ECSA

ENGINEERING COUNCIL OF SOUTH AFRICA

An Effective Regulator Assuring Engineering Excellence

Discipline-specific Training Guide for Registration as a Professional Engineer, Technologist, and Technician in Electrical l Engineering

R-05-ELE-PE/PT/PN

REVISION 0: 08 February 2024

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

TABLE OF CONTENTS

INTRODUCTION **6**

DEFINITIONS **7**

ABBREVIATIONS **9**

BACKGROUND **11**

1. PURPOSE OF THIS DOCUMENT **12**

2. AUDIENCE **12**

2.1 Persons registered with ECSA as a candidate 13

2.2 Persons not registered with ECSA as a candidate 14

3. TYPE OF ENGINEERING WORK **14**

4. DEVELOPING ENGINEERING COMPETENCIES **16**

4.1 Training for registration as a Professional Engineer 16

4.1.1 Outcome 1: Define, investigate and analyse complex engineering problems (Responsibility Level E) 16

4.1.2 Outcome 2: Design or develop solutions to complex engineering problems (Responsibility Levels C and D) 17

4.1.3 Outcome 3: Comprehend and apply advanced and local knowledge of the widely applied principles underpinning good practice that is specific to the jurisdiction in which the Engineer practices. (Responsibility Level E) 17

4.1.4 Outcome 4: Manage part or all of one or more complex engineering activities (Responsibility Level D) 18

4.1.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C) 19

4.1.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural, and environmental effects of complex engineering activities seeking to achieve sustainability. (Responsibility Level B) 19

4.1.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all complex engineering activities. (Responsibility Level E) 20

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.1.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E) ..20

4.1.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of complex engineering activities. (Responsibility Level E) 21

4.1.10 Outcome 10: Be responsible for making decisions on part or all of complex engineering activities. (Responsibility Level E) 21

4.1.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work (Responsibility Level D) ... 21

4.2 Training for registration as a professional engineering technologist 22

4.2.1 Outcome 1: Define, investigate and analyse broadly defined engineering problems (Responsibility Level E) 22

4.2.2 Outcome 2: Design or develop solutions to broadly defined engineering problems (Responsibility Levels C and D) 23

4.2.3 Outcome 3: Comprehend and apply knowledge that is embodied in established engineering practices that is specific to the jurisdiction in which the Engineering Technician practices. (Responsibility Level E) 24

4.2.4 Outcome 4: Manage part or all of one or more broadly defined engineering activities (Responsibility Level D) 24

4.2.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C) 25

4.2.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural, and environmental effects of broadly defined engineering activities seeking to achieve sustainability (Responsibility Level B) 25

4.2.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all broadly defined engineering activities (Responsibility Level E) 26

4.2.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E) ..27

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.2.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of broadly defined engineering activities. (Responsibility Level E) 27

4.2.10 Outcome 10: Be responsible for making decisions on part or all of broadly defined engineering activities. (Responsibility Level E) 28

4.2.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work. (Responsibility Level D) .. 29

4.3 Training for registration as a Professional Engineering Technician 30

4.3.1 Outcome 1: Define, investigate and analyse well-defined engineering problems (Responsibility Level E) 30

4.3.2 Outcome 2: Design or develop solutions to well-defined engineering problems (Responsibility Levels C and D) 30

4.3.3 Outcome 3: Comprehend and apply knowledge that is embodied in established engineering practices that is specific to the jurisdiction in which the engineering technician practises. (Responsibility Level E) 31

4.3.4 Outcome 4: Manage part or all of one or more well-defined engineering activities. (Responsibility Level D) 32

4.3.5 Outcome 5: Communicate clearly using multiple mediums and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C) 33

4.3.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural and environmental effects of well-defined engineering activities seeking to achieve sustainability. (Responsibility Level B) 33

4.3.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all well-defined engineering activities. (Responsibility Level E) 34

4.3.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E) .. 35

4.3.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of well-defined engineering activities. (Responsibility Level E) 36

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.3.10 Outcome 10: Be responsible for making decisions on part or all of well-defined engineering activities. (Responsibility Level E) 36

4.3.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work. (Responsibility Level D) .. 37

5. FUNCTIONS PERFORMED 37

5.1 Degrees of responsibility 37

5.2 Candidates training programme 40

6. CONCLUSION 41

REVISION HISTORY 43

APPENDIX A: TRAINING ELEMENTS 45

APPENDIX B: TRAINING ELEMENTS 60

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

INTRODUCTION

All persons applying for registration as a Professional Engineer, Technologist and Technicians are expected to demonstrate the competencies specified in document **R-02-STA-PE/PT/PN** through work performed at the prescribed level of responsibility, irrespective of the candidate's discipline.

Training and Mentoring Guide for Professional Categories (document **R-04-T&M-GUIDE-PC**) provides key aspects of training, which are:

- duration of training and length of time working at level required for registration
- principles of planning, training and experience
- progression of training programme
- documenting training and experience
- demonstrating responsibility.

It is therefore important to standardise the framework for all engineering disciplines to ensure that all ECSA registration categories are aligned.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

DEFINITIONS

Applicant: A person applying to the ECSA for registration in any of the category as per section 18 of the Engineering Professions Act 46 of 2000.

Broadly defined engineering problems: Composed of many inter-related conditions and requiring underpinning methods, procedures, and technical judgement to create a solution within a set of originally broadly defined circumstances

Commitment and Undertaking: An agreement entered into between an employer and ECSA under which the employer commits to the training of candidates to the standard required for registration in an identified Professional Category. A C&U may be entered into for one or more of the Professional Categories.

Competency Assessment: A summative assessment of an applicant's competence against the prescribed standard based on evidence from the applicant's work and other assessments that include a Professional Review.

Competency Standard: Statement of competency required for a defined purpose.

Engineering problem: A problematic situation that is amenable to analysis and solution using engineering sciences and methods.

Engineering science: A body of knowledge based on the natural sciences that uses mathematical formulation where necessary, which extends knowledge and develops models and methods to support its application, to solve problems and provide the knowledge base for engineering specialisations.

Ill-posed problem: Problems for which the requirements are not fully defined or may be defined erroneously by the requesting party.

Integrated performance: An overall satisfactory outcome of an activity requires several outcomes to be satisfactorily attained. For example, a design requires analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.

Level descriptor: A measure of performance demands at which outcomes must be demonstrated.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Mentor: A professionally registered person who guides the competency development of a candidate in an appropriate category.

Outcome: A statement of the performance that a person must demonstrate to be judged competent at the professional level.

Practice area: A generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner by virtue of the path of education, training and experience followed.

Range statement: The required extent of or limitations on expected performance stated in terms of situations and circumstances in which outcomes are to be demonstrated.

Supervisor: A person who oversees and controls engineering work performed by a candidate.

Well-defined engineering problems: Problems composed of inter-related conditions and requiring underpinning methods, procedures, and techniques to create a solution within a set of originally well-defined circumstances.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

ABBREVIATIONS

BEng	Bachelor of Engineering
BSc Eng	Bachelor of Science in Engineering
BTech (Eng)	Bachelor of Technology in Engineering
B Eng (Tech)	Bachelor of Engineering in Technology
DSTG	Discipline-specific Training Guide
CPD	Continuing Professional Development
C&U	Commitment and Undertaking
ICASA	Independent Communications Authority of South Africa
IEA	International Engineering Alliance
ECSA	Engineering Council of South Africa
ICT	Information Computer Technology
JBCC	Joint Building Contract Committee
MEng	Master of Engineering
NDip	National Diploma
NEC	New Engineering Contract
NRS	National Rationalised Specifications
PE	Professional Engineer
PGDip	Postgraduate Diploma
PN	Professional Engineering Technician
PT	Professional Engineering Technologist
SABS	South African Bureau of Standards
SANS	South African National Standard

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

TERs	Training and Experience Reports
TES	Training and Experience Summary
VA	Voluntary Associations
VIP	Value Improved Practices

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

BACKGROUND

The illustration below defines the documents that comprise the Engineering Council of South Africa (ECSA) system for registration in professional categories. The illustration also locates the current document.

