ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Discipline-Specific Training Guide for Registration as Professional Engineering Technologist in Electrical Engineering

R-05-ELE-PT

REVISION No. 4: 15 July 2021

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TABLE OF CONTENTS

DEFINITIONS .......................................................................................................................... 4
ABBREVIATIONS .................................................................................................................... 6
BACKGROUND ......................................................................................................................... 7
1. PURPOSE OF THIS DOCUMENT ......................................................................................... 7
2. AUDIENCE .......................................................................................................................... 8
3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER COMMITMENT AND UNDERTAKING ......................................................................................... 9
4. ORGANISING FRAMEWORK FOR OCCUPATIONS .......................................................... 10
   4.1 Electrical Power Engineering ......................................................................................... 11
   4.2 Electronics Engineering ................................................................................................. 12
   4.3 Telecommunications Engineering .................................................................................. 13
   4.4 Control Engineering ....................................................................................................... 15
   4.5 Alternative Sources of Energy Engineering .................................................................... 19
5. NATURE AND ORGANISATION OF THE INDUSTRY ...................................................... 20
   5.1 Investigation .................................................................................................................. 21
   5.2 Research and development ............................................................................................ 22
   5.3 Process design ............................................................................................................... 22
   5.4 Risk and impact ............................................................................................................. 22
   5.4 Engineering project management .................................................................................. 23
   5.5 Implementation/Commissioning .................................................................................... 24
   5.6 Operations and maintenance ......................................................................................... 24
6. DEVELOPING COMPETENCY: DOCUMENT R-08-PT .................................................... 24
   5.1 Contextual knowledge ..................................................................................................... 24
   6.2 Functions performed ....................................................................................................... 25
   6.3 Statutory and regulatory requirements .......................................................................... 25
   6.4 Desirable formal learning .............................................................................................. 26
7. PROGRAMME STRUCTURE AND SEQUENCING .............................................................. 27
   7.1 Best practice ................................................................................................................. 27
7.2 Multi-disciplinary exposure ................................................................. 28
7.3 Orientation requirements ................................................................. 28
7.4 Realities ......................................................................................... 29
7.5 Generalists, specialists, researchers and academics ...................... 29
7.6 Moving into or changing candidacy training programmes ................ 29

REVISION HISTORY .............................................................................. 30
APPENDIX A: TRAINING ELEMENTS .................................................. 32
DEFINITIONS

Assessment criteria: A set of measurable performance requirements which indicate that a person meets a specified outcome at the required level.

Broadly defined engineering problems: A class of problems with characteristics as defined in document E-02-PT.

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 to provide the knowledge base for engineering specialisations.

Engineering Speciality: the extension of engineering fundamentals to create theoretical frameworks and bodies of knowledge for engineering practice areas.

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

Evaluation: Determination of the compliance of a result with prescribed criteria based on documentation, inspection and the application of judgement supported by reasoning.

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 will require 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.

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

Engineering Management: the generic management functions of planning, organising, leading and controlling, applied together with engineering knowledge in contexts including the management of projects, construction, operations, maintenance, quality, risk, change and business.
Over-determined problem: A problem for which the requirements are defined in excessive detail, making the required solution impossible to attain in all its aspects.

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.

Specified Category: A category of registration for persons registered through the Engineering Profession Act, 46 of 2000 or through a combination of the Engineering Profession Act and external legislation with specific Engineering competencies at NQF Level 5 regarding an identified need to protect the public safety, health and interest of the public and the environment in the performance of an engineering activity.

Sydney Accord: An agreement for the mutual recognition of engineering programmes that provide the educational foundation for professional engineering technologists.

Supervisor: A person who oversees and controls engineering work performed by a Candidate.
### ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>BDEA</td>
<td>Broadly defined engineering problem</td>
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<tr>
<td>ECSA</td>
<td>Engineering Council of South Africa</td>
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<td>DSTG</td>
<td>Discipline-specific Training Guide</td>
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<td>ICT</td>
<td>Information Computer Technology</td>
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<td>JBCC</td>
<td>Building Contract Committee</td>
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<td>NEC</td>
<td>New Engineering Contract</td>
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<td>PDA</td>
<td>Personal Digital assistants</td>
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<td>TER</td>
<td>Training and Experience Report</td>
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<tr>
<td>VIPs</td>
<td>Value Improved Practices</td>
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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.

![Diagram illustrating the documents defining the ECSA registration system](image)

Figure 1: Documents defining the ECSA registration system

1. PURPOSE OF THIS DOCUMENT

All persons applying for registration as a Professional Engineering Technologist are expected to demonstrate the competencies specified in document R-02-STA-PE/PT/PCE/PN
through work performed at the prescribed level of responsibility, irrespective of the Candidate’s discipline.


In document R-04-T&M-GUIDE-PC, attention is drawn to the following sections:
- 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.

Document R-08-PT provides a high-level, outcome-by-outcome understanding of the competency standards that form an essential basis for this Discipline-specific Training Guide (DSTG).

