ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*		
Qualification Standard for **Advanced Certificate in Engineering Technology NQF Level 6**		
Status: Approved by Council.		
Document: E-21-PN	**Rev: Final Rev 1**	**27 March 2014**

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.

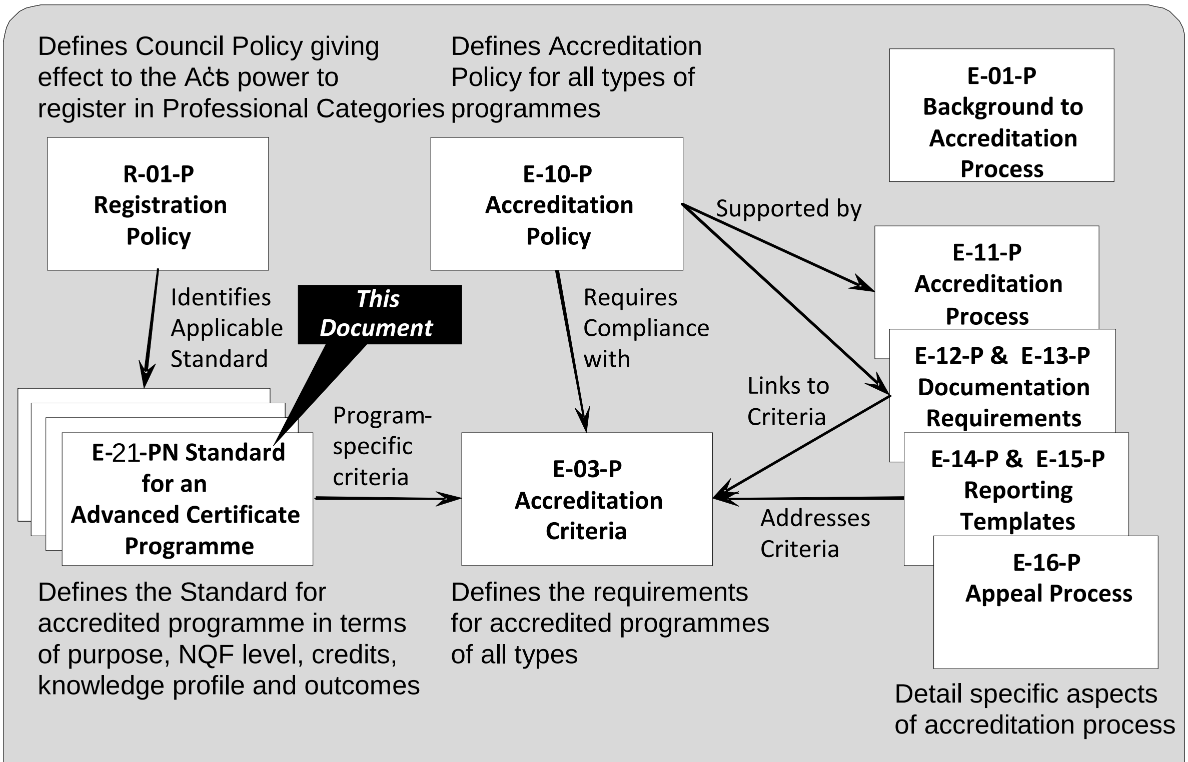

Figure 1: Documents defining the ECSA Accreditation System

1. Purpose

This document defines the standard for an accredited Advanced Certificate in Engineering Technology-type programmes 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. HEQSF and NQF Specification

Field: Manufacturing, Engineering and Technology
Sub-Field: Engineering and Related Design
NQF Level: Level 6
Credits: 140 credits total: Not less than 120 Credits shall be at NQF level 6
Acceptable titles: Advanced Certificate Engineering Technology

Abbreviation: Adv Cert (EngTech)
Qualifiers: See section 3

3. Qualifiers

The qualification must have a qualifier(s) defined in the provider's rules for the advanced certificate and reflected on the academic transcript and advanced 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; and

    be comparable with those typically used within the Dublin Accord Signatories
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. 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 designations but having only minor differences in content or undifferentiated purposes, only one programme should be accredited.