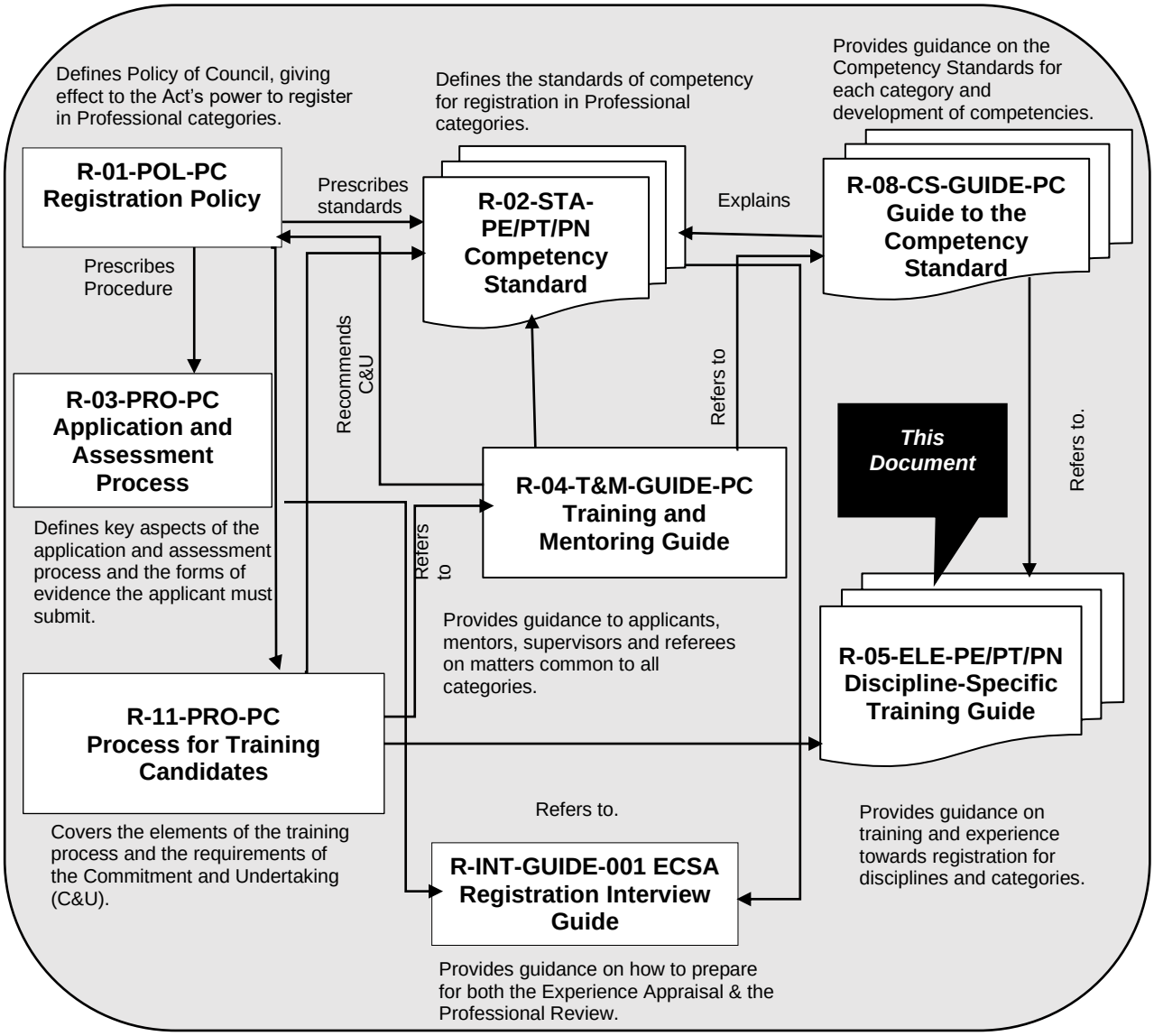

Figure 1: Documents defining the ECSA registration system

1. PURPOSE OF THIS DOCUMENT

This document provides a discipline-specific training guideline, outcome-by-outcome, for candidate Electrical Engineers, Technologists and Technicians or any other person who intends to register as a Professional with ECSA in the respective discipline.

This document must be read in conjunction with the following:

- *Policy on Registration in Professional Categories* (document **R-01-POL-PC**)
- *Processing of Applications for Registration of Candidates and Professionals* (document **R-03-PRO-PC**).
- *Training and Mentoring Guide for Professional Categories* (document **R-04-TM-GUIDE-PC**)

2. AUDIENCE

The Discipline-specific Training Guide (DSTG) is directed towards applicants, including their supervisors and mentors in the discipline of Electrical Engineering, which comprises Electrical Power Engineering, Electronic Engineering, Telecommunications Engineering and Alternative Energy Engineering, such as Renewables and Energy Efficiency.

These specialist areas are further defined as:

- **Electrical Power Engineering** encompasses electrical systems, components, motors and equipment, as well as electrical engineering materials, products and processes.
- **Electronic Engineering** covers electronic systems and electronic engineering materials, products and processes.
- **Telecommunications Engineering** encompasses the design, construction and management of systems that carry out the transmission, processing and storage of information as electrical or optical signals and the control services based on this capability.
- **Alternative Energy Engineering** encompasses the design, construction and management of systems that carry out the generation, transmission and processing of alternative sources of electrical energy, such as renewables as well as management thereof.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

The guide is intended to support the applicants training programme in gaining experience through incorporating elements of good practice also indicated in the **R-02-COP-ELE**: Code of Practice for the Performance of Electrical Engineering Work.

The guide applies to persons who:

(a) have registered with ECSA as a Candidate Engineer, Technologist or Technician

(b) hold an ECSA accredited qualification or acceptable combination of accredited qualifications prescribed for the category

(c) through ECSA educational qualification evaluation or assessment, have met the minimum educational in a specific category

(d) have qualifications recognised by the Washington, Sidney and Dublin Accords where ECSA is a signatory thereof

(e) hold a qualification or combination of qualifications recognised under an international academic agreement relevant to the category; or

(f) hold a qualification or combination of qualifications that have been determined on a case-by-case evaluation to satisfy criteria for substantial equivalence to an accredited qualification for the category by virtue of:

- the qualifications being awarded in a jurisdiction, or a quality assurance system by ECSA; or
- examination of detailed documentation on the qualifications reflecting substantial equivalence.

2.1 Persons registered with ECSA as a candidate

Candidate engineering practitioner refers to persons registered with ECSA after completing the relevant engineering undergraduate programme accredited or substantially assessed to be equivalent by ECSA. The training and development can be done under a Commitment & Undertaking (C&U) candidacy programme as per document **R-11-PRO-PC** or through the training academies programme as outlined in document **A-01-POL**.

The training under C&U or training academies is structured to align with the ECSA standard competency outcomes for the benefit of the candidate. The professional mentor, supervisors,

coach and the candidate must ensure that the training covers all developmental aspects aligned with the competency outcomes required for registration as a professional.

2.2 Persons not registered with ECSA as a candidate

Regardless of the training development path followed by any individual, all persons wishing to register with ECSA must present the same evidence of having met the ECSA-prescribed competency standard when assessed. Application for registration as a professional in a specific category is accepted without being registered as a candidate Engineer, Technologist or Technician, or without training through a C&U candidacy programme or through training academies. However, mentorship and adequate supervision are critical in ensuring effective development towards achieving the competencies required for professional registration.

If the trainee's employer does not offer C&U, the trainee must establish the level of mentorship and supervision the employer is able to provide and in the absence of an internal mentor, the services of an external mentor should be secured. The discipline specific Voluntary Association (VA) recognised by ECSA may be consulted to assist the trainee with an external mentor. A mentor must be familiar with of all expected stages of the training development process as well as ECSA's registration requirements.

It should be noted that the DSTG is intended to assist graduates who are still gaining work experience and knowledge towards professional registration. Experienced persons wishing to register as a professional may apply this guide retrospectively to identify possible gaps in their respective training and development.

Document **R-08-CS-GUIDE-PE/PT/PN** adequately describes what is expected of individuals whose formative developments have not followed conventional paths, for example, academics, researchers and specialists.

3. TYPE OF ENGINEERING WORK

Electrical engineering practitioners perform functions like investigating plant failures, planning, design and construction of plant, operation and maintenance of plant and materials, urban and rural development reticulation, commissioning of electrical networks and plants, as well as electrical reticulation of buildings. The field of Electrical Engineering also encompasses electronic

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

devices, apparatus and instrumentation and control of processes for industrial systems together with biomedical devices, robotics and consumer products. New technologies in Electrical Engineering have introduced new categories as follows:

- Big Data Engineering Practitioner
- Biometrics Engineering Practitioner
- Solution Architect Engineering Practitioner
- Internet of Things Engineering Practitioner
- Energy Efficiency Engineering Practitioner
- Renewables Engineering Practitioner
- Intelligent Transport Driving Engineering Practitioner
- Autonomous Driving Engineering Practitioner
- 3D Printing Engineering Practitioner
- Cyber Security and Physical Systems Engineering Practitioner.

Electrical engineering practitioners must have a strong understanding of mathematics, physics and data science, as well as excellent problem-solving skills and attention to detail. They work in a variety of industries, including telecommunications, power generation and distribution, electronics, building services and manufacturing, among others. The education, training and experience will determine the category in which a candidate can register and what type of engineering problems they can solve. These practitioners can register in one of the categories within the electrical engineering discipline.

- Professional Engineer – solves complex engineering problems and performs complex engineering activities.
- Professional Engineering Technologist – solves broadly defined engineering problems and performs broadly defined engineering activities.
- Professional Engineering Technician – solves well-defined engineering problems and performs well-defined engineering activities.

The characteristics and details of each level descriptor can be found in the competency standard for registration **R-02-STA-PE/PT/PN** that defines the competencies required for each category.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4. DEVELOPING ENGINEERING COMPETENCIES

4.1 Training for registration as a Professional Engineer

4.1.1 Outcome 1: Define, investigate and analyse complex engineering problems (Responsibility Level E)

As per the ECSA outcomes, engineers are expected to be able to define, investigate and analyse complex engineering problems by identifying systems and sub-systems in resolving complex problems, using data and information technologies where applicable. The complex engineering problem may be defined as a design requirement, an applied research and development requirement or a problematic situation in an existing component, system or process. The investigation and analysis require in-depth fundamental and specialised engineering knowledge, including the collection, organising and evaluation of the information from all applicable sources, including investigation where appropriate. The work typically includes the research, planning, design, manufacturing, commissioning and installation of electronic, electrical and telecommunications complex systems and electrical equipment.

As an example, engineers could conduct research and advise on the design and direct the construction and the operation of electrical systems and components. They would advise on and direct the functioning, maintenance and repair of equipment and study, and advise on technological aspects of electrical engineering materials, products and processes.

The typical tasks may include:

- conducting research and developing new or improved theories and methods relating to the area of speciality
- advising on and designing electronic components or power stations and systems that generate, transmit and distribute electricity
- specifying the instrumentation, measurement and control of equipment for monitoring and control of systems
- supervising, controlling, developing and monitoring the operation and maintenance of electrical systems

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- advising on and designing systems for electrical motors, electrical traction and other equipment such as electrical domestic appliances
- specifying electrical installation and application in industrial structures and other buildings and objects
- establishing control standards and procedures to monitor performance and safety of electrical generating and distribution systems, motors and equipment
- determining manufacturing methods for electrical systems and maintaining and repairing existing electrical systems, motors and equipment
- designing electronic circuits and components for use in fields such as aerospace, guidance and propulsion control, acoustics or instruments and controls
- researching and advising on radar, telemetry and remote-control systems, microwaves and other electronic equipment
- designing and developing signal processing algorithms and implementing these through appropriate choice of hardware and software
- controlling robotics and processes of manufacturing plants
- increasing energy efficiency and management of systems.

4.1.2 Outcome 2: Design or develop solutions to complex engineering problems (Responsibility Levels C and D)

The engineering design of the solution to a complex engineering problem includes having a detailed requirements specification that aligns with the design required and having potential solutions or methods to be used to approach and resolve the complex problem. The preferred option or way forward is influenced by factors that best fit the solution, taking into consideration cost, practicability, innovation and impact, if any, outside the requirements.