The guides R-04-T&M-GUIDE-PC and R-08-PT are subordinate to the ‘Policy on Registration in Professional Categories’ (document R-01-POL-PC), the document R-02-STA-PE/PT/PCE/PN and the ‘Processing of Applications for Registration of Candidates and Professionals’ (document R-03-PRO).

2. AUDIENCE
The DSTG is directed towards Candidates and their Supervisors and Mentors in the discipline of Electrical Engineering, which comprises bio-engineering, computer engineering, control engineering, mechatronic engineering, electronic engineering, power engineering, software engineering, information engineering, telecommunications engineering and others. The guide is intended to support a programme of training and experience through incorporating elements of good practice.
The guide applies to persons who wish to be registered as a Professional Engineering Technologist with the ECSA. The applicants must:

- have an accredited BTech programmes (Nated-aligned) (with a cognate NDip (Nated-aligned) as prerequisite) listed on ECSA website
- have an accredited BEng Tech programme (E-02-PT) and Adv Dip Eng programme (E-05-PT) listed on ECSA website
- hold a relevant academic qualification that is recognised by the ECSA through accreditation or evaluation or be in possession of a Sydney Accord recognised qualification
- be registered as a Candidate Engineering Technologist or demonstrate training to an acceptable level of competence in specific elements relating to Electrical or Electronics Engineering for at least 3 years after obtaining a Bachelor of Engineering Technology
- have embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) with a Mentor guiding the professional development process at each stage; or
- be part of an ECSA certified Training Academy.

3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER COMMITMENT AND UNDERTAKING

Irrespective of the development path followed, all applicants for registration must present the same evidence of competence and be assessed against the same standards. Application for registration as a Professional Engineering Technologist is permitted without being registered as a Candidate Engineering Technologist and without training through a C&U candidacy programme. Mentorship and adequate supervision are, however, key factors in effective development to attain the level required for registration.

If the Candidate’s employer does not offer C&U, the Candidate must establish the level of mentorship and supervision the employer is able to provide. In the absence of an internal Mentor, the services of an external Mentor should be secured. The Voluntary Association for the discipline may be consulted for assistance in locating an external Mentor. A Mentor must keep abreast of all stages of the development process.
The DSTG is written for graduates who are training and gaining experience towards registration. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development. Applicants who have not enjoyed mentorship are advised to request an experienced Mentor (internal or external) to act as an application adviser while they prepare their applications for registration.

4. ORGANISING FRAMEWORK FOR OCCUPATIONS

Electrical Technologist – Organising Framework for Occupations (OFO)

Electrical Technologists form a collective group of engineers who conduct research and design, advise, plan and direct the construction and operation of electronic, electrical and telecommunication systems, computer and software systems, components, motors and equipment. Electrical Technologists organise and establish control systems to monitor the performance and safety of electrical and electronic components, assemblies and systems.

The functions of Electrical Technologists include the planning, design, construction, operation and maintenance of materials, components, plants and systems for generating, transmitting, distributing and utilising electrical energy. The field of Electrical Engineering encompasses electronic devices, apparatus and control systems for industrial systems together with biomedical devices, robotics and consumer products. Computing, communication and software for critical applications, instrumentation and control of processes are addressed through the application of electrical, electromagnetic and information engineering sciences.

Engineering Technologists are generally practising in specialist areas or operating in a broadly defined application of systems. Specialist areas may include the following:

- Electrical Power Engineering
- Electronics Engineering
- Telecommunications Engineering
- Control and Automation Engineering
- Control and Instrumentation Engineering
- Instrumentation Engineering
• Computer Engineering
• Computer and Software Engineering.

4.1 Electrical Power Engineering

Power Engineering is a subfield of Electrical Engineering that deals with the generation, transmission and distribution of electric power including the utilisation of the electrical apparatus connected to such networks. Much of this field is concerned with the problems regarding three-phase AC power, the standard for large-scale power transmission and distribution across the modern world. However, a significant fraction of the field is concerned with the conversion of AC and DC power and the development of specialised power systems such as those used in aircraft and for electric railway networks. Power Engineering draws the bulk of its theoretical base from Electrical Engineering. Power Engineering covers electrical power system components, generators, motors and equipment, electrical engineering materials and the development and processing of products.

Power Engineering Technologists may work on systems that do not connect to the grid. These systems are called off-grid power systems and may be used in preference to on-grid systems for a variety of reasons. Power Engineering Technologists may conduct research and advise on the designs and direct the construction and operation of electrical systems, components, motors and equipment. They may also advise on these systems and direct their functioning, maintenance and repair. In addition, Power Engineering Technologists may study and give advice on the technological aspects of electrical engineering materials, products and processes.

Typical tasks that a Power Engineering Technologist may undertake include:
• conducting research and developing new or improved theories and methods relating to Electrical Power Engineering
• advising on and designing power stations and systems that generate, transmit and distribute electrical power
• building services
• infrastructure (medium/high voltage reticulation)
• Industrial engineering services.
Power Engineering is a field that covers the spectrum of engineering specialisations listed below:

- **Electricity generation** covers the selection, design and construction of facilities that convert energy from primary forms to electric power.
- **Electric power transmission** requires the engineering of high voltage transmission lines and substations to interface to generation and distribution systems. High voltage direct current systems are one of the elements of an electric power grid.
- **Electric Power Distribution Engineering** covers the elements of a power system from a substation to the end customer.
- **Power system protection** is the study of the ways an electrical power system can fail and the methods to detect and mitigate such failures.

