ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Qualification Standard for Higher Certificate in Engineering: NQF Level 5			
Status: Approved by Council			
Document: E-07-PN	**Rev 3**	**26 November 2015**	

Background: The ECSA Education System Documents

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

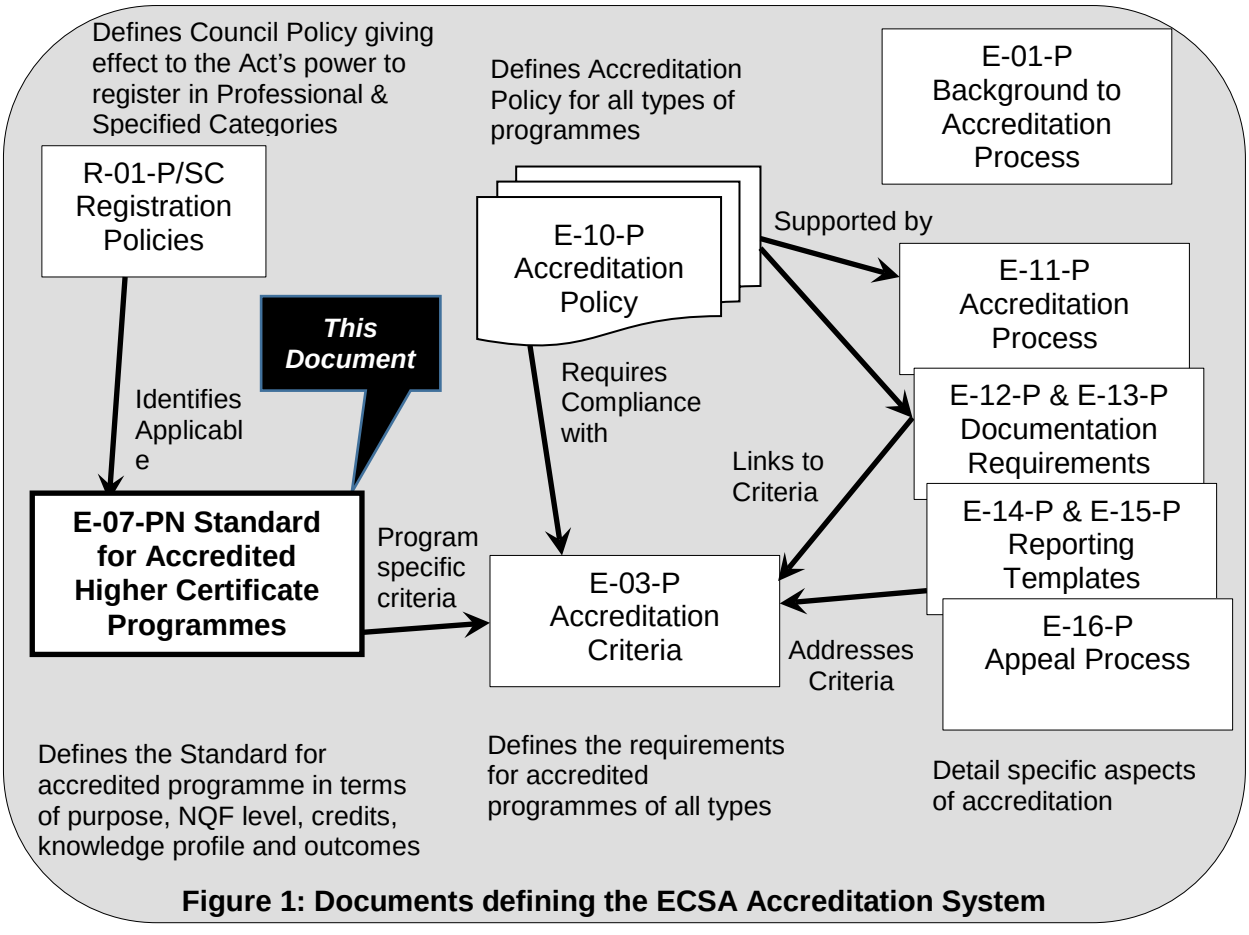

Figure 1: Documents defining the ECSA Accreditation System

Purpose

This document defines the standard for accredited Higher Certificate in Engineering-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 ECSA document E-03-P.