4.1.3 Outcome 3: Comprehend and apply advanced and local knowledge of the widely applied principles underpinning good practice that is specific to the jurisdiction in which the Engineer practices. (Responsibility Level E)

Applicant engineers should be able to provide evidence that they comprehend and have mastered the engineering principles and technologies for their practice areas and that they apply first-principle analytical thinking in demonstrating this competency for the associated complex

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

programme. This includes the application of fundamental principles, practices, sounds testable assumptions or previously encountered techniques the candidate has used to solve the problem.

The theoretical knowledge gained from completing an BEng/BSc degrees should also be applied, as well as knowledge of applicable engineering standards, codes of practice, legislation and regulations.

4.1.4 Outcome 4: Manage part or all of one or more complex engineering activities (Responsibility Level D)

The area in which Electrical Engineers work generally follows the conventional stages of the life cycle of the project or product as follows:

- Research and development of new products or systems, advancement of solutions to system problems or system obsolescence.
- System or product design to establish a new system or product, solve system or product problems, achieve a particular desired result or select equipment for a particular purpose.
- Operation, maintenance and support of the system, network or product.
- Project Engineering to install, test and commission the necessary equipment or system to achieve the desired result.
- Decommissioning the system or network.

A schema, presented in **APPENDIX B: TRAINING ELEMENTS**

, indicates the functions in which a candidate should be competent when carrying out the various phases of a project. The functions include:

- solving problems based on engineering and contextual knowledge
- implementing and operating engineering projects, systems, products and processes
- mitigating risk and impact
- managing engineering activities.

These functions are aligned to the overall competency of the outcomes expected from the applicants. In addition, applicants must state the requirement of the project in terms of delivery,

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

refer to the initial production requirements for the project and state whether they obtained results and if not, why they were unsuccessful.

4.1.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C)

Other than technical skills, engineers are expected to work on their communication skills to communicate clearly with others in the course of their engineering activities. This entails clearly demonstrating the ability to write clear, concise, effective, technically, legally and editorially correct reports using a structure and style that meets communication objectives and user/audience requirements.

Applicants are also expected to issue clear instructions to subordinates using appropriate language and communication aids, ensuring that language and other communication barriers are overcome. They are also required to make oral presentations using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.

4.1.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural, and environmental effects of complex engineering activities seeking to achieve sustainability. (Responsibility Level B)

Risk and impact mitigation must include the probability and impact of all the risks connected with the project. The focus areas of the project must be indicated on a risk matrix. Mitigation must include the time of mitigation and the person responsible. Solutions should include a Plan A and a Plan B. The risk document must be a live document through the life cycle of a project and must include:

- technical risk
- environmental risk
- quality risk
- commercial risk (late or wrong deliveries of equipment)
- schedule risk
- social risk
- cultural risk

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- construction risk.

4.1.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all complex engineering activities. (Responsibility Level E)

Applicants are expected to have, as a minimum, a working knowledge of the following regulations and Acts and an understanding of how these legislation affects their working environment:

- Engineering Profession Act, 46 of 2000, including the ECSA rules and Code of Conduct
- Occupation Health and Safety Act, 85 of 1993 as amended by Act 181 of 1993 (latest revision used)
- Wiring Code – SANS 10142
- Building Regulations – National Building Regulations and Building Standards Act, 103 of 1977) as amended by Act 49 of 1995, SANS 10400
- Factory Regulations
- Machinery and Works Regulations
- Labour Relations Act, 66 of 1995
- Environment Conservation Act, 73 of 1989 as amended by Act 52 of 1994 and Act 50 of 2003
- Mine Health and Safety Act, 29 of 1996
- Industry-specific work instructions and specifications
- South African National Standard (SANS) applicable specifications.

Other Acts not listed here may also be pertinent to an applicant's work environment. Applicants are expected to have a basic knowledge of the applicable Acts.

4.1.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E)

Candidates are expected to conduct themselves in an ethical manner, always demonstrating professionalism during the course of their engineering activities. This includes having the ability to identify ethical problems and unethical behaviour, and solutions to such problems. Unethical behaviour may be in the form of fraud, corruption, maladministration or illegal activities.

In addition, applicants should have knowledge of the ECSA Code of Conduct with an understanding of how it relates to their area of practice. Attention to the health and safety of persons, area of competency, truth, integrity and honest behaviour is of paramount importance.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.1.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of complex engineering activities. (Responsibility Level E)

Engineers are expected to exercise sound judgement during the course of engineering activities by considering several factors based on consequences they foresee and the regulatory requirements, such as policies and standards.

Applicants are therefore expected to demonstrate this competency by evaluating a situation in the absence of full evidence presented to them. The requirement is that engineers thoroughly investigate, analyse, identify several factors and understand the risks associated with certain decisions.

4.1.10 Outcome 10: Be responsible for making decisions on part or all of complex engineering activities. (Responsibility Level E)

Having the contextual knowledge and operating on Level E of degree of responsibility affords candidates an opportunity to demonstrate how they were able to make decisions and take on responsibility for significant parts of one or more complex engineering activities. Seeking advice or guidance from the relevant superiors will assist applicants in making informed decisions and assuming responsibility for those decisions.

4.1.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work (Responsibility Level D)

The following list of formal learning activities is by no means extensive or comprehensive; it is simply a sample of useful courses.

- Project management
- Conditions of Contract / Value Engineering – New Engineering Contract (NEC), Joint Building Contract Committee (JBCC), etc.
- Standards
- Specifications
- Preparation of specifications
- Negotiation skills

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- Engineering finance
- Risk analysis
- Quality systems
- Occupational health and safety
- Engineering ethics
- Discipline-specific courses
- Energy efficiency
- Electrical tariffs
- Maintenance engineering
- Environment impacts
- Management
- Report writing
- Planning methods
- System engineering
- Industrial relations
- Public speaking.

Training and courses that do not carry official continuing professional development (CPD) points are also appropriate, such as courses or training offered within the employer organisation or by other organisations.

4.2 Training for registration as a professional engineering technologist

4.2.1 Outcome 1: Define, investigate and analyse broadly defined engineering problems (Responsibility Level E)

Electrical Technologists are involved with broadly defined engineering activities and solve broadly defined engineering problems. It is critical to properly understand the problem and its extent before attempting to solve such a problem. It is therefore critical to define, investigate and analyse broadly defined engineering problems before deciding on solutions.

Defining engineering problems involves identifying an engineering problem to solve and specifying clear goals or criteria that the final product or system must meet. This process must lead to an agreed definition of the problem to be solved.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Applicants are expected to be exposed to the technical investigation process of a network, complex engineering systems, plant or equipment and product failure. The nature of the engineering problem is ill-posed and it requires identification and refinement into the technological area under investigation. Investigating a broadly defined engineering problem cannot be a desktop exercise as it requires in-depth knowledge and history of the system, other attempted or successful solutions and how far-reaching a solution to the problem may be.

Analysis and the development of solution

Applicants involved in manufacturing and designing products, power generating plants, power networks and systems engineering must be able to demonstrate their ability to investigate a product or equipment failure by applying a systematic approach. This may involve justified assumptions and evaluation of results from investigated information. Applicants willing to be registered as Professional Engineering Technologists should therefore demonstrate an ability to define, investigate and analyse broadly defined engineering problems.

4.2.2 Outcome 2: Design or develop solutions to broadly defined engineering problems (Responsibility Levels C and D)

Engineering design and development of a solution is a critical step as this results in a plant/system or components operating within acceptable engineering and safety parameters. Engineering problems are solved by applying standards, codes and procedures, and justification for operating outside these standards and codes must be provided. Applicants are expected to be able to demonstrate different options for developing a solution. The solution should be supported by engineering principles and concepts. Applicants should strive to solve engineering problems demonstrating a step-by-step approach adhering to proven logic. Applicants should indicate alternatives or approaches towards solving the problem that have been tested against factors that include but are not limited to costs, engineering parameters, sustainability and environmental considerations before a solution is selected. There is always more than one solution to solving a broadly defined engineering problem.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.2.3 Outcome 3: Comprehend and apply knowledge that is embodied in established engineering practices that is specific to the jurisdiction in which the Engineering Technician practices. (Responsibility Level E)

In solving broadly defined engineering problems, Electrical Engineering Technologists must comprehend and apply knowledge, accepted engineering procedures, systems and methodologies. Applicants should be able to understand and demonstrate that during engineering problem solving, they have:

- applied engineering principles, practices, technologies, including the application of BTech or BEng (Tech) theory in the practice area
- indicated working knowledge of areas of practice that interact with the practice area to underpin teamwork
- applied related knowledge of finance, statutory, safety and management.

4.2.4 Outcome 4: Manage part or all of one or more broadly defined engineering activities (Responsibility Level D)

The practice areas under which Electrical Engineering Technologists work generally follow a conventional project or product development life cycle model, which could be as follows:

- Research and development to develop new products or systems to solve a system problem or a problem due to obsolescence.
- System or product design to develop a new system or product or to solve a system or product problem, to achieve a particular desired result or to select equipment for a particular purpose.
- Project engineering to install, test and commission the necessary equipment or system for the desired result.
- Operation and maintenance of the system or network or support of the product.
- Decommissioning of the system or network.

In relation to the above engineering activities, applicants are expected to display personal and work process management abilities for the following:

- Managing self, people, work priorities, processes and resources in broadly defined engineering work.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- Evident role in planning, organising, leading and controlling broadly defined engineering activities.
- Knowledge of conditions and operation of contractors and their ability.

4.2.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C)

Professional communication is a vital skill for Electrical Engineering Technologists to possess since all their decisions will be communicated to different parties. Candidate Technologists communicate the engineering activities to relevant stakeholders, managers and supervisors on the work deliverables.

Effective communication plays vital role in ensuring that the expectations are clearly understood. It is expected that Applicant Electrical Engineering Technologists demonstrate the ability to:

- write clear, concise, effective technical, legal and editorially correct reports
- issue clear instructions to stakeholders using appropriate language and communication skills
- conduct oral presentations using structured style, language and visual aids.

The above capabilities should be demonstrated at **Responsibility level C** (i.e., contributing).