In most projects, a Power Engineering Technologist must coordinate with persons in many other disciplines such as Civil and Mechanical Engineers, environmental experts and legal and financial personnel. Major power system projects such as a large generating station may require scores of design professionals in addition to the power system engineers. At most levels of professional power system engineering practice, the Engineer requires as much in the way of administrative and organisational skills as Electrical Engineering knowledge.

### 4.2 Electronics Engineering

**Electronics Engineering** is an Electrical Engineering discipline that utilises non-linear and active electrical components (e.g., semiconductor devices, especially transistors, diodes and integrated circuits) to design electronic circuits, devices, microprocessors, microcontrollers and other systems. The discipline also designs passive electrical components, usually based on printed circuit boards.

**Electronics** is a subfield within the wider Electrical Engineering academic subject but denotes a broad engineering field that covers subfields such as Analogue Electronics, Digital Electronics, Consumer Electronics, embedded systems and power electronics. Electronics Engineering deals with the implementation of applications, principles and algorithms that are developed within many related fields, for example, solid-state physics, radio engineering, telecommunications, control systems, signal processing, systems engineering, computer engineering, instrumentation engineering and electric power control and robotics.
Typical tasks an **Electronics Technologist** may undertake include

- Defining, comprehending and applying the knowledge to solve electronic engineering problems.
- Conducting research and developing new or improved theories and methods relating to Electronics Engineering.
- Advising on and designing electronic devices or components, circuits, semi-conductors and systems.
- Specifying production or installation methods, materials and quality standards and directing production or installation of electronic products and systems.

Practising Electronics Technologists may be involved in design, operations, maintenance and commissioning within the following areas:

- Communications
- Mechatronics
- Electronics design information
- Supervisory control and data acquisition (SCADA) and electronic control
- Control and instrumentation
- Television
- Biomedical and clinical
- Fire safety (rail network control – fire detection)
- Railway signalling
- Aircraft electronic systems.

### 4.3 Telecommunications Engineering

**Telecommunications Engineering** deals with the transmission of information across a channel such as a co-axial cable, optical fibre or free space. Transmissions across free space require information to be encoded in a carrier wave to shift the information to a carrier frequency suitable for transmission. This is known as modulation. Popular analogue modulation techniques include amplitude modulation and frequency modulation. The choice of modulation affects the cost and performance of a system and the Engineer must balance these two factors carefully. Once the transmission characteristics of the system are determined, Telecommunications Engineers
design the transmitters and receivers needed for the system. The transmitters and receivers are sometimes combined to form a two-way communication device known as a transceiver. A key consideration in the design of transmitters is their power consumption because this is closely related to their signal strength. If the signal strength of a transmitter is insufficient, the signal’s information will be corrupted by noise.

Telecommunications Engineering Technologists apply the conceptual designs and systems, conduct research, provide advice on the system design and direct the construction, maintenance and repair of telecommunication systems and equipment with some guidance from the engineers. Telecommunications Engineering Technologists apply and advise on technological aspects of Telecommunications Engineering, materials, products and processes. Plans, designs and monitors broadly define complex telecommunication networks and associated broadcasting equipment.

Typical tasks a Telecommunication Engineering Technologist may undertake include:

- conducting research and developing new or improved theories and methods relating to Telecommunications Engineering
- advising on and designing telecommunication devices, components, systems, equipment and distribution centres
- specifying production and installation methods, materials and quality and safety standards
- directing production and installation work of telecommunication products and systems
- supervising, controlling, developing and monitoring the operation and maintenance of telecommunication systems, networks and equipment
- determining manufacturing methods for telecommunication systems
- maintaining and repairing existing telecommunication systems, networks and equipment
- organising and directing the maintenance and repair of existing telecommunication systems, networks and equipment
- researching and advising on telecommunication equipment
- planning and designing communication networks based on wired, fibre optic and wireless communication media
• designing and developing signal processing algorithms and implementing these through appropriate choice of hardware and software
• designing telecommunication networks and radio and television distribution systems, including both cable transmission and over the air broadcasting.

Practising Telecommunications Engineering Technologists may be involved in design, operations, maintenance and commissioning within the following areas:

• Broadcasting
• Digital signal processing
• Communications
• Fibre optics
• Radio frequency
• Radar Engineering
• Radio Engineering
• Radio and telecommunication
• Satellite transmission
• Signal processing systems
• Communications consulting
• Communications specialist (ICT)
• Telecommunications consulting
• Telecommunication network planning
• Microwave.

4.4 Control Engineering

Control Engineering has a wide range of applications from the flight and propulsion systems of commercial airplanes to the cruise control present in many modern cars. Control Engineering also plays an important role in industrial automation.

