environmental protection.

Graduate Attribute 6: Professional and Technical Communication

Communicate effectively, both orally and in writing within an engineering context.

Range Statement: Material to be communicated in the following context:

1. Audiences are engineering peers, academic personnel and related engineering persons using prescribed formats.
2. Written reports range from 300-2000 words plus tables, diagrams and appendices.
3. Methods of providing information include the conventional methods of the discipline, for example engineering drawings and sketches.

Graduate Attribute 7: Impact of Engineering Activity

Demonstrate knowledge and understanding of the impact of engineering activity on society and the environment.

***Range Statement*:** The combination of social and environmental factors must be appropriate to the discipline or sub-discipline of the qualification. Evidence may include examples of situations in which the graduate is likely to participate.

Issues and impacts to be addressed:

1. Are encompassed by standards and documented codes of practice; and
2. Are *specifically-defined,* discrete and part of an engineering system.

Graduate Attribute 8: Individual and Teamwork

Demonstrate knowledge and understanding of basic engineering management principles.

Range Statement:

1. Tasks are discipline or sub-discipline specific and within the technical competence of the graduate.
2. Management principles include:
3. Planning*:* set objectives and review achievement.
4. Organising: identify and organize tasks. Recognise responsibilities.
5. Leading*:* set example, communicate, motivate.
6. Controlling*:* monitor own performance and check against standards.

Graduate Attribute 9: Independent Learning

Engage in independent and life-long learning.

***Range Statement*:** Information relevant to the assigned task is sourced and organised.

Graduate Attribute 10: Engineering Professionalism

Understand and commit to ethics, responsibilities and norms of engineering practice.

***Range Statement*:** Evidence includes case studies, memorandum of agreement, code of conduct, membership of professional societies etc typical of engineering practice situations in which the graduate is likely to participate.

Graduate Attribute 11: Specified Category Discipline

Demonstrate knowledge and understanding on the conduct of specialised work including tests and inspections on specific machinery, systems, operations, procedures and associated equipment.

Range Statement: Machinery as defined in the Regulations of the Occupational Health and Safety Act (Act No 85 of 1993), SANS codes, International Codes of Practice and Manufacturers Installation and Maintenance Instructions.

10. 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). In the case of engineering technician education, the equivalence of this whole qualification standard together with the Advanced Certificate in Engineering is ensured through the Dublin Accord.

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

11. INTEGRATED ASSESSMENT

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 the Graduate Attributes. Evidence should be derived from major work or multiple instances of limited scale work.

12. RECOGNITION OF PRIOR LEARNING

Recognition of prior learning (RPL) may be used to demonstrate competence for admission to this programme. This qualification may be achieved in part through recognition of prior learning processes. Credits achieved through RPL must not exceed 50% of the total credits and must not include credits at the exit level.

13. ARTICULATION POSSIBILITIES

Completion of the Higher Certificate, Type A, meets the minimum entry requirement for admission to an appropriate Advanced Certificate. Accumulated credits may also be presented for admission into a cognate Diploma. A Higher Certificate may also allow access to an appropriate Bachelor's degree.

14. MODERATION AND REGISTRATION OF ASSESSORS

Providers of programmes shall in the quality assurance process demonstrate that an effective moderation process exists to ensure that the assessment system is consistent and fair.

Registration of assessors is delegated by the Higher Education Quality Committee to the Higher Education providers responsible for programmes.

Revision Number	Revision Date	Revision Details	Approved By
Draft 1	15 July 2013	Added LMI Graduate Attributes to use as a discussion document.	Technology SGG Working Group
Draft 2	22 July 2013	Revise document to a generic model as recommended at the meeting of 19 July 2013	SGG Specified Category
Draft 3	12 September 2013	Input from JIC and CRC incorporated. Approved by SGG Specified Categories.	SGG Specified Categories
Rev 1	22 November 2013	Input from JIC and CRC incorporated. Approved by SGG Specified Categories.	Council Approved
Rev 2	17 April 2019	Routine review Approval	RPSC

The Standard for:

Qualification Standard for Higher Certificate in Engineering for Specified Categories: NQF Level 5

Revision 2 dated 17 April 2019 and consisting of 17 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards **(RPS).**

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Business Unit Manager

26/07/2019

Date

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Executive: **RPS**

26/07/2019

Date

This definitive version of this policy is available on our website

Appendix A: Consistency of Graduate Attributes with Critical Cross-field Outcomes

Appendix A: Consistency of Graduate Attributes with Critical Cross-field Outcomes (Normative)

SAQA Critical Cross-Field Outcomes	Equivalent Graduate Attributes
Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.	GA 1, 2, 3, 5, 11
Working effectively with others as a member of a team, group, organisation and community.	GA 8, 11
Organising and managing oneself and one's activities responsibly and effectively.	GA 8, 11
Collecting, analysing, organising and critically evaluating information.	GA 1, 3, 5, 11
Communicating effectively using visual, mathematical and/or language skills.	GA 2, 6, 11
Using science and technology effectively and critically, showing responsibility toward the environment and health of others.	GA 2, 3, 4, 5, 7, 11
Demonstrating an understanding of the world as a set of related systems by recognising that problem context do not exist in isolation.	GA 1, 3, 11
Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual aware of: • reflecting on and exploring a variety of strategies to learn more effectively • participating as responsible citizens in the life of local, national and global communities • being culturally and aesthetically sensitive across a range of contexts • exploring education and career opportunities • developing entrepreneurial opportunities	 GA 9 GA 10 GA 7 GA 8 GA 3