4.2.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural, and environmental effects of broadly defined engineering activities seeking to achieve sustainability (Responsibility Level B)

Broadly defined engineering problems always impact the social, environmental and cultural components. Applicants should be able to recognise and address the impact of their broadly defined engineering activities on these components and where there are negative effects, provide mitigating measures.

- Social effects encompass all issues that affect people and their livelihood, directly or indirectly. Engineering activities may have affected people's way of life, political system, health and wellbeing, and personal and property rights.
- Environmental effects include people's environment, namely air and water quality, dust and exposure to noise and adequacy of sanitation as well as large ecosystems. This might include

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

disruption of ecosystems, fauna and flora and increased land temperatures and historical buildings.

- Cultural effects include people's customary beliefs, religion, language and norms, for example ceremonies and customs of a particular group or society.

It is important to note that engineering activities should be based on the correct level descriptor of broadly defined activities.

4.2.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all broadly defined engineering activities (Responsibility Level E)

The gazetted Identification of Engineering work (IDoEW) promotes safety and protection of the public and the environment by ensuring that only registered professionals in the different categories of registration, who have demonstrated the required competence and academic qualifications, performed engineering work or took responsibility for engineering work performed per category. Applicants wishing to register with ECSA as Professional Engineering Technologists are expected to have a working knowledge of the related regulations and acts and be able to demonstrate how this legislation affects their engineering activities at **Responsibility Level E** (performing). The most commonly used engineering regulating standards and Acts for applicants to meet in the course of executing the engineering work are the following:

- Engineering Profession Act, 46 of 2000, including the rules and the ECSA Code of Conduct
- Occupation Health and Safety Act, 85 of 1993 as amended by Act 181 of 1993
- Wiring Code – SANS 10142
- Building Regulations – National Building Regulations and Building Standards Act, 103 of 1977 as amended by Act 49 of 1995
- Factory Regulations – SANS 10400
- Machinery and Works Regulations
- Labour Relations Act, 66 of 1999
- Environment Conservation Act, 73 of 1989 as amended by Act 52 of 1994 and Act 50 of 2003
- Industry Specific Work Instructions – Mine Health and Safety Act. 29 of 1996
- SANS applicable specifications
- Related ICASA licensing requirements.

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- Mine Health and Safety Act 29 of 1996 and Regulations.

The candidate is expected to have a basic knowledge of the applicable Acts that are applicable to their area of practice. This list is not exhaustive.

4.2.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E)

Applicant Electrical Engineering Technologists are involved in tender evaluations and adjudications, and contract management (e.g., NEC3). Ethical problems such as tender fraud and corruption, bribery payment, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts and overstating of compensation events may occur. Applicant Electrical Engineering Technologists are expected to identify ethical problems and affected parties, and the best solution to resolve the problem at **Responsibility Level E** (i.e., performing).

Most engineering projects are multi-disciplinary in nature, with many role players performing speciality work that could result in individuals conducting engineering activities that they have no education, training or competency for. It is imperative that Applicant Electrical Engineering Technologists familiarise themselves with ECSA's Rules of Conduct: Ethics regarding integrity and competency.

4.2.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of broadly defined engineering activities. (Responsibility Level E)

Taking risky decisions may lead to equipment failure, excessive installation and maintenance costs, and damage to persons and property. Evaluation of engineering solutions may include engineering calculations to substantiate decisions taken and assumptions made. Therefore, judgement exercised by the applicant in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies is crucial.

The design of new product or equipment has technical risk that needs to be considered in the acquisition of any new technologies. While the application of developmental technology potentially offers significantly enhanced capability over existing systems, it can also lead to excessive delays and cost 'blow-outs'. Furthermore, technical risk could have negative impacts

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

on the project, system or entire infrastructure if the implementation is not successful as anticipated.

In developing engineering solutions, applicants should be able to demonstrate the factors taken into consideration, bearing in mind risk, consequences in technology application and affected parties. Failure to identify or properly manage this risk may result in performance degradation, security breaches, system failures, increased maintenance time and a significant amount of technical debt for the organisation. It is essential to have a reliable analysis solution for technical-risk management to ensure early detection of problems.

Therefore, applicants must familiarise themselves with the organisational risk policies and standards. These risks may be identified or demonstrated under the practice areas, such as research and development, engineering systems design, advisory, planning and directing the construction and operation of electronic, electrical and telecommunication systems, computer and software systems, components, rotating machines, and equipment and building services related projects.

4.2.10 Outcome 10: Be responsible for making decisions on part or all of broadly defined engineering activities. (Responsibility Level E)

Responsible decision-making includes applying engineering knowledge acquired from accredited engineering programmes. It includes considerations from engineering, social, environmental and sustainable development factors in solving a broadly defined engineering problem. Applicants should be able to demonstrate recognition of social and environmental issues as well as application of relevant academic level knowledge in formulating decisions. The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.

Applicant Electrical Engineering Technologists should discharge responsibilities for significant parts of one or more activities taken into consideration relating to the impact of engineering, social, environmental and sustainable development at **Responsibility Level E**. It is important for Applicant Electrical Engineering Technologists to demonstrate how they had sought some advice from a responsible authority on matters outside their area of competence.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.2.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work. (Responsibility Level D)

Applicants intending to register as Professional Engineering Technologists are expected to undertake independent learning activities sufficient to maintain and extend their competence. The following list of formal learning activities is by no means exhaustive; it is simply a sample of useful courses to assist applicants:

- Project management
- Conditions of Contract\Value Engineering – NEC, JBCC, etc.
- Standard specifications
- Preparation of specifications
- Negotiation skills
- Engineering finance
- Risk analysis and quality systems
- Occupational health and safety
- Discipline specific courses
- Energy efficiency
- Electrical tariffs
- Maintenance engineering
- Environment impacts management
- Technical and business report writing
- Planning methods
- Systems engineering
- Industrial relations
- Business presentation skills/public speaking
- Artificial intelligence
- Internet of things
- Cyber security
- Systems resilience.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Training and courses that do not carry official CPD points are also appropriate, such as courses or training offered within the employer organisation or by other organisations.

4.3 Training for registration as a Professional Engineering Technician

4.3.1 Outcome 1: Define, investigate and analyse well-defined engineering problems (Responsibility Level E)

During training, Applicant engineering technician should be exposed to the technical investigation of equipment, plant and product failure. The intent is for applicants to be able to clearly define the engineering problem and investigate and analyse well-defined engineering problems. For engineering technicians to solve well-defined engineering problems, it is imperative to understand the nature of the engineering problem. Inability to understand the engineering problem could lead to incorrect design or development of solutions. Defining an engineering problem requires in-depth knowledge and history of the system, other attempted or successful solutions, and how far-reaching a solution to the problem may be. Investigation of the engineering problem could be in a form of equipment failure in the electrical system, development of new products and provision of services to a greenfield area.

Engineering problems should be thoroughly investigated through site visits, collecting technical information and checking engineering drawings. No investigation can be completed using desktop information only. Sufficient technical and business information about a plant or systems should be collected, evaluated and analysed for accuracy and reliability. Analysis of the information assists applicants to review the instruction given in the initial engineering problem and assess if the work instruction was well understood. Engineering analysis involves applying scientific analytic principles and processes to reveal the properties and state of the system, device or mechanism under study. Applicants Electrical Engineering Technicians or persons willing to register as Professional Engineering Technicians should be able to demonstrate how well-defined engineering problem/s were defined and investigated.

4.3.2 Outcome 2: Design or develop solutions to well-defined engineering problems (Responsibility Levels C and D)

Once the analysis of the engineering problem has been established, applicants are expected to either design or develop engineering solutions to resolve well-defined engineering problems.

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Well-defined engineering problems can be solved in a standardised or prescribed ways. They are encompassed by standards, codes and documented procedures. Electrical Engineering Technicians encounter various engineering problems and should provide solutions to return the plant, system, or subsystem to its normal functioning state. Designing or developing solutions for a well-defined engineering problem normally follow the following steps:

- List possible solutions.
- Evaluate and rank the possible solutions.
- Develop a detailed plan for the most attractive solutions.
- Re-evaluate the plan to check desirability.
- Check the result through calculations.
- Implement the plan.
- Communicate the results.

Applicant Electrical Engineering Technicians should be able to demonstrate the application of calculations and engineering concepts in either designing or developing solutions to a well-defined engineering problem. Engineering norms and standards should be applied in the process of developing well-defined engineering solutions.

4.3.3 Outcome 3: Comprehend and apply knowledge that is embodied in established engineering practices that is specific to the jurisdiction in which the engineering technician practises. (Responsibility Level E)

Applicant Electrical Engineering Technicians are required to apply engineering knowledge acquired during the accredited undergraduate programmes to resolve the well-defined engineering problems and subsequently provide solutions to such problems. During training, applicant engineering technicians are expected to be introduced to engineering standards, procedures and different systems used in the process of engineering problem solving. It is imperative that applicant engineering technicians are able to understand and demonstrate application of acceptable engineering theory, engineering standards, engineering procedures, systems and governing laws in solving well-defined engineering problems.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Engineering problem-solving of well-defined activities involves justifying the reasoning on why National Diploma theory is applied and, in most cases, requires the engineering technician to perform calculations to justify certain engineering decisions and assumptions.

Applicant Electrical Engineering Technicians are expected to work within prescribed engineering standards and codes in solving engineering problems or to justify operating outside these standards and codes. Engineering technicians may also rely on knowledge from the National Rationalised Specifications (NRS), South African Berea of Standards (SABS), technical standards and specifications to develop solutions to well-defined engineering activities.

4.3.4 Outcome 4: Manage part or all of one or more well-defined engineering activities. (Responsibility Level D)

The areas in which Applicant Electrical Engineering Technicians work generally follow a conventional project or product development life cycle model,

Electrical Technicians may contribute to or participate in a project by managing one or more activities in the project life cycle. The key activities of project management involve time, cost and quality. Applicant Electrical Engineering Technicians should be able to manage their activities to minimise project delays or engineering work activities, either in operations and maintenance or capital projects. Sometimes work priorities need to be tracked using project management software tools to manage project activities' critical path.