• Control and Instrumentation Engineering often utilises feedback in designing control systems. For example, in a car with cruise control, the vehicle’s speed is continuously monitored and fed back to the system, which adjusts the engine’s power output
accordingly. Where there is regular feedback, control theory can be used to determine how the system responds to feedback.

- **Instrumentation Engineering** deals with the design of devices to measure physical quantities such as pressure, flow and temperature. These devices are known as instrumentation.

- **Computer Engineering** deals with the design of computers and computer systems. This may involve the design of new computer hardware, the design of palmtop computers/personal digital assistants (PDAs) or the use of computers to control an industrial plant. Development of embedded systems – systems made for specific tasks (e.g., mobile phones) – is also included in this field. Computer Engineering includes the micro controller and its applications. The Computer Engineering Technologist may also work on a system’s software. However, the design of complex software systems is often the domain of Software Engineering, which is usually considered a separate discipline.

- **Computer and Software Engineering** addresses the relationships and interactions between software, hardware and external systems in solving real Engineering problems. Computer Engineering concentrates on the ways in which computing ideas are mapped into working physical systems. Computer Engineering rests on the intellectual foundations of Electrical Engineering, computer science, the natural sciences and mathematics.

- **Computer and Software Engineering Technologists** provide advice, consult, design and direct the construction, maintenance and repair of software, equipment and computer-based systems. These technologists predominately apply the technological aspects of computer-based systems, software, products and processes. They perform system analysis on the requirements of computer-based systems and software and specify the systems required. Computer and Software Engineering Technologists plan, design and monitor broadly defined, complex, computer-based systems, software and networks and the associated communication equipment.

Typical tasks a Computer and Software Engineering Technologist may undertake include:

- conducting research and developing new or improved theories and methods relating to Computer and Software Engineering
• advising on and designing computer-based systems and components, system equipment, software and distribution centres
• specifying production and installation methods, materials and quality and safety standards
• directing production and installation work of computer-based products, software and systems
• supervising, controlling, developing and monitoring the operation and maintenance of computer-based systems, software, networks and equipment
• organising and directing the maintenance and repair of existing computer-based systems, programmes and equipment
• researching and advising on computer-based equipment and software
• planning and designing computer-based communication networks based on wired, fibre optic and wireless communication media and ultra-high-speed data networks
• conducting system analyses, designing and developing complex computer-based systems
• implementing complex computer-based systems through appropriate choice of hardware and managing the development of the necessary software
• determining manufacturing methods for computer-based systems and the maintenance and repair of existing computer-based systems, networks and equipment.

Practising Computer Engineering Technologists may be involved in design, operations, maintenance and commissioning within the following areas:
• Computer communication
• Computer network design
• Computer network sales
• Software Engineering
• Systems Engineering
• Computer-system design or analytics.

Power and Electronics Engineering Technologists also practise in combinations of the above specialities as well as other disciplines such as Mechatronics Engineering which involves robotic
and process control. Typical tasks that a Power and Electronics Engineering Technologist may undertake include:

- specifying instrumentation, measurement and control of equipment for the monitoring and control of electrical generation, transmission and distribution systems
- supervising, controlling, developing and monitoring the operation and maintenance of electrical generation, transmission and distribution systems
- advising on and designing systems for electrical motors, electrical domestic appliances, electrical traction and other electrical equipment
- executing the development and application of engineering standards and procedures
- 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 in addition to maintenance and repair of existing electrical systems, motors and equipment
- designing and developing electrical apparatus
- supervising, controlling, developing and monitoring the operation and maintenance of electronic equipment and systems
- establishing control standards and procedures to ensure efficient functioning and safety of electronic systems and equipment
- organising and directing the maintenance and repair of existing electronic systems and equipment
- designing electronic circuits and components for use in fields such as aerospace, guidance and propulsion control, acoustics or instruments and controls
- determining manufacturing methods for electronic systems and maintenance and repair of existing electronic systems and equipment
- 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
- developing apparatus and procedures to test electronic components, circuits and systems
• designing, specifying and implementing control and instrumentation of plants and processes
• designing, specifying, controlling and monitoring of equipment for fire and safety in plants and factories
• controlling robotics and processes of manufacturing plants
• increasing energy efficiency of photovoltaic cells.

4.5 Alternative Sources of Energy Engineering

Alternative Sources of Energy Technologists conduct research and advise on design and direct the construction, maintenance and repair of renewable energy sources such as wind, solar and wave. These technologists study and advise on the technological aspects of computer-based systems, software, products and processes. They perform system analysis on computer-based system requirements and software and specify the systems required. Alternative Energy Technologists plan, design and monitor complex computer-based systems, software, networks and associated communication equipment.

