ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Qualification Standard for Higher Certificate in Engineering for Specified Categories: NQF Level 5			
Status: Approved By Council			
Document: E-07-SC	**Rev: 1**	**22 November 2013**	

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 categories are shown in Figure 1 which also locates the current document.

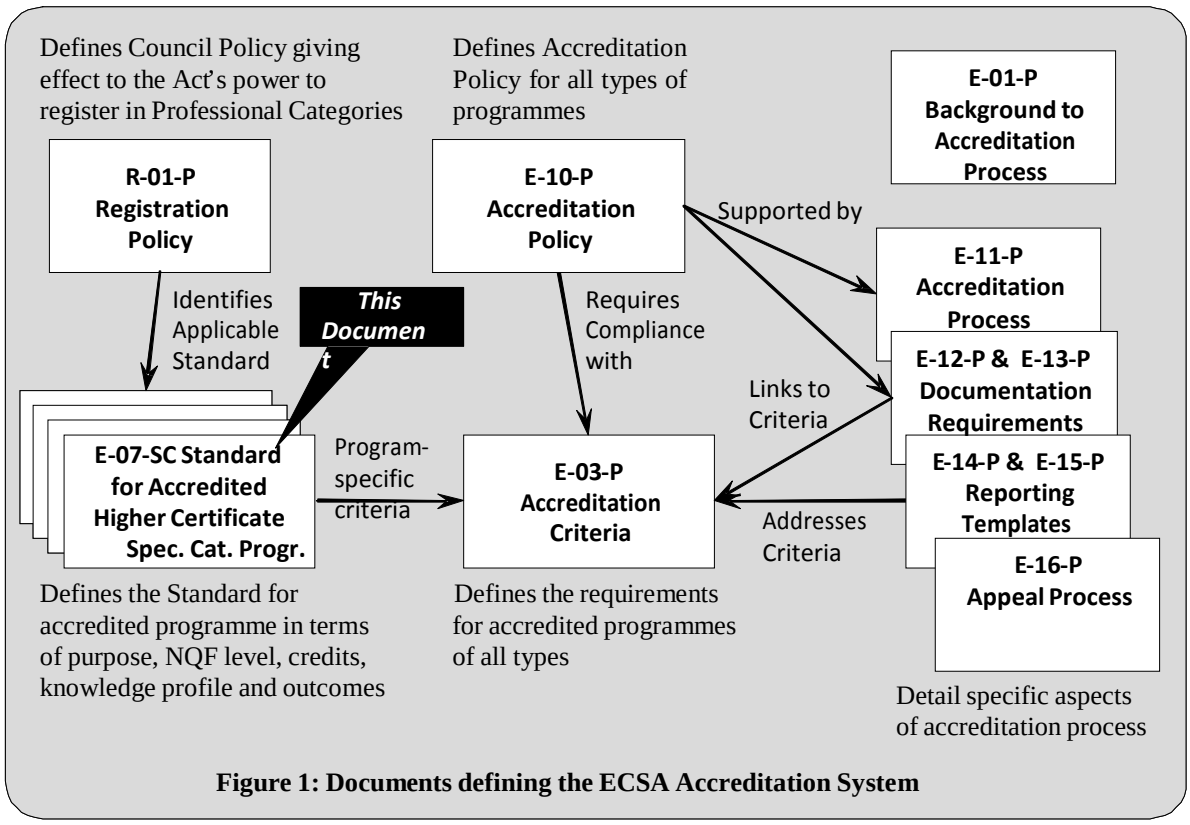

Figure 1: Documents defining the ECSA Accreditation System

1. Purpose

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 exit level outcomes. 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.
3. The qualifier(s) must:
    - clearly indicate the nature and purpose of the programme;
    - be consistent with the fundamental engineering science content on the programme;
4. 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.

Specifically the purpose of educational programmes designed to meet this qualification are to build the necessary knowledge, understanding, abilities and skills required for further learning towards becoming a competent practicing Engineering Technician. This qualification provides:

1. 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;
2. The educational base that may be required for registration in a Specified Category with ECSA. (refer to qualification rules).
3. Entry to programmes e.g. Advanced Certificate, Diploma or Bachelor Degree Programme

Engineering students completing this qualification will demonstrate competence in all the Exit Level Outcomes 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 toward 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	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 totalling not less than 50% of the total credits that provides 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 exit level outcomes 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: (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 Complementary Studies knowledge of type (b) must be sufficient and appropriate to support the student in satisfying Exit Level Outcomes 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 exit level outcomes 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. 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 and phrases having specific meaning are defined in this document or in the ECSA document E-01-P.

Notes:

1. For Critical Crossfield Outcomes linked to Exit Level Outcomes 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 is characterised by:
    a. can be solved mainly by specific practical engineering knowledge, underpinned by related theory;
    and one or both of:
    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 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 exit level outcomes may be demonstrated in a provider-based and / or simulated workplace context.

Exit Level Outcome 1: Problem solving

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

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 9: Independent Learning

Engage in independent and life-long learning.

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

Exit Level Outcome 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

Exit Level Outcome 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 exit level outcomes 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 exit level outcomes. 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.

Appendix A: Method of Calculation of 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:

1. 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.
2. Two weeks of full-time activity accounts for assessment in a semester.
3. 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 and Contact Time Multiplier

The credit for the course is: C = {W (L*TL *ML + T*TT *MT) + P*TP *MP + X*TX *MX + A*TA }/10

Where:

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
T = 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 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.

Appendix B: Consistency of Exit Level Outcomes with Critical Cross-field Outcomes (Normative)

SAQA Critical Cross-Field Outcomes	Equivalent Exit Level Outcome
Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.	ELO 1, 2, 3, 5, 11
Working effectively with others as a member of a team, group, organisation and community.	ELO 8, 11
Organising and managing oneself and one's activities responsibly and effectively	ELO 8, 11
Collecting, analysing, organising and critically evaluating information.	ELO 1, 3, 5, 11
Communicating effectively using visual, mathematical and/or language skills	ELO 2, 6, 11
Using science and technology effectively and critically, showing responsibility toward the environment and health of others	ELO 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	ELO 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	ELO 9 ELO 10 ELO 7 ELO 8 ELO 3

Appendix C: Exemplified Associated Assessment Criteria

The assessment criteria presented here are typifying, not normative.

Exit Level Outcome 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.

Exit Level Outcome 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 *narrowly-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.

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 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

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 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.

Exit Level Outcome 11:

Refer to ECSA website to access the applicable discipline specific criteria, e.g.

Lift Inspectors	SCDS 01
Lifting Machinery Inspectors	SCDS 02
Medical Equipment Maintainers	SCDS 03
Fire Protection System Inspectors	SCDS 04
Any future Specified Category prescribed by the Council	SCDS 0n

Revision History

Version	Date	Revision Authorized by	Nature of revision
Draft 1	15 July 2013	Technology SGG Working Group	Added LMI exit level outcomes to use as a discussion document.
Draft 2	22 July 2013	SGG Specified Category	Revise document to a generic model as recommended at the meeting of 19 July 2013
Draft 3	12 September 2013	SGG Specified Categories	Input from JIC and CRC incorporated. Approved by SGG Specified Categories.
Rev 1	22 November 2013	Council Approved	Input from JIC and CRC incorporated. Approved by SGG Specified Categories.

ECSA CONTROLLED COPY	**Executive: Policy Development and Standards Generation**	 John Cato **2016-08-17** Date