Applicant Electrical Engineering Technicians must expose themselves to the tools/software used to manage well-defined engineering activities and understand their role within the team. Applicant Electrical Engineering Technicians or persons wishing to register with ECSA as a Professional Technicians must particate in and contribute to the work activities in the project life cycle. Applicant Electrical Engineering Technicians are not expected to change their places of employment to acquire all the skills in the project life cycle as listed above.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.3.5 Outcome 5: Communicate clearly using multiple mediums and collaborate inclusively with a broad range of stakeholders in the course of engineering activities. (Responsibility Level C)

While conducting engineering works, Applicant Electrical Engineering Technicians are expected to effectively communicate with their team members, supervisors, clients and contractors. Professional communication is a vital skill for Applicant Electrical Engineering Technicians to possess since all their decisions are communicated to different parties. Professional communication is important for Applicant Electrical Engineering Technicians to run effective meetings, work with people who are not technical, work with other cultures, issue and receive instructions, report on engineering works and share ideas.

The main type of professional communication includes oral, written and graphical techniques, or a combination thereof. During the execution of engineering work activities, Electrical Technicians hold meetings, develop technical reports, develop tender document specification and develop bills of quantity. This should be clear and concise to convey the message to the recipients. Creating presentations using visual aids and supporting documents for the purpose of presenting to colleagues, team members, supervisors or client is an important part of engineering problem solving. Oral and written communication skills are important for effective professional communication.

Applicants should develop effective communications skills during training and be able to demonstrate such skills to be registered as Professional Engineering Technicians.

4.3.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural and environmental effects of well-defined engineering activities seeking to achieve sustainability. (Responsibility Level B)

Performing engineering work always means there will be impact socially, environmentally and culturally. This is because engineering work happens within the environment and are meant to improve services or products but not impact cultural beliefs and norms. Social effects encompass all issues that affect people and their livelihood, directly or indirectly. Engineering activities may have affected people's way of life, political system, health and wellbeing, and personal and property rights.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Environmental effects include people's environment, namely air and water quality, dust and exposure to noise and adequacy of sanitation as well as large ecosystems. This might include disruption of ecosystems, fauna and flora and increased land temperatures and impact on historical buildings.

Cultural effects include people's customary beliefs, religion, language and norms, for example ceremonies and customs of a particular group or society.

Applicants should always remember that these activities are mostly outward looking. Applicants must be able to describe the impact of engineering work on these items and be able to provide mitigation measures to affected parties. Stakeholder engagement is always important in mitigating impacts to a level acceptable to affected parties.

4.3.7 Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons during all well-defined engineering activities. (Responsibility Level E)

Engineering work is performed under various legal and regulatory requirements that ensures the safety of personnel, protection of environment and continued service delivery to the public. Applicant Electrical Engineering Technicians should be familiar with major laws and regulations applicable in their area of operation. Regulations includes standards and specifications that are there to provide safety and ensure continuation of service. Such knowledge ensures that work is done safely and no unnecessary risks are taken during such work.

Applicant should be able to identify such laws and regulations and be able to demonstrate applicability. These include but are not limited to the following:

- Occupational Health and Safety Act, 85 of 1993
- Mine Health and Safety Act, 29 of 1996
- National Environmental Act, 107 of 1990
- Municipal Finance Management Act, 56 of 2003
- Public Finance Management Act, 1 of 1999
- Environment Conservation Act, 73 of 1989
- Labour Relations Act, 66 of 1995
- Municipal by-laws.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

Regulations may include but are not limited to:

- Operation regulations for high voltage systems
- Electrical machinery regulations
- Electrical Installation regulations
- SABS standards
- NRS standards
- Industry-specific work Instructions, technical standards and specifications.

The candidate is expected to have a basic knowledge of the applicable Acts that are applicable to their area of practice. This list is not exhaustive.

4.3.8 Outcome 8: Conduct engineering activities ethically (Responsibility Level E)

Ethical problems arise during engineering activities, for example using unsustainable material for a solution or contravening other regulations in the process of developing solutions. Other general ethical problems may also arise while performing engineering activities. Engineering practitioners should be able to identify ethical issues arising during engineering activities, identify affected parties and how such issues may affect them. A solution to an ethical problem must take into consideration all affected parties.

Applicant Electrical Engineering Technicians must perform engineering work and make technical decisions while adhering to the ECSA Code of Conduct for registered persons. Engineering work should be performed taking into consideration the following factors:

- Make decisions within the limits of the practitioner's education, training and experience
- Act with integrity and in accordance with the general norms of professional conduct
- Strive to respect the interests of the public and health and safety and minimise environmental impact.

Where the scope of work falls outside the area of expertise, Applicant Electrical Engineering Technicians should seek guidance from relevant parties. Conflict of interest while conducting engineering activities should be avoided/declared so that decisions are made transparently and with the best interests at heart.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.3.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of well-defined engineering activities. (Responsibility Level E)

Sound judgment and decision-making can be defined as one's ability to objectively assess situations or circumstances using all the relevant information and apply past experience to come to a conclusion. Applicant Electrical Engineering Technicians should be able to make judgement towards a sustainable solution after ensuring that all factors, including consideration of other disciplines, have been taken into consideration.

It is essential to have a reliable analysis solution for technical-risk management to ensure early detection of problems. This prevents issues from occurring without warning and drastically decreases the effort required to alleviate sudden infrastructure or system problems. Applicant Electrical Engineering Technicians must familiarise themselves with organisational risk policies and standards. These risks may be identified or demonstrated in building services, product development or research and development related projects. Applicant Electrical Engineering Technicians should strive to acquire experience in all generic engineering competencies of problem-solving implementation, operation, risk and impact mitigation, and management of engineering activities.

4.3.10 Outcome 10: Be responsible for making decisions on part or all of well-defined engineering activities. (Responsibility Level E)

Responsible decision-making includes applying engineering knowledge acquired from accredited engineering programmes. It includes using relevant calculations to justify why certain solutions are chosen to solve well-defined engineering problems. Where an Applicant Electrical Engineering Technicians does not have the required knowledge, it is responsible to ask for advice from relevant authority or those who have the information. This could be on matters within the Electrical Engineering discipline or other disciplines but impacting the work of the Applicant Electrical Engineering Technicians. Any decisions taken should be evaluated for shortcomings to ensure no surprises at the end of the project/ activity.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

4.3.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work. (Responsibility Level D)

Professional development refers to continuing education and career training after a person has entered the workforce to assist in developing new skills, broadening of knowledge, stay up to date on current trends, technologies and advance their career. A registered Professional Engineering Technician is required to maintain and extend the level of competency through CPD activities to maintain registration.

When applying for registration, applicants should provide evidence of initial professional development (IPD) that has been attained during the training period. These activities could include engineering courses, management courses and computer courses. Enrolling towards a post graduate engineering programmes is part of development activities. Candidates must be able to demonstrate professional development by:

- adopting strategy towards own professional development
- selecting appropriate professional development activities
- keeping thorough records of professional development activities
- demonstrating independent learning ability completing development activities.

Applicants training towards registration are not required to satisfy formal CPD requirements.

5. FUNCTIONS PERFORMED

5.1 Degrees of responsibility

Progression throughout the candidacy period presented in document **R-04-T&M-Guide-PC** and below in **Table 1** refers to the gradual increase in the degree of responsibility to which candidate engineers are exposed during professional training. Considering the nature of work, specific examples and outcomes appropriate to training in Electrical Engineering are given in Table 1 presented below:

Table 1: Progression throughout the candidacy period

Degree of responsibility	Nature of work	Activities/duties to be undertaken during training
A: Being exposed	The Candidate undergoes induction and observes processes and work of competent practitioners.	• Understand the business environment and the dynamics that shape the businesses and industries in which they operate. • Understand the business model, its key conversion processes and critical outcomes. • Understand the value added by Electrical Engineering Practitioners and other professionals in the business.
B: Assisting	The Candidate performs specific processes under close supervision.	• Develop insight and understanding of the different processes and systems in transforming inputs into goods and services. • Develop an appreciation of the numerous resources at the disposal of Electrical Engineering practitioners. • Obtain experience in the day-to-day operations of the business to gain insight and understanding of the different processes and systems involved in transforming inputs into goods and services, with specific emphasis on productivity and quality measurements.
C: Participating	The Candidate performs specific processes as directed, with limited supervision.	• Gain first-hand experience of a broad range of Electrical Engineering activities (e.g., process design and re-engineering, planning and control, work study, value engineering, materials and information management, people management skills, logistics, specialists' inputs, tools and equipment and quality assurance). • Note the problems and limitations of particular philosophies, methods and techniques, with emphasis on cost/effort and relative benefit.
D: Contributing	The Candidate performs specific work with detailed approval of work outputs.	• Be involved in activities such as the planning of production, the control of quality and costs of process study and work study, good material handling and workplace layout, activity-based costing, benchmarking, business cases, process re-engineering, maintenance practice and procedures, project management and system specification. Of particular importance is the collective working of such activities in the economic use of people, materials and machines. • Give specific attention to human aspects concerning communication, interpersonal relationships and teamwork, training and cost analysis, budget control and profit accountability. These should proceed in parallel, applying

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

Degree of responsibility	Nature of work	Activities/duties to be undertaken during training
		Electrical Engineering techniques and utilising computers in problem-solving.
E: Performing	The Candidate works in a team without supervision, recommends work outputs and is responsible but not accountable.	• Assume escalating technical responsibility and increasingly co-ordinate the work of others. • Gain exposure to and develop skills in management areas such as labour relations, management accounting, business law and general business management. This is important for developing well-rounded Engineering Practitioners. • Seek assignments that require judgement, even if full information is unavailable. This leads to a position of professional responsibility, which is of great value and should be pursued.

Special considerations in the discipline, sub-discipline or specialty must be given to the competencies specified in the following groups:

- Knowledge-based problem-solving (this should be a strong focus)
- Management and communication
- Identifying and mitigating the impacts of engineering activity
- Judgement and responsibility
- Independent learning.

It is useful to measure the progression of a candidate's competency using the Degree of Responsibility, the Problem-Solving and the Engineering Activity scales as specified in document **R-02-STA-PE/PT/PN**.