Typical tasks an Alternative Energy Technologist may undertake include:

• conducting research and developing new or improved theories and methods relating to Alternative Energy Engineering
• advising on and designing computer-based systems, components, systems equipment, software and distribution centres
• specifying production and installation methods, materials and quality and safety standards
• directing production and installation work of computer-based products, software and systems
• supervising, controlling, developing and monitoring the operation and maintenance of alternative energy systems, software, networks and equipment
• organising and directing the maintenance and repair of existing computer-based systems, programmes and equipment
• researching and advising on alternative energy equipment and software
• planning and designing computer-based communication networks based on wired, fibre optic and wireless communication media and ultra-high-speed data networks
• performing system analyses together with designing and developing complex computer-based systems
• implementing these computer-based systems through appropriate choice of hardware and managing the development of the necessary software
• determining manufacturing methods for computer-based systems and directing the maintenance and repair of existing computer-based systems, networks and equipment.

Practising Alternative Energy Technologists may concentrate in one or more of the following areas:

• Computer Engineering
• Control and Instrumentation Engineering
• Energy Management Engineering
• Electrical Design Engineering
• Electrical Power Generation Engineering
• Electromechanical Engineering
• Power Distribution Engineering
• Power Systems Engineering
• Power Transmission Engineering
• Power Engineering
• Computer System Engineering (Analyst/Engineer)
• Computer System Design Engineering
• Computer Communication Engineering (specialist)
• Computer Network Design Engineering
• Computer Network Sales Engineering
• Software Engineering
• Systems Engineering.

5. NATURE AND ORGANISATION OF THE INDUSTRY

Electrical Engineering Technologists may be employed in either the private or the public sector. In the private sector, these technologists would typically be involved in consulting or contracting or be employed in the supply or manufacturing industry. Engineering consultants are responsible
for planning, designing, documenting and supervising the construction of projects on behalf of their clients. Engineering contractors are responsible for project implementation and their activities include planning, construction and labour and resource management. Electrical Engineering Technologists working in supply or manufacturing companies would be involved in production, supply and quality control and may participate in research and development.

The public sector, which is usually the client, is responsible for service delivery although in some departments, design and construction are also carried out. Electrical Engineering Technologists are required at all levels of the public sector, including national, provincial and local government, state-owned enterprises and public utilities. The public sector largely addresses planning and specifies and oversees the implementation, operation and maintenance of infrastructure. Extensions of the public sector include tertiary academic institutions and research organisations.

Depending on where the Candidate is employed, there may be situations where the in-house opportunities are insufficiently diverse to develop the competencies required in all the groups noted in document R-02-STA-PE/PT/PCE/PN. For example, opportunities for developing problem-solving competence (designing and developing solutions) and for managing Engineering activities (constructing and implementing solutions) may not be available to the Candidate. In such cases, employers are encouraged to put a secondment system in place.

It is a common practice that in situations where an organisation cannot provide training to Candidates in certain areas, Candidates' secondment is arranged with other organisations to allow Candidates to develop all the standard competencies required for registration. Secondment of Candidates is usually reciprocal and thus, both employers and employees mutually benefit. Seconding candidates among Consultants, contractors, public entities and the private sector should be possible and encouraged.

5.1 Investigation

Applicants are expected to be exposed to the technical investigation of equipment, plant and product failure. The intent is for the applicant to be able to define the Engineering problem, investigate and analyse the broadly defined Engineering problems. Ultimately, the applicant must be able to demonstrate different options for developing a solution. Engineering Technologists
involved in designing products, generating plants, power networks and systems must be able to demonstrate their ability to investigate a product or equipment failure.

5.2 Research and development
Research and development are difficult to manage since the defining feature of research is that the researcher does not know in advance exactly how to accomplish the desired result. Sometimes research projects are abandoned or deferred due to company financial constraints, and this may leave the Engineering Technologist practising in this area in a dilemma. If the project is cancelled or placed on hold before the Engineering Technologist has completed the research cycle, the Candidate or applicant is unlikely to meet all the competency minimum standards for registration as a Professional Engineering Technologist.

It is strongly recommended that Candidates or applicants practising in the specialised area of research and development continually engage with their employers and become involved in more than one project to minimise the risk of spending time on a project that carries the risk of being cancelled.

5.3 Process design
Process design is the design of processes for desired physical and/or chemical transformation of materials. Process design is central to Chemical Engineering and can be considered the summit of the field, bringing together all the field's components.

Process design can be the design of new facilities or the modification or expansion of existing facilities. The design starts at a conceptual level and ultimately ends in the form of fabrication and construction plans. Very often, organisations introduce processes to standardise their designs and operations for efficiency purposes. Engineering Technologists operating in the manufacturing industries and coal/nuclear generating plants are expected to understand the process design of their plant.

5.4 Risk and impact
Technical risk is a major factor to be considered in the acquisition of 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 on the project, system or entire infrastructure if the implementation does not perform as anticipated.

Failure to identify or properly manage this risk results 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. This will prevent issues from occurring without warning and drastically decrease the effort required in alleviating sudden infrastructure or system problems.

Therefore, Candidate Technologists or applicants must familiarise themselves with the organisational risk policies and standards. These risks may be identified or demonstrated in building services, product development or research and development related projects.

### 5.5 Engineering project management

The areas in which Electrical Technologists work generally follow a conventional project or product development life cycle model:

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

Candidates are not expected to change their places of employment to acquire all the skills in the areas listed above. However, it is expected that Candidate Technologists or persons wishing to register with ECSA must ensure that they are employed in the areas that encourage them to undertake tasks that provide experience in all the generic engineering competencies of problem-solving.