QUALIFICATION TYPE AND VARIANT

Higher Certificate In Engineering

GENERAL CHARACTERISITCS

This is an entry-level qualification. The qualification is primarily vocational, with strong industry-orientated focus. The qualification also serves to provide students with the basic introductory knowledge, cognitive and conceptual tools and practical techniques for higher educational studies in their chosen field of study. It emphasises selected general principles together with more specific procedures and their 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. The Higher Certificate may include a simulated work experience or work integrated learning (WIL) component.

(The Higher Education Qualifications Sub-Framework, CHE, 2013)

Preamble

The competence of a Registered Engineering Specified Category Practitioner at the level required for specific independent practice, that is, on qualifying for registration, is generally developed in two stages. First, a Higher Certificate meeting this standard provides the educational foundation enhanced by work-integrated learning. Second, competence must be further developed through training and experience, typically for four or more years. The educational foundation has an application-oriented theoretical basis of natural sciences and mathematics to underpin practically-oriented engineering science and engineering specialist knowledge. Conceptual knowledge is used in specific engineering applications and design. Work-integrated learning provides part of the required practical experience while training and experience after graduation develops contextual knowledge and the ability to solve problems in specific real-life situations using established methods.

As indicated in the qualification title definition, the qualification may be awarded as a result of programmes in several disciplines and cross disciplinary fields, including newly emerged fields. This standard specifies the generic knowledge profile and outcomes common to all programmes. Standards are not defined at the second qualifier level.

Note

Words and phrases having specific meaning are defined in Section 11 of this document or in Engineering Council of South Africa (ECSA) Document E-01-P. The method recommended for calculating credits is detailed in ECSA Document E-01-P available at www.ecsa.co.za**.**

1. HEQSF specification

HEQSF Qualification Type	Higher Certificate	
Variant	Vocationally – oriented	
NQF Exit Level	**Minimum Total Credits**	**Minimum Credits at Exit Level**
5	140	140

2. Qualification title

First Qualifier: Higher Certificate in Engineering

Second Qualifier: The second qualifier must indicate an engineering discipline or accepted practice area and normally contain the word *engineering.* The qualifier must be consistent with the engineering science content of the programme. Disciplinary qualifiers are currently Aeronautical, Agricultural, Chemical, Civil, Electrical, Industrial, Metallurgical, Mechanical, and Mining.

3. Purpose statement

The primary purpose of this vocationally-oriented higher certificate is to develop focused knowledge and skills as well as experience in a work-related context. The Higher Certificate equips graduates with the knowledge base, theory, skills and methodology of one or more engineering disciplines as a foundation for further training and experience towards becoming a competent engineering specified category practitioner. This foundation is achieved through a thorough grounding in mathematics and natural sciences specific to the field, engineering sciences, engineering design and the ability to apply specific established methods. Engineering knowledge is complemented by methods for understanding of the impacts of engineering solutions on people and the environment.

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

4. Normal duration of study

Programmes have normal durations of one year, excluding simulated work experience or work-integrated learning, with not less than 140 Credits.

5. 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 6, and
- the skills and applied competence defined in section 7.

6. Knowledge

Knowledge demonstrated by the graduate has the following characteristics:

6.1: At least the number of credits in the knowledge areas shown:

Knowledge area	Minimum Credits
Mathematical Sciences	14
Natural Sciences	7
Engineering Sciences	63
Design and Synthesis	14
Computing and Information Technology	14
Complementary studies	7

Note: These credits total 119. Credits in selected knowledge areas must be increased to satisfy the 140 minimum total credits.

6.2: The level of knowledge of mathematics, natural sciences and engineering sciences is characterized by:

- A coherent range of fundamental principles in mathematics and natural science underlying a discipline or recognised practice area.
- A coherent range of fundamental principles in engineering science and technology underlying an engineering discipline or recognised practice area.
- A codified practical knowledge in recognised practice area.
- 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.

6.3: A coherent progression of learning in mathematics, natural sciences and engineering fundamentals that provides a progression to the exit level.

6.4: Specialist knowledge of engineering methods at the exit-level in a sub-discipline or specialist field. Specialist study may take the form of compulsory or elective credits.

6.5: 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.

6.6: This standard does not specify detailed curriculum content. The engineering fundamentals and specialist engineering science content must be consistent with the second qualifier.

7. Skills and Applied Competence

The graduate is able to demonstrate competence in the graduate attributes 1 to 10. 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 having specific meaning are defined in this document or in the ECSA document E-01-P.

Note:

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.

Level Descriptor: *Specifically-defined engineering problems*:

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

and have one or more of the characteristics:

b. are fully defined but require feedback;
c. are discrete, specifically focussed tasks within engineering systems;
d. are routine, frequently encountered and in familiar specified context;

and have one or more of the characteristics:

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.