APPENDIX B: TRAINING ELEMENTS

below has been developed against the Degree of Responsibility Scale. Activities should be selected to ensure candidates reach the required level of competency and responsibility.

It should be noted that candidates working at **Responsibility Level E** carry responsibility equivalent to that of a registered person **except** that the candidate's supervisor is accountable for the candidate's recommendations and decisions.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

5.2 Candidates training programme

There is no ideal training programme structure or unique sequencing that constitutes best practice. The training programme for each candidate depends on the available work opportunities the employer assigns to the candidate at the time.

It is suggested that applicants work with their mentors to determine appropriate projects to gain exposure to elements of the asset life cycle. In addition, applicants need to ensure that their designs are constructible, operable and designed considering life cycle costing and long-term sustainability. A regular reporting structure with suitable recording of evidence of achievement against the competency outcomes and responsibility needs to be in place.

The training programme should be such that candidates progress through the levels of work capability (described in document **R-04-T&M-GUIDE-PC**) to ensure that by the end of the training period, applicants exhibit Responsibility Level E and are able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

Value improved practices (VIPs) are out-of-the-ordinary practices used to improve cost, schedule, and/or reliability of capital construction projects. VIPs are:

- used primarily during front-end-loading
- formal, documented practices involving a repeatable work process
- predominantly facilitated by specialists from outside the project team.

Examples of VIPs include the following:

- Technology selection
- Process simplification
- Classes of facility quality
- Waste minimisation
- Energy optimisation
- Process reliability modelling
- Customisation of standards and specifications
- Predictive maintenance
- Design to capacity

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

- Value engineering
- Constructability.

The DSTG assumes that applicants enter a programme after graduation and continue with the programme until they are ready to apply for professional registration. The guide also assumes that applicants are supervised and mentored by persons who meet the requirements stated in document **R-04-T&M-GUIDE-PC**. In the case of a person changing from one candidacy programme to another or moving into a candidacy programme from a less structured environment, it is essential that the following steps are completed:

- Applicants must complete the Training and Experience Summary (TES) and the Training and Experience Reports (TERs) for the previous programme or the unstructured experience. Regarding the latter, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant supervisor or mentor.
- On entering the new programme, the mentor and supervisor should review a applicant's development while being mindful of the past experience and the opportunities and requirements of the new programme. At minimum, the mentor and supervisor should plan the next phase of the applicant's programme.

6. CONCLUSION

To attain registration as a professional, applicants should be able to meet the educational requirements for the category and demonstrate competency against prescribed standard for the registration category. Demonstrating competency is achieved by meeting requirements for the 11 outcomes. Applicants or persons willing to be registered as professionals must ensure, together with their mentors, that the training provided is geared towards achieving the ECSA competency outcomes. Focusing on one training aspect for the entire duration of training will not assist candidates or applicants to achieve the necessary skills to demonstrate all the standard competency outcomes.

The development of training remains the responsibility of the candidate or applicant to ensure that the training plan being provided covers all aspects of the outcomes. It has been common practice that in situations where a department or organisation is unable to provide training in certain areas, secondments are arranged with other departments or organisations so that the candidate or

CONTROLLED DISCLOSURE
When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.
QM-TEM-001 Rev 2 – ECSA Policy/Procedure

applicant is able to develop all the competencies required for registration. These secondments are usually reciprocal in nature and benefit the employee as well as the employer. Secondments between consultants and contractors and between the public and private sectors should be possible to allow applicants to acquire the necessary competencies.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Rev 0 Draft A	12 Dec 2023	The DSTG have been merged into one Discipline Specific Training Guide for Registration as a Professional Engineer, Technologist and Technician in Electrical Engineering and to ensure that the DSTG clearly detail how each outcome can be achieved.	RDDR BU
Rev 0 Draft B	13 Dec 2023	The three DSTGs have been reviewed to ensure that the document clearly explains how the candidate can achieve the eleven outcomes. The document now has an introductory section, and new abbreviations have been added under the section for abbreviations. The following additions have been made under section 2, Audience Renewables and Energy Efficiency have been added and the specialist areas are further defined as: • **Electrical Power Engineering -** encompasses electrical systems, components, motors, equipment, and engineering materials, products, and processes. • **Electronic Engineering -** covers electronic systems, electronic engineering materials, products, and processes. • **Telecommunications Engineering -** encompasses the design, construction, and management of systems that transmit, process, and storage information as electrical or optical signals and the control services based on this capability. • **Alternative Energy Engineering -** encompasses the design, construction, and management of systems that carry out the generation, transmission, and processing of alternative sources of electrical energy, such as renewables, as well as management thereof. Under section 3, Type of Engineering work, the following have been added: • Energy Efficiency Engineer • Renewables Engineer Under section 4.1, Training for Registration as a Professional Engineer, Investigation & Analysis, further information has been added to ensure what is expected of the candidate, including a list of what typical tasks may include. Under section 4.2, Training for Registration as a Professional Engineer, Investigation & Analysis, further	Working group

Revision number	Revision date	Revision details	Approved by
		information has been added to ensure what is expected of the candidate.	
Rev 0 Draft C	14 Dec 2023	Document revised with WG and Registration BU	RI BU, Registration BU and WG
Rev 0 Draft D	30 Jan 2024	Reviewed and checked	Executive: RPSC
Rev 0	08 Feb 2024	Approval	RPSC
Rev 0	08 Feb 2024	Added Appendix and changed Header and cover page	RPSC

The Discipline-specific Training Guide for:

Registration as a Professional Engineer, Technologist or Technician in

Electrical Engineering

Revision 0 dated 08 February 2023 and consisting of 39 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Regulatory Instruments and International Relations (**ERSIR**).

..... 9/12/2024.....

Business Unit Manager Date

..... 2024/12/09.....

Executive: RSIR Date

This definitive version of this policy is available on our website.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

APPENDIX A: TRAINING ELEMENTS

Synopsis: Applicants should achieve specific competencies at the prescribed level during their development towards professional registration, at the same time accepting more and more responsibility as experience is gained. The outcomes achieved and established during the candidacy phase should form the template for all engineering work performed after professional registration regardless of the level of responsibility at any particular stage of an engineering career:

1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical training to develop possible solutions: select the best and present to the recipient.
3. Apply theoretical knowledge to justify decisions taken and processes used.
4. Understand role in the work team, and plan and schedule work accordingly.
5. Issue complete and clear instructions and report comprehensively on work progress.
6. Be sensitive about the impact of the engineering activity and take action to mitigate this impact.
7. Consider and adhere to legislation applicable to the task and the associated risk identification and management.
8. Adhere strictly to high ethical behavioural standards and ECSA's Code of Conduct.
9. Display sound judgement by considering all factors, their interrelationship, consequences and evaluation when all evidence is not available.
10. Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain and evaluating shortcomings.
11. Become conversant with your employer's training and development programme and develop your own lifelong development programme within this framework.

Complex, Broadly-defined and Well-defined engineering work is usually characterised by the application of engineering deviating from standard procedures, codes and systems, the deviation verified by research, modelling and/or substantiated design calculations.

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing.

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
1. Purpose This standard defines the competence required for registration as a **Professional Engineer, Technologist and Technician**. Definitions of terms having particular meaning within this standard is given in text in relevant section.	DSTGs give context to the purpose of the Competency Standards. The **Engineer, Technologist and Technician** operate within the 12 disciplines ECSA recognises. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given in section 4 of the specific DSTG. DSTGs are used to facilitate experiential development towards ECSA registration and assist in compiling the required portfolio of evidence (specifically the Engineering Report in the application form). **NOTE:** The training period must be used to develop the trainee's competence towards achieving the standards below at a Responsibility Level E, i.e., Performing. (Refer to the specific DSTG)
2. Demonstration of competence Competence must be demonstrated within Complex, broadly defined and Well-defined *engineering activities,* defined below, by integrated performance of the outcomes defined at the level defined for each outcome. Required contexts and functions may be specified in the applicable DSTG. **Level Descriptor:** Complex engineering activities (**CEA**), Broadly-defined engineering activities (**BDEA**), and Well-	Engineering activities can be divided into (approximately): 5% Complex (Professional Engineers) 5% Broadly Defined (Professional Engineering Technologists) 10% Well-defined (Professional Engineering Technicians) 15% Narrowly Well-defined (Registered Specified Categories) 20% Skilled Workman (Engineering Artisan) 55% Unskilled Workman (Artisan Assistants) Activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

defined engineering activities (**WDEA**) have several of the following characteristics: a) Scope of practice area is linked to technologies used and changes by adoption of new technology into current practice. b) Practice area is located within a wider, complex context, requires teamwork, and has interfaces with other parties and disciplines. c) Involves a variety of resources, including people, money, equipment, materials and technologies. d) Requires resolution of occasional problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues. e) Are constrained by available technology, time, finance, infrastructure, resources, facilities, standards and codes and applicable laws. f) Have significant risks and consequences in the practice area and in related areas.	**Level Descriptor: CEA, *BDEA and WDEA*** in the various disciplines are characterised by several or all of the following: a) Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation. b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on **CEA, *BDEA and WDEA*** activities and problems. **CEA, *BDEA and WDEA*** activities in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team. c) The bulk of the work involves familiar, defined range of resources, including people, money, equipment, materials, but new technologies are investigated and implemented. d) Most of the impacts in the sub discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of broadly defined non-standard engineering principles. e) The work packages and associated parameters are constrained by operational context with variations limited to different locations only. (Cannot be covered by standards and codes.) f) Even locally important minor risks can have far reaching consequences.
Activities include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; manufacture or construction; engineering operations; maintenance; project management; research; development and commercialisation.	**Activities** include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management. For **Engineers, Technologists and Technicians**, research, development and commercialisation happen more frequently in some disciplines but are seldom encountered in others.
3. Outcomes to be satisfied:	**Explanation and Responsibility Level**
Group A: Engineering Problem Solving	