Examples of acceptable qualifiers in accordance with HEQSF policy are:

- Advanced Certificate in Engineering Technology , abbreviated Adv Cert (Eng Tech)

In case of a second Qualifier:

- Advanced Certificate in Engineering Technology in Civil Engineering, abbreviated, Adv Cert (Eng Tech) (Civil Engineering)

4. Purpose of the Qualification

This qualification is primarily vocational, or industry oriented. The knowledge emphasises general principles and application or technology transfer. The qualification provides students with a sound knowledge base in a particular field or discipline and the ability to apply their knowledge and skills to particular career or professional contexts, while equipping them to undertake more specialised and intensive learning. Programmes leading to this qualification tend to have a strong vocational, professional or career focus and holders of this qualification are normally prepared to enter a specific niche in the labour market.

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 Professional Engineering Technician. This qualification provides:

1. Preparation for careers in engineering and areas that potentially benefit from more advanced engineering skills, for achieving technical proficiency and to make a contribution to the economy and national development;
2. The educational base together with a Diploma in Engineering Technology or an Advanced Certificate in Engineering required for admission to the Advanced Diploma.

Engineering students completing this qualification will demonstrate competence in all the Exit Level Outcomes contained in this standard.

5. Rationale

Professional Engineering Technicians are characterized by the ability to apply proven, commonly understood techniques procedures, practices and codes to solve *well-defined* engineering problems. They manage and supervise engineering operations, construction and activities. They work independently and responsibly within an allocated area or under guidance.

Professional Engineering Technicians must therefore have a working understanding of engineering sciences underlying the techniques used, together with financial, commercial, legal, social and economic, health, safety and environmental methodologies, procedures and best practices.

The process of further professional development of a Candidate or Professional Engineering Technician starts with the attainment of a qualification that meets this standard. After graduation a programme of training and experience is completed to attain the competencies for registration in the category Professional Engineering Technician.

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 6, including integrated projects of no less than 70 credits. 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	
Total	140
Mathematical Sciences	7
Natural Sciences	7
Engineering Sciences	35
Engineering Design & Synthesis	35
Sustainability / Restoration	7
Complementary Studies	7
Available for re-allocation in above areas	42

Credits available for reallocation must be assigned to the knowledge areas to form a coherent, balanced programme.

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

6.2 Core and Specialist Requirements

The programme shall have a coherent core of integrated project work totalling not less than 50% of the total credits that provides a viable platform for lifelong learning. The coherent core must enable development in a traditional discipline or in an emerging field. The coherent core integrates 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

The programme is premised on work-integrated learning principles. WIL may take various forms including simulated learning, work-directed theoretical learning, problem-based learning, project-based learning and workplace-based 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 an Advanced Certificate in Engineering or the Diploma in Engineering Technology in the appropriate field.

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 Cross-field 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: *Well-Defined engineering problems* applicable to this Qualification Standard is characterised by:
    a. Can be solved mainly by practical engineering knowledge, underpinned by related theory;
    and one or more of the characteristics:

b. are largely defined but may require clarification;
c. are discrete, focussed tasks within engineering systems;
d. are routine, frequently encountered, may be unfamiliar but in familiar context;

and one or more of the characteristics:

e. can be solved in standardized or prescribed ways;
f. are encompassed by standards, codes and documented procedures; requires authorization to work outside limits;
g. information is concrete and largely complete, but requires checking and possible supplementation;
h. involve several issues but few of these imposing conflicting constraints and a limited 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 or workplace context.

Exit Level Outcome 1: Problem Solving

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

Exit Level Outcome 3: Engineering Design

Perform procedural design of *well-defined* components, systems, works, products 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 *well-defined* engineering problems:

1. A routine integrated design project should be used to provide evidence of compliance with this outcome.
2. The problem would be typical of that which the graduate would participate in a typical employment situation shortly after graduation.
3. The selection of components, systems, engineering works, products or processes to be designed is dependent on the sub-discipline.
4. An integrated design project should include one or more of the following impacts: sustainability and restoration, social, economic, legal, health, safety, and environmental.

Exit Level Outcome 4: Investigation

Conduct investigations of *well-defined* problems through locating and searching relevant codes and catalogues, conducting standard tests, experiments and measurements.

***Range Statement*:** The balance of investigation should be appropriate to the discipline. An investigation 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.