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solving, implementation, operation, risk and impact mitigation and management of engineering activities.

A schema is presented in the Appendix that indicates the functions in which a Candidate should be competent when carrying out the various phases of a project:

- Solving problems based on engineering and contextual knowledge
- Implementing or operating Engineering projects, systems, products and processes
- Mitigating risk and impact
- Managing the Engineering activities.

Three levels of description are given. Regarding the third level, the description is largely independent of the discipline. Discipline specifics may be included as fourth and fifth levels as required. These specifics would include the types of evidence of performance that would be appropriate at each line and record keeping of the evidence.

5.6 Implementation/Commissioning
In the commissioning of equipment or systems, the applicant must demonstrate an understanding of the engineering concepts utilised in the system: (i) how the equipment functions; (ii) the reason the equipment was acquired; and (iii) the impact that these concepts will have on the business.

5.7 Operations and maintenance
In the maintenance environment, the Candidates or persons wishing to register must demonstrate: (i) the engineering and financial implications involved; (ii) why the equipment is maintained at the prescribed intervals; and (iii) what tests have to be done to verify the proper functioning of the equipment before re-commissioning.

6. DEVELOPING COMPETENCY: DOCUMENT R-08-PT
6.1 Contextual knowledge
Candidate Technologists or applicants are expected to be aware of the Voluntary Associations applicable to the Electrical Engineering fraternity and the functions and services rendered by those associations to their respective members.
6.2 Functions performed

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

- Group A: Knowledge based problem solving (this should be a strong focus)
- Group B: Management and Communication
- Group C: Identifying and mitigating the impacts of engineering activity
- Group D: Judgement and responsibility
- Group E: Independent learning.

It is useful to measure the progression of the Candidate’s competency by using the Degree of Responsibility, the Problem Solving and the Engineering Activity scales as specified in document R-04-T&M-GUIDE-PC.

The Appendix has been developed against the Degree of Responsibility Scale. Activities should be selected to ensure the Candidate reaches the required level of competency and responsibility.

It should be noted that persons 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.

6.3 Statutory and regulatory requirements

Candidate Technologists or persons wishing to register with the ECSA are expected to have a working knowledge of the following regulations and Acts and how this legislation affects their working environment:

- Engineering Profession Act, 46 of 2000, including the rules and the ECSA Code of Conduct
- Wiring Code – SANS 10142
- Factory Regulations – SANS 10400
• Machinery and Works Regulations
• Labour Relations Act, 66 of 1999
• Industry Specific Work Instructions – Mine Health and Safety Act. 29 of 1996
• SANS applicable specifications
• Related ICASA licensing requirements.

Other Acts not listed here may also be pertinent to a Candidate’s work environment. Candidates are expected to have a basic knowledge of the Acts that are applicable to their work environment.

6.4 Desirable formal learning
The following list of formal learning activities is by no means extensive and is simply a sample of useful courses:

• 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.

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

7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best practice
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.

It is suggested that Candidates/applicants work with their Mentors to determine appropriate projects to gain exposure to elements of the asset life cycle. This will ensure that Candidates’ designs are feasible, implementable and sustainable and have considered, life-cycle costing. A regular reporting structure, demonstrating evidence of achievement against the competency outcomes and the responsibility level must be maintained.

The training programme should be such that the Candidate progresses 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, the Candidate exhibits Responsibility Level E and is 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 are as follows:

- 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
- Value Engineering
- Constructability.

7.2 Multi-disciplinary exposure

Interface management among various disciplines needs to be formalised. Details of signed off interface documents between different disciplines are essential.

7.3 Orientation requirements

The following orientation requirements should be undertaken:

- Introduction to company safety regulations
- Company code of conduct
- Company staff code and regulations
- King IV Governance structure requirements
- Organisational business objectives and departmental roles of the company
- Hands-on experience and orientation in each of the major company divisions.
7.4 Realities

Irrespective of the discipline, it is unlikely that the period of training will be less than 3 years, which is the minimum time required by ECSA. Typically, the period of training is longer and is determined by the availability of functions in the actual work situation among other factors.

7.5 Generalists, specialists, researchers and academics

Document R-08-PT adequately describes what is expected of persons whose formative development has not followed a conventional path, for example, academics, researchers and specialists. The overriding consideration is that irrespective of the route followed, the applicant must provide evidence of competence against the 11 minimum outcome standards.