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

Outcome 1: Define, investigate and analyse *Complex, broadly defined and Well-defined,* engineering problems	**Responsibility Level E** Analysis of an engineering problem means the 'separation into parts possibly with comment and judgement'. Complex, *Broadly, Well-defined* means: 'not minute or detailed' and 'not kept within narrow limits'.
Complex, Broadly-defined and Well-defined engineering problems have the following characteristics. a) They require coherent and detailed engineering knowledge, underpinning the technology area; and one or more of the following: b) Are ill-posed, under- or over-specified, require identification and interpretation into the technology area. c) Encompass systems within complex engineering systems; d) Belong to families of problems which are solved in well-accepted but innovative ways. *and one or more of:* e) Can be solved by structured analysis techniques f) May be partially outside standards and codes; must provide justification to operate outside. g) Require information from practice area and sources interfacing with practice area that is complex and incomplete.	a) Coherent and detailed engineering knowledge for **Engineer, Technologist and Technician** means the problem encountered cannot be solved without the combination of all the relevant detail including engineering principles applicable to the situation. b) The nature of the problem is not immediately obvious, and further investigation to identify and interpret the real nature of the problem is necessary. c) The problem is not easily recognised as part of the larger engineering task, project or operation and may be obscured by the complexity of the larger system. d) It is recognised that the problem can be classified as ~~a~~ falling within a typical solution requiring innovative adaptation to meet the specific situation. e) Solving the problem needs a step-by-step approach adhering to proven logic. f) The standards, codes and documented procedures must be analysed to determine to what extent they are applicable to solve the problem and justification must be given to operate outside these. g) The responsibility lies with the **Engineer, Technologist and Technician** to verify that some information received as part of the problem encountered may remain incomplete and solutions to problems may need justified assumptions.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

h) Involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties. *and one or both of:* i) Require judgement in decision-making in practice area, considering interfaces to other areas. j) Have significant consequences which are important in practice area but may extend more widely.	h) The problem handled by **Engineer, Technologist and Technician** may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, not maintainable, not sustainable, etc; the **Engineer, Technologist and Technician** will have to justify his/her recommendation. i) Practical solutions to problems include knowledge and judgement of the roles displayed by the multi-disciplinary team and impact of own work in the interactive environment. j) **The Engineer, Technologist and Technician** must realise that their actions might seem to be of local importance only but may develop into significant consequences extending beyond their own ability and practice area.
Assessment criteria: A structured analysis of broadly defined problems typified by the following performances is expected: 1.1 Performed or contributed to defining engineering problems leading to an agreed definition of the problems to be solved. 1.2 Performed or contributed to investigating engineering problems including collecting, organising and evaluating information. 1.3 Performed or contributed to analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results.	To perform an engineering task an **Engineer, Technologist and Technician** will typically receive an instruction from a senior person (customer) to do a specific task, and must: 1.1 Ensure the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation. 1.2 Ensure the engineering problem and related information are segregated from the bulk of the information, investigated and evaluated. 1.3 Ensure that the instruction and information to do the work is fully understood and complete, including engineering theory needed to understand the task and acceptance criteria, and to carry out and/or check calculations. If needed supplementary information must be gathered, studied and understood. Concepts and assumptions must be justified by engineering theory and calculations, if applicable.
3. Outcomes to be satisfied:	**Explanation and Responsibility Level**
Range statement: The problem may be a design requirement, an applied research and development requirement or a problematic situation in an existing component, system or process. The problem is one amenable to solution by	Please refer to section 4 of the specific DSTG.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

technologies known to the Candidate. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.	
Outcome 2: Design or develop solutions to **Complex, Broadly-defined and Well-defined** engineering problems	**Responsibility Levels C and D** Design means 'drawing or outline from which something can be made'. Develop means 'come or bring into a state in which it is active or visible'.
Assessment criteria: This outcome is normally demonstrated after a problem analysis as defined in Outcome 1. Working systematically to synthesise a solution to a broadly defined problem, typified by the following performances is expected: 2.1 Designed or developed solutions to **Complex, Broadly-defined and Well-defined** engineering problems. 2.2 Systematically synthesised solutions and alternative solutions or approaches to the problem by analysing designs against requirements, including costs and impacts on outside parameters. (requirements). 2.3 Drawing up of detailed specification requirements and design documentation for implementation to the satisfaction of the client.	After the task received is fully understood and interpreted, a solution to the problem posed can be developed (designed). To synthesise a solution is 'the combination of separate parts, elements, substances, etc. into a whole or into a system' by the following: 2.1 The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an attachment. 2.2 The **Engineer, Technologist and Technician** will in some cases be unable to support proposals with the complete theoretical calculation to substantiate every aspect and must in these cases refer his / her alternatives to an engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified. 2.3 The best complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc. for the execution of work to meet customer requirements.
Range Statement: Solutions are those enabled by the technologies in the Candidate's practice area.	Applying theory to do ***Complex, Broadly-defined and Well-defined*** *engineering* work is mostly done in a way that has been used before, probably developed by engineers in the past, and documented in written

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

	procedures, specifications, drawings, models, examples, etc. **The Engineer, Technologist and Technician** must seek approval for any deviation from these established methods but must also initiate and/or participate in the development and revision of these norms.
Outcome 3: Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems or methodologies and those specific to the jurisdiction in which he/she practices.	**Responsibility Level E** Comprehend means 'to understand fully'. The jurisdiction in which an **Engineer, Technologist and Technician** practices is given in section 4 of the specific DSTG.
Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 Apply engineering principles, practices, technologies, including the application of, B Eng, BTech or B Eng (Tech) and N Dip, theory in the practice area. 3.2 Indicate working knowledge of areas of practice that interact with practice area to underpin teamwork. 3.3 Apply related knowledge of finance, statutory, safety and management.	Design work for **Engineer, Technologist and Technician** is based on B Eng, BTech, N Dip, theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel einineering., **Engineer, Technologist and Technician** develop and apply codes and procedures in their design work. Investigation would be on broadly defined incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations. 3.1 Calculations at B Eng, BTech or B Eng (Tech) and/or NDip, theoretical level confirming the correct application and utilisation of equipment, materials and systems listed in section 4 of the specific DSTG must be done on broadly defined activities. 3.2 The understanding of **complex, broadly defined, well defined,** procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team. 3.3 The ability to manage the resources within legal and financial constraints must be evident.
Range Statement: Applicable knowledge includes: a) Technological knowledge that is well-established and applicable to the practice area irrespective of location,	a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment. A combination of educational knowledge and practical experience

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others.	must be used to substantiate decisions taken including a comprehensive study of systems, materials, components and projected customer requirements and expectations. New ideas, materials, components and systems must be investigated, evaluated and applied accompanied by complex theoretical motivation.
b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.	b) In spite of having a working knowledge of interacting disciplines, **Engineer, Technologist and Technician** take responsibility for the multidisciplinary team of specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, architects on buildings, Electrical Engineers on communication equipment, etc.
c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practice area, a selection of law of contract, health and safety, environmental, intellectual property, contract administration, quality management, risk management, maintenance management, regulation, project and construction management.	c) Jurisdictional in this instance means 'having the authority', and **Engineer, Technologist and Technician** must be aware of and decide on the relevant requirements applicable to each specific project that he/she is responsible for. They are usually appointed as the 'responsible person' for specific projects in terms of the OHS Act.
Group B: Managing Engineering Activities	**Explanation and Responsibility Level**
Outcome 4: Manage part or all of one or more ***Complex, Broadly-defined and Well-defined*** engineering activities.	**Responsibility Level D** Manage means 'control'.
Assessment criteria: The Candidate is expected to display personal and work process management abilities: 4.1 Managed self, people, work priorities, processes and resources in broadly defined engineering work. 4.2 Role in planning, organising, leading and controlling broadly defined engineering activities evident.	In Engineering operations **Engineer, Technologist and Technician** are typically given the responsibility to carry out projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 The basic elements of managements must be applied to broadly defined engineering work.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

4.3 Knowledge of conditions and operation of contractors and the ability.	4.3 Depending on the project, **Engineer, Technologist and Technician** can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
Outcome 5: Communicate clearly with others in the course of his/her broadly defined engineering activities.	**Responsibility Level C**
Assessment criteria: Demonstrates effective communication by: 5.1 Ability to write clear, concise, effective technical, legal and editorially correct reports shown. 5.2 Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident. 5.3 Oral presentations made using structure, style, language, visual aids	Refer to Range Statement for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
Range Statement for Outcomes 4 and 5: Management and communication in ***Complex, Broadly-defined and Well-defined*** *engineering* involves: a) Planning ***Complex, Broadly-defined and Well-defined*** activities b) Organising ***Complex, Broadly-defined and Well-defined*** activities c) Leading ***Complex, Broadly-defined and Well-defined*** activities	a) Planning means 'the arrangement for doing or using something, considered in advance' b) Organising means 'put into working order, arrange in a system, make preparations for' c) Leading means to 'guide the actions and opinions of, influence, persuade' d) Controlling means the 'means of regulating, restraining, keeping in order, check'

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

d) Controlling ***Complex, Broadly-defined and Well-defined*** activities.	**The Engineer, Technologist and Technician** write specifications for the purchase of materials and/or work to be done, recommendations on tenders received, place orders and variation orders, write work instructions, report on work done, draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write work procedures, write inspection and audit reports, write commissioning reports, prepare and present motivations for new projects, compile budget reports, report on studies done and calculations carried out, report on customer requirements, report on safety incidents and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report on cost control, etc.
Group C: Impacts of Engineering Activity	**Explanation and Responsibility Level**
Outcome 6: Recognise the foreseeable social, cultural and environmental effects of ***Complex, Broadly-defined and Well-defined*** engineering activities generally	**Responsibility level B** Social means 'people living in communities; of relations between persons and communities'. Cultural means 'all the arts, beliefs, social institutions, etc. characteristic of a community'. Environmental means 'surroundings, circumstances, influences'.
Assessment criteria: This outcome is normally displayed in the course of analysis and solution of problems. The candidate typically shows: 6.1 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown. 6.2 Measures taken to mitigate the negative effects of engineering activities evident.	6.1 Engineering impacts heavily on the environment, e.g., servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wildlife, dangerous rotating and other machines, demolishing of structures, etc. 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases, compensation paid, etc.
Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her broadly defined engineering activities.	**Responsibility level E**