Exit Level Outcome 5: Engineering methods, skills, tools, including Information technology

Use appropriate techniques, resources, and modern engineering tools including information technology for the solution of *well-defined* engineering problems, with an awareness of the limitations, restrictions, premises, assumptions and constraints.

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

1. Sub-discipline-specific tools processes or procedures;
2. Computer packages for computation, simulation, 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 sustainable development, 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 is in a simulated professional 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 (a minimum of 2 000 words excluding tables, diagrams and appendices), covering material at the exit level.
3. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, physical models, bills of quantities as well as subject-specific methods.

Exit Level Outcome 7: Impact of Engineering Activity

Demonstrate knowledge and understanding of the impact of engineering activity on the society, economy, workplace and physical environment, and address issues by defined procedures.

***Range Statement*:** The combination of social, workplace, physical environmental and sustainability factors must be appropriate to the sub-discipline of the qualification. Evidence may include case studies typical of the technical practice 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.
2. Involve a limited range of stakeholders with differing needs.
3. Have consequences that are locally important and are not far reaching.
4. Are *well-defined* and discrete and part of an engineering system.
5. Consideration be given to sustainability of resources utilised in engineering projects.

Exit Level Outcome 8: Individual and Teamwork

Demonstrate knowledge and understanding of engineering management principles and apply these to one’s own work, as a member and leader in a technical team and to manage projects.

***Range Statement*:**

1. The ability to manage a project should be demonstrated in the form of the project indicated in ELO 3 or ELO 4.

2. Tasks are discipline specific and within the technical competence of the graduate.
3. Projects could include: laboratories, business plans, design etc
4. Management principles include:
    - Planning: set objectives, select strategies, implement strategies and review achievement.
    - Organising: set operational model, identify and assign tasks, identify inputs, delegate responsibility and authority.
    - Leading: give directions, set example, communicate, motivate.
    - Controlling: monitor performance, check against standards, identify variations and take remedial action.

Exit Level Outcome 9: Independent Learning

Engage in independent and life-long learning through well-developed learning skills.

***Range Statement*:** The learning context is well-structured with some unfamiliar elements.

Exit Level Outcome 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.

Exit level Outcome 11: Workplace Practices as part of an Integrated Project

Demonstrate an understanding of workplace practices to solve engineering problems consistent with academic learning achieved.

Note: The purpose of work-integrated learning is to enable the learner to connect academic learning with workplace practice.

Range Statement: Tasks to demonstrate this outcome may be performed in one or more of the following curriculum types:

1. Work-directed theoretical learning: in which theoretical forms of knowledge are introduced and sequences in ways that meet both academic criteria and are applicable and relevant to the career-specific components.
2. Problem-based learning: where students work in small self-directed groups to define, carry out and reflect on a task which is usually a real-life problem.
3. Project-based learning: that brings together intellectual enquiry, real world problems and student engagement in meaningful work.
4. Workplace learning: where students are placed in a professional practice or simulated environment within a training programme.
5. Simulated learning.

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). International comparability of this component of a suite of engineering technician education qualifications 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 **Articulation Possibilities**

Completion of the Advanced Certificate meets the minimum entry requirement into a cognate Advanced Diploma programme. Accumulated credits may also be presented for admission into other science and engineering education programmes. A qualification may not be awarded for early exit from an Advanced Certificate programme.

13. 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
Working effectively with others as a member of a team, group, organisation and community.	ELO 8
Organising and managing oneself and one's activities responsibly and effectively	ELO 8
Collecting, analysing, organising and critically evaluating information.	ELO 1, 3, 5
Communicating effectively using visual, mathematical and/or language skills	ELO 2, 6
Using science and technology effectively and critically, showing responsibility toward the environment and health of others	ELO 2, 3, 4, 5, 7
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
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	ELO 9
• participating as responsible citizens in the life of local, national and global communities	ELO 10
• being culturally and aesthetically sensitive across a range of contexts	ELO 7
• exploring education and career opportunities	ELO 8
• developing entrepreneurial opportunities	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 analysed and defined and criteria are identified for an acceptable solution.
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 modelled and analysed.
1.5 Solutions are evaluated and the best solution is selected.
1.6 The solution is formulated and presented in an appropriate form.