7.6 Moving into or changing candidacy training programmes

This guide assumes that the Candidate enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the Candidate is 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:

- The Candidate must complete the Training and Experience Summary (TES) and the Training and Experience Reports (TERs) for the previous programme or unstructured experience. In regard to the latter, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant Supervisor.
- On entering the new programme, the Mentor and Supervisor should review the Candidate’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 Candidate’s programme.
**REVISION HISTORY**

<table>
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<tr>
<th>Revision number</th>
<th>Revision date</th>
<th>Revision details</th>
<th>Approved by</th>
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<tbody>
<tr>
<td>Rev 0: Concept A</td>
<td>26 Jan 2012</td>
<td>Initial attempt at Electrical DSTG</td>
<td>Carien Botha</td>
</tr>
<tr>
<td>Rev 0: Concept B</td>
<td>10 Jun 2012</td>
<td>Further attempt with schedule RAH</td>
<td>Schalk Claasen</td>
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<tr>
<td>Rev 0: Concept C</td>
<td>09 Sept 2012</td>
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<tr>
<td>Rev 0: Concept D</td>
<td>29 Oct 2012</td>
<td>Standard section 1–3 Formatting</td>
<td>Schalk Claasen and Carien Botha</td>
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<td>Rev 0: Concept D(3)</td>
<td>11 Jan 2013</td>
<td>Software added and other corrections</td>
<td></td>
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<tr>
<td>Rev 1</td>
<td>12 Mar 2013</td>
<td>Review in accordance with approved DSTG Framework</td>
<td>Registration Committee for Professional Engineers</td>
</tr>
<tr>
<td>Rev 2</td>
<td>16 Nov 2017</td>
<td>Review in accordance with approved DSTG Framework</td>
<td>Registration Committee for Professional Engineers</td>
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<tr>
<td>Rev 3 Draft A</td>
<td>28 June 2021</td>
<td>The document has been revised to include definitions and to update document numbers in cases where the document number of referenced document have changed for consistency and to align with the internal document numbering requirements. Additional information is added under the heading, “Audience”.</td>
<td>Executive: RPS</td>
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<tr>
<td>Rev 3</td>
<td>15 July 2021</td>
<td>Approval</td>
<td>RPSC</td>
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The Discipline-specific Training Guide for:

Candidate Professional Engineering Technologist in Electrical Engineering

Revision 3 dated 15 July 2021, ad consisting of 29 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards (RPS).

.....................................      .................................
Business Unit Manager                                    Date

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Executive: RPS                                      Date

This definitive version of this policy is available on our website.
APPENDIX A: TRAINING ELEMENTS

Synopsis: A Candidate-Engineering Technologist should achieve specific competencies at the prescribed level during his/her development towards professional registration, while 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 stage of an Engineering career:

1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical Engineering training concepts to develop best possible solutions and present to the clients.
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 cognisant about the impact of the Engineering activity and act to mitigate this impact.
7. Consider and adhere to legislation applicable to the task and the associated risk identification and management.
8. Strictly adhere 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 program and develop your own lifelong development programme within this framework.

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

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing
<table>
<thead>
<tr>
<th>Competency Standards for Registration as a Professional Engineering Technologist</th>
<th>Explanation and Responsibility Level</th>
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</thead>
<tbody>
<tr>
<td><strong>1. Purpose</strong>&lt;br&gt;This standard defines the competence required for registration as a Professional Engineering Technologist. Definitions of terms having particular meaning within this standard is given in text in Appendix B.</td>
<td>DSTGs give context to the purpose of the Competency Standards. Professional Engineering Technologists operate within the nine 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. DSTG’s 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).&lt;br&gt;&lt;br&gt;&lt;strong&gt;NOTE:&lt;/strong&gt; 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 7.1 in the specific DSTG)</td>
</tr>
<tr>
<td><strong>2. Demonstration of competence</strong>&lt;br&gt;Competence must be demonstrated within broadly defined engineering activities, defined below, by integrated performance of the outcomes defined in section 3 at the level defined for each outcome. Required contexts and functions may be specified in the applicable Discipline Specific Guidelines.</td>
<td>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)&lt;br&gt;&lt;br&gt;Activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.</td>
</tr>
<tr>
<td><strong>Level Descriptor:</strong> Broadly defined engineering activities (BDEA) have several of the following characteristics:&lt;br&gt;a) Scope of practice area is linked to technologies used and changes by adoption of new technology into current practice.&lt;br&gt;b) Practice area is located within a wider, complex context, requires teamwork, and has interfaces with other parties and disciplines.&lt;br&gt;c) Involves a variety resources, including people, money, equipment, materials and technologies.&lt;br&gt;d) Requires resolution of occasional problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues.</td>
<td><strong>Level Descriptor:</strong> BDEA in the various disciplines are characterised by several or all of the following:&lt;br&gt;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.&lt;br&gt;b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on complex activities and problems. Broadly defined activities in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team.&lt;br&gt;c) The bulk of the work involves familiar, defined range of resources, including people, money, equipment, materials, but new technologies are investigated and implemented.&lt;br&gt;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.</td>
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### Subject: Discipline-Specific Training Guide for Registration as Professional Engineering Technologist in Electrical Engineering

<table>
<thead>
<tr>
<th>Compiler:</th>
<th>Approving Officer:</th>
<th>Next Review Date:</th>
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<tbody>
<tr>
<td>MB Mtshali</td>
<td>EL Nxumalo</td>
<td>15/07/2025</td>
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</table>

| 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. |

| 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 | 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 Engineering Technologists, 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

**Outcome 1:** Define, investigate and analyse *broadly defined* engineering problems

**Responsibility Level E**

Analysis of an engineering problem means the ‘separation into parts possibly with comment and judgement’. *Broadly* means ‘not minute or detailed’ and ‘not kept within narrow limits’.