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: See section 6.2.

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

Graduate Attribute 5: Engineering methods, skills and tools, including Information Technology

Use 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 is in the following context:

1. Audiences are engineering peers, academic personnel and related engineering persons using appropriate formats;
2. Written reports range from short (minimum 300 words) to long (minimum 2 000 words) plus tables, diagrams and appendices;
3. Methods of providing information including the conventional methods of the discipline, for example engineering drawings and sketches.

Graduate Attribute 7: Sustainability and Impact of Engineering Activity

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

Range Statement: The combination of social and environmental factors must be appropriate to the discipline of the qualification. Evidence may include examples 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* and 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 specific and within the technical competence of the graduate.
2. Management principles include:
   - 2.1 Planning: set objectives and review achievement;
   - 2.2 Organising: identify and organize tasks. Recognize responsibilities.
   - 2.3 Leading: set example, communicate, motivate;
   - 2.4 Controlling: monitor own performance and check against standards.

Graduate Attribute 9: Independent Learning Ability
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 professional ethics, responsibilities and norms of engineering technical 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.

8. Contexts and conditions for assessment

Graduate Attributes defined in 7 above are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or an actual 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.

9. Award of the qualification

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

10. Progression

Completion of this 140-credit Higher Certificate meets the minimum entry requirement for admission to an Advanced Certificate designed to support articulation to satisfy an engineering technician education benchmark. This Higher Certificate provides the base for the graduate to enter training and experience toward specific independent practice as an engineering specified category practitioner and registration as a Registered Engineering Specified Category Practitioner.

11. Guidelines

11.1 Pathway
This qualification lies on a HEQSF Vocational Pathway.

11.2 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 (=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 (=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.

ANNEXURE A

NQF LEVEL DESCRIPTORS

The qualification is awarded at **level 5** on the National Qualifications Framework (NQF) and therefore meets the following level descriptors:

a. Scope of knowledge, in respect of which a learner is able to demonstrate an informed understanding of the core areas of one or more fields, disciplines or practices, and an informed understanding of the key terms, concepts, facts, principles, rules and theories of that field, discipline or practice

b. Knowledge literacy, in respect of which a learner is able to demonstrate an awareness of how knowledge or a knowledge system develops and evolves within the area of study or operation

c. Method and procedure, in respect of which a learner is able to demonstrate an ability to apply standard methods, procedures or techniques within the field, discipline or practice, and to plan and manage an implementation process within a well-defined familiar and supported environment

d. Problem solving, in respect of which a learner is able to demonstrate an ability to identify, evaluate and solve defined, routine and new problems within a familiar context, and to apply solutions based on relevant evidence and procedures or other forms of explanation appropriate to the field, discipline or practice demonstrating an understanding of the consequences

e. Ethics and professional practice, in respect of which a learner is able to demonstrate an ability to take account of, and in accordance with prescribed organisational and professional ethical codes of conduct, values and practices and to seek guidance on ethical and professional issues where necessary

f. Accessing, processing and managing information, in respect of which a learner is able to demonstrate an ability to gather information from a range of sources, including oral, written or symbolic texts, to select information appropriate to the task, and to apply basic processes of analysis, synthesis and evaluation to that information.

g. Producing and communicating information, in respect of which a learner is able to demonstrate an ability to communicate information reliably, accurately and coherently using conventions appropriate to the context, in written or oral or signed form or in practical demonstration, including an understanding of and respect for conventions around intellectual property, copyright and plagiarism, including the associated legal implications

h. Context and systems, in respect of which a learner is able to demonstrate an ability to operate in a range of familiar and new contexts, demonstrating an understanding of different kinds of systems, their constituent parts and the relationships between these parts, and to understand how actions in one area impact on other areas within the same system

i. Management of learning, in respect of which a learner is able to demonstrate an ability to evaluate his or her performance or the performance of others and to take appropriate action where necessary, and take responsibility for his or her learning within a structured learning process and to promote the learning of others

j. Accountability, in respect of which a learner is able to demonstrate an ability to account for his or her actions, to work effectively with and respect others, and in a defined context, to take supervisory responsibility for others and for the responsible use of resources where appropriate

ANNEXURE B: Exemplified Associated Competency Indicators

The competency indicators presented here are typifying, not prescriptive.