Exit Level Outcome 2:

2.1 An appropriate mix of knowledge of mathematics, statistics, natural science and engineering science knowledge at a fundamental level is brought to bear on the solution of *well-defined* engineering problems.
2.2 Applicable principles and laws are used.
2.3 Engineering materials, components, systems or processes are analysed.
2.4 Concepts and ideas are presented in a logical and methodical manner.
2.5 Reasoning about engineering materials, components, systems or processes is performed.
2.6 Procedures for dealing with uncertain/ undefined/ill-defined variables are outlined and justified.
2.7 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 analysis and optimisation of the product, or system or process, subject to relevant premises, assumptions and constraints.
3.5 Alternatives are evaluated for implementation and a preferred solution is selected based on techno-economic analysis and judgement.
3.6 The design logic and relevant information is communicated in a technical report.
3.7 Procedures are applied to evaluate the selected design and assessed in terms of the impact and benefits including sustainable development.

Exit Level Outcome 4:

4.1 The scope of the investigation is defined.
4.2 Investigations are planned and conducted within an appropriate discipline.
4.3 Available literature is searched and material is evaluated for suitability to the investigation.
4.4 Relevant equipment or software is selected and appropriately used for the investigation.
4.5 Data obtained is analysed and interpreted.
4.6 Conclusions are drawn from an analysis of all available evidence.
4.7 The purpose, process and outcomes of the investigation are recorded in a technical report.

Exit Level Outcome 5:

5.1 The method, skill or tool is assessed for applicability and limitations against the required result.
5.2 The method, skill or tool is applied correctly.
5.3 Results produced by the method, skill or tool are tested and assessed.
5.4 Relevant computer applications are selected and used.

Exit Level Outcome 6:

6.1 The structure, style and language of written and oral communication is appropriate for the purpose of the communication and the target audience.

6.2 Graphics used are 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 impact of technology is demonstrated in terms of the benefits and limitations to society.

7.2 The engineering activity is analysed in terms of the impact on occupational and public health and safety.

7.3 The engineering activity is analysed in terms of the impact on the physical environment including sustainable considerations.

7.4 The methods to minimise/mitigate impacts outlined in 7.2 and 7.3 are considered.

Exit Level Outcome 8:

8.1 The principles of planning, organising, leading and controlling are demonstrated.

8.2 Work is carried out strategically, effectively and on time.

8.3 Individual contributions made to team activities support the output of the team as a whole.

8.4 Functioning as a team leader is demonstrated.

8.5 A project is organised and managed.

8.6 Effective communication is carried out in the context of individual and team work.

Exit Level Outcome 9:

9.1 Learning tasks are identified, planned and managed.

9.2 The requirement for independent learning is identified/ recognised and demonstrated.

9.3 Relevant information is sourced, organised and evaluated.

9.4 Knowledge acquired outside of formal instruction is comprehended and applied.

9.5 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 nature and complexity of ethical dilemmas is described in terms of required practices, legislation and limitations of authority.

10.2 The ethical implications of engineering decisions are described in terms of the impact on environment including sustainable development, the business, costs and trustworthiness.

10.3 Judgements in decision making during problem solving and design are ethical and within acceptable boundaries of current competence.

10.4 Responsibility is accepted for consequences stemming from own actions or inaction.

10.5 Decision making is limited to area of current competence.

Exit level Outcome 11:

11.1 Orientation to the working environment is described in terms of company structure and conventions, rules, policies, working hours, dress codes and reporting lines.

11.2 Labour practices used in the workplace are described in accordance with relevant legislation.

11.3 Workplace safety is described in terms of the application of relevant safety, health and environmental legislation.

11.4 General administration procedures are described in terms of how they operate and the key purpose.

11.5 Work activities are conducted in a manner suited to the work context.

Range: Work activities include assisting, contributing, observing and applying at least four of the specific practices below:

- Engineering processes, skills and tools, including measurement.
- Investigations, experiments and data analysis.
- Problem solving techniques.
- Application of scientific and engineering knowledge;
- Engineering planning and design;
- Professional and technical communication;
- Individual and teamwork; or
- The impact of engineering activity on health, safety and the environment.

11.6 Knowledge and understanding gained from the work-integrated learning period is reported in a prescribed format, using appropriate language and style.

Revision History

Version	Date	Revision Authorized by	Nature of revision
Rev1	10 May 2012	Technology SGG Working Group	Reconfiguration of document approved by Council to align with E-02-PE