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

Assessment criteria: 7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity. 7.2 Circumstances stated where applicant assisted in or demonstrated awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.	7.1 The OHS Act is supplemented by a variety of parliamentary acts, regulations, local authority by-laws, standards and codes of practice. Places of work might have standard procedures, instructions, drawings and operation and maintenance manuals available. These documents, depending on the situation (emergency, breakdown, etc.) are consulted before work is commenced and during the activity. 7.2 It is essential to attend a Risk Management (Assessment) course, and to investigate and study the materials, components and systems used in the workplace. The **Engineer, Technologist and Technician** seeks advice from knowledgeable and experienced specialists if the slightest doubt exist that safety and sustainability cannot be guaranteed.
Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include the following: a) Requirements include both explicit regulated factors and those that arise in the course of particular work. b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied. c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used. d) Safe and sustainable materials, components and systems.	a) The impacts will vary substantially with the location of the task, e.g., the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex. It is identified and studied by the **Engineer, Technologist and Technician** before starting the work. b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirms or checks that the instructions are in line with regulations. The **Engineer, Technologist and Technician** is responsible to see that this is done, and if not, establish which regulations apply, and ensure that they are adhered to. Usually, the people working on site are strictly controlled.W.r.t. health and safety, but the **Engineer, Technologist and Technician** checks that this is done, but may authorise unavoidable deviation after setting conditions for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. c) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The **Engineer, Technologist and Technician** needs to identify, analyse and manage any long-term risks and develop strategies to solve these by using alternative technologies. d) The safe and sustainable materials, components and systems must be selected and prescribed by the **Engineer, Technologist and Technician** or other professional specialists must be consulted. It is the

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

e) Regulatory requirements are explicit for the context in general.	responsibility of the **Engineer, Technologist and Technician** to use his/her knowledge and experience to confirm that prescriptions by others are correct and safe. e) Application of regulations associated with the particular aspects of the project must be carefully identified and controlled by the **Engineer, Technologist and Technician**.
Group D: Exercise judgment, take responsibility, and act ethically	**Explanation and Responsibility Level**
Outcome 8: Conduct engineering activities ethically.	**Responsibility level E** Ethically means 'science of morals; moral soundness'. Moral means 'moral habits; standards of behaviour; principles of right and wrong'.
Assessment Criteria: Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: 8.1 Conversance and operation in compliance with ECSA's Rules of Conduct for registered persons confirmed 8.2 How ethical problems and affected parties were identified, and the best solution to resolve the problem selected.	Systematic means 'methodical; based on a system'. 8.1 ECSA's Code of Conduct, as per ECSA's website, is known and adhered to. 8.2 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.
Outcome 9: Exercise sound judgement in the course of ***Complex, Broadly-defined and Well-defined*** engineering activities	**Responsibility level E** Judgement means 'good sense: ability to judge'.
Assessment criteria: Judgement is displayed by the following performance:	

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

9.1 Judgement exercised in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies. 9.2 Factors taken into consideration given, bearing in mind, risk, consequences in technology application and affected parties.	9.1 The extent of a project given to a junior **Engineer, Technologist and Technician** is characterised by the several broadly defined and a few well-defined factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded. 9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Evaluation includes engineering calculations to substantiate decisions taken and assumptions made.
Range Statement for Outcomes 8 and 9*: Judgement* in decision-making involves: a) taking several risk factors into account; **or** b) significant consequences in technology application and related contexts; **or** c) ranges of interested and affected parties with widely varying needs.	In Engineering, about 5% of engineering activities can be classified as broadly defined where the **Engineer, Technologist and Technician** uses standard procedures, codes of practice, specifications, etc, but develops variations and completely unique standards when needed. Judgement must be displayed to identify any activity falling inside the broadly defined range, as defined above: a) Getting the work done in spite of numerous risk factors needs good judgement and substantiated decision-making. b) Consequences are part of the project e.g., extra cost due to unforeseen conditions, incompetent contractors, long-term environmental damage, etc. c) Interested and affected parties with defined needs that may be in conflict, e.g., need for a service irrespective of environmental damage, local traditions and preferences, etc. needs sound management and judgement.
Outcome 10: Be responsible for making decisions on part or all of all of one or more ***Complex, Broadly-defined and Well-defined*** engineering activities	**Responsibility level E** Responsible means 'legally or morally liable for carrying out a duty; for the care of something or somebody in a position where one may be blamed for loss, failure, etc.'.
Assessment criteria: Responsibility is displayed by the following performance: 10.1 Engineering, social, environment and sustainable development taken into consideration in discharging responsibilities for significant parts of one or more activities. 10.2 Advice sought from a responsible authority on matters	10.1 All interrelated factors taken considered are indicative of professional responsibility accepted working on broadly defined activities.

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

outside your area of competence. 10.3 Academic knowledge of at least B Eng, BTech N Dip, level combined with past experience used in formulating decisions.	10.2 The **Engineer, Technologist and Technician** does not operate on tasks at a higher level than, complex, broadly defined, well defined and consults professionals at engineer level if elements of the project to be done are beyond his/her education and experience, e.g., power system stability. 10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction and corrective action, if necessary, forms an important element. The calculations, for example fault levels, load calculations, losses, etc. are done to ensure that the correct material and components are utilised.
Range Statement: Responsibility must be discharged for significant parts of one or more ***Complex, Broadly-defined and Well-defined*** engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Demonstrating responsibility is under supervision of a competent engineering practitioner but is expected to perform as if he/she is in a responsible position.	
Group E: Initial Professional Development (IPD)	**Explanation and Responsibility Level**
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his or her competence.	**Responsibility level D**
Assessment criteria: Self-development managed typically: 11.1 Strategy independently adopted to enhance professional development evident. 11.2 Awareness of philosophy of employer regarding professional development evident.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a programme drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and being in charge of experiential development towards **Engineer, Technologist and Technician** engineering**.**
Range Statement: Professional development involves: a) planning own professional development strategy	a) In most places of work training is seldom organised by a training department. It is up to the **Engineer, Technologist and Technician** to manage his/her own experiential development. **Engineer,**

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

b) selecting appropriate professional development activities c) recording professional development strategy and activities, while displaying independent learning ability.	**Technologist and Technician** frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely. b) Preference must be given to engineering development rather than developing soft skills. c) Developing a learning culture in the workplace environment of the **Engineer, Technologist and Technician** is vital to his/her success

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

APPENDIX B: TRAINING ELEMENTS

1	**Introduction**
1.1	*Induction programme* (typically 1–5 days)
1.1.1	Company structure
1.1.2	Company policies
1.1.3	Company Code of Conduct
1.1.4	Company safety regulations
1.1.5	Company staff code
1.1.6	Company regulations
1.2	*Exposure to Practical Aspects of Engineering (typically 6–12 months) and covers how things are:* (Responsibility Levels A–B)
Experience in one or more of these sectors but not all:	
1.2.1	Manufacturing
1.2.2	Construction
1.2.3	Erection
1.2.4	Field installation
1.2.5	Testing
1.2.6	Commissioning
1.2.7	Operation
1.2.8	Maintenance
1.2.9	Fault location
1.2.10	Problem investigation
2	**Design or develop solution**
2.1	*Experience in design and application of design knowledge* (typically 12–18 months). *Focus is on planning, design and application* (Responsibility Levels C–D)
In one or more of the above sectors:	
2.1.1	Analysis of data and systems
2.1.2	Planning of networks and systems
2.1.3	System modelling and integration
2.1.4	System design

2.1.5	Network/circuit design
2.1.6	Component/product design
2.1.7	Software design
2.1.8	Research and investigation
2.1.9	Preparation of specifications and associated documentation
2.1.10	Preparation of contract documents and associated documentation
2.1.11	Development of standards
2.1.12	Application of quality systems
2.1.13	Configuration Management
3	**Engineering tasks**
3.1	*Experience in the execution of engineering tasks* (rest of training period). *Focus should be on projects and project management* (Responsibility Level E)
3.1.1	Working in one or more of these sectors but not all
3.1.1.	Design or develop solution
3.1.2	Manufacture
3.1.3	Construction
3.1.4	Erection
3.1.5	Installation
3.1.6	Commissioning
3.1.7	Maintenance
3.1.8	Modifications
3.2	*Organising for implementation of 3.1* (Responsibility Level E)
3.2.1	Manage resources
3.2.2	Optimisation of resources and processes
3.3	*Controlling for implementation or operation of 3.1* (Responsibility Level E)
3.3.1	Monitor progress and delivery
3.3.2	Monitor quality
3.4	*Completion of 3.1* (Responsibility Level E)
3.4.1	Commissioning completion
3.4.2	Documentation completion
3.4.3	Documentation handover

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure

3.5	*Maintenance and repair of 3.1* (Responsibility Level E)
3.5.1	Planning and scheduling maintenance
3.5.2	Monitor quality
3.5.3	Oversee maintenance and repair
4	**Risk and impact mitigation**
4.1	*Impact and risk assessments* (Responsibility Level E)
4.1.1	Risk assessments
4.2	*Regulatory compliance* (Responsibility Level E)
4.2.1	Health and safety
4.2.2	Codes and standards
4.2.3	Legal and regulatory
5	**Managing engineering activities**
5.1	*Self-management* (Responsibility Levels C–D)
5.1.1	Manages own activities
5.1.2	Communicates effectively
5.2	*Team environment* (Responsibility Levels C–D)
5.2.1	Participates in and contributes to team planning activities
5.2.2	Manages people
5.3	*Professional communication and relationships (networking)* (Responsibility Levels C–D)
5.3.1	Establishes and maintains professional and business relationships
5.3.2	Communicates effectively
5.4	*Exercising judgement and taking responsibility* (Responsibility Level E)
5.4.1	Ethical practices
5.4.2	Code of Conduct
5.4.3	Exercises sound judgement in the course of complex engineering activities
5.4.4	Is responsible for decision-making in some or all engineering activities
5.5	*Competency development* (Responsibility Level D)
5.5.1	Plans own development programme
5.5.2	Constructs initial professional development record

CONTROLLED DISCLOSURE

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the ECSA Document Management System.

QM-TEM-001 Rev 2 – ECSA Policy/Procedure