Graduate Attribute 1:

1.1 The problem is defined and the criterion for an acceptable solution is identified.
1.2 Relevant information and engineering knowledge and skills are identified for solving the problem.
1.3 Various approaches are considered and formulated that would lead to workable solutions.
1.4 Solutions are identified in terms of strengths and weaknesses for the overall solution.
1.5 Solutions are prioritised in order of suitability.
1.6 The preferred solution is formulated and presented in an appropriate form.

Graduate Attribute 2:

2.1 An appropriate mix of knowledge of mathematics, natural and engineering science at a fundamental level and in a specialised area is brought to bear on the solution of *specifically-defined* engineering problems.
2.2 Applicable principles and laws are applied.
2.3 Appropriate engineering materials, components or processes are selected.
2.4 Concepts and ideas are communicated effectively.
2.5 Reasoning about engineering materials, components, systems or processes is performed.
2.6 Work is performed within the boundaries of the practice area.

Graduate Attribute 3:

3.1 The design problem is formulated to satisfy user needs, applicable standards, codes of practice and legislation.
3.2 The design process is planned and managed to focus on important issues and recognises and deals with 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 are performed that include component testing to relevant premises, assumptions and constraints.
3.5 Alternatives are evaluated for implementation and a preferred solution is selected on an elementary, technical and cost basis.
3.6 The design logic and relevant information is communicated in a report
3.7 Occupational health and safety and environmentally related risks are identified and appropriate measures considered

Graduate Attribute 4:

4.1 Tests, experiments and measurements are conducted within an appropriate discipline.
4.2 Available literature is identified and selected for suitability to the task.
4.3 Equipment is used in accordance with original equipment manufacture's specifications.
4.4 Information is interpreted and derived from available data.
4.5 Conclusions are drawn from an evaluation of all available evidence.
4.6 The purpose, process and outcomes of the task are recorded in a report.
4.7 Occupational health and safety and environmentally related risks are identified and appropriate measures taken.

Graduate Attribute 5:

5.1 The appropriate method, skill or tool is selected and applied to achieve the required result.
5.2 Results produced by the method, skill or tool are verified against requirements.
5.3 Computer applications are selected and used as required.

Graduate Attribute 6:

6.1 The structure, style and language of written and oral communication are appropriate for the purpose of the communication and the target audience.
6.2 Graphics used are appropriate and effective in enhancing the meaning of 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 with the intended meaning being apparent.

Graduate Attribute 7:

7.1 The engineering activity is considered in terms of the impact on the public health and safety.
7.2 The engineering activity is considered in terms of the impact on the occupational health and safety.
7.3 The engineering activity is considered in terms of the impact on the natural environment.

Graduate Attribute 8:

8.1 The principles of planning, organising, leading and controlling are explained.
8.2 Individual work is carried out effectively and on time.
8.3 Individual contributions made to team activities support the output of the team as a whole.

Graduate Attribute 9:

9.1 Learning tasks are identified, planned and managed.
9.2 Independent learning is undertaken: knowledge acquired outside of formal instruction is comprehended and applied.
9.3 Awareness is displayed of the need to maintain continued competence through keeping abreast of up-to-date tools and techniques available in the workplace.

Graduate Attribute 10:

10.1 The ethical implications of the impact of engineering decisions are known and understood.
10.2 Responsibility is accepted for consequences stemming from own actions or failure to act.
10.3 Decision making is limited to area of current competence.

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 NQF level descriptors nor the HEQSF is 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.

Revision History

Version	Date	Revision Authorized by	Nature of revision
Rev 1	10 May 2012	Technology SGG Working Group	Reconfiguration of Council approved document to align with E-02-PE
Draft A	5 April 2015	SGG Working Document	New CHE format applied. E-07-PN Types A and B and E-07SC Rev 1 documents consolidated. “Assessment Criteria” replaced with “Competency Indicators”.
Draft B	19 April 2015	SGG Working Document	Cleaned up towards final format
Draft E	29 May 2015	SGG draft for submission to the ESGB	Logical improvements recommended by the SGG implemented. Consensus on the inclusion of Competency Indicators could not be reached
Draft D	29 July 2015	Amended and approved by the ESGB	Minor editing – final version for submission to parties involved, Council and CHE
Rev 2	26 November 2015	Approved by Council	
Rev 3	23 January 2016	Approved by ESGB – no deviation from Council approved version	Council approved version revised and CHE objection against the use of their logo and ECSA using the wrong procedure to register the standard addressed.
ECSA CONTROLLED COPY		**Executive: Policy Development and Standards Generation**	 John Cato **2016-08-17** Date