**Broadly defined engineering problems** have the following characteristics. They require coherent and detailed engineering knowledge, underpinning the technology area; and one or more of the following:

| a) | are ill-posed, under- or over-specified, require identification and interpretation into the technology area |
| b) | encompass systems within complex engineering systems; belong to families of problems which are solved in well-accepted but innovative ways; and one or more of: |
| c) | can be solved by structured analysis techniques |

<p>| a) | Coherent and detailed engineering knowledge for Engineering Technologists 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. |</p>
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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<tbody>
<tr>
<td>4) d)</td>
<td>may be partially outside standards and codes; must provide justification to operate outside</td>
</tr>
<tr>
<td>4) e)</td>
<td>require information from practice area and sources interfacing with practice area that is complex and incomplete</td>
</tr>
<tr>
<td>4) f)</td>
<td>involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties; \textit{and one or both of:}</td>
</tr>
<tr>
<td>4) g)</td>
<td>require judgement in decision-making in practice area, considering interfaces to other areas</td>
</tr>
<tr>
<td>4) h)</td>
<td>have significant consequences which are important in practice area but may extend more widely.</td>
</tr>
<tr>
<td>4) i)</td>
<td>It is recognised that the problem can be classified as a falling within a typical solution requiring innovative adaptation to meet the specific situation.</td>
</tr>
<tr>
<td>4) j)</td>
<td>Solving the problem needs a step-by-step approach adhering to proven logic.</td>
</tr>
<tr>
<td>4) k)</td>
<td>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.</td>
</tr>
<tr>
<td>4) l)</td>
<td>The responsibility lies with the Engineering Technologist to verify that some information received as part of the problem encountered may remain incomplete and solutions to problems may need justified assumptions.</td>
</tr>
<tr>
<td>4) m)</td>
<td>The problem handled by an Engineering Technologist may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, not maintainable, not sustainable, etc; the Technologist will have to justify his/her recommendation.</td>
</tr>
<tr>
<td>4) n)</td>
<td>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.</td>
</tr>
<tr>
<td>4) o)</td>
<td>Engineering Technologists 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.</td>
</tr>
</tbody>
</table>

**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 engineering technologist 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:

<table>
<thead>
<tr>
<th>Range statement</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome 2:</strong></td>
<td><strong>Responsibility Levels C and D</strong></td>
</tr>
<tr>
<td>Design or develop solutions to broadly defined engineering problems</td>
<td>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’.</td>
</tr>
<tr>
<td><strong>Assessment criteria:</strong> 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:</td>
<td>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:</td>
</tr>
<tr>
<td>2.1 Designed or developed solutions to broadly defined engineering problems</td>
<td>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.</td>
</tr>
<tr>
<td>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)</td>
<td>2.2 The Engineering Technologist 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.</td>
</tr>
<tr>
<td>2.3 Drawing up of detailed specification requirements and design documentation for implementation to the satisfaction of the client.</td>
<td>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.</td>
</tr>
</tbody>
</table>

**Range Statement:** Solutions are those enabled by the technologies in the Candidate’s practice area.

**Applying theory to do broadly 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 procedures, specifications, etc.
**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 Engineering Technologist 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.

1. **Apply engineering principles, practices, technologies, including the application of BTech or B Eng (Tech) theory in the practice area.**
2. **Indicate working knowledge of areas of practice that interact with practice area to underpin teamwork.**
3. **Apply related knowledge of finance, statutory, safety and management.**

**Design work for Engineering Technologists is based on BTech theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel technology. Engineering Technologists 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.**

1. **Calculations at BTech or B Eng (Tech) 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.**
2. **The understanding of broadly defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team.**
3. **The ability to manage the resources within legal and financial constraints must be evident.**

**Range Statement:** Applicable knowledge includes:

1. **Technological knowledge that is well-established and applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others.**

2. **The specific location of a task to be executed is the most important determining factor in the layout design of equipment. A combination of educational knowledge and practical experience 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.**

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Subject: Discipline-Specific Training Guide for Registration as Professional Engineering Technologist in Electrical Engineering

Compiler: MB Mtshali

Approving Officer: EL Nxumalo

Next Review Date: 15/07/2025

Page 38 of 44

b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.

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.

b) In spite of having a working knowledge of interacting disciplines, Engineering Technologists 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.

Jurisdictional in this instance means ‘having the authority’, and Engineering Technologists 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

Outcome 4:
Manage part or all of one or more broadly defined engineering activities.

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.

4.3 Knowledge of conditions and operation of contractors and the ability.

Responsibility Level D
Manage means ‘control’.

In Engineering operations Engineering Technologists will typically be 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.

4.3 Depending on the project, Engineering Technologists 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 well-defined engineering involves:**

<table>
<thead>
<tr>
<th>a) Planning</th>
<th>b) Organising</th>
<th>c) Leading</th>
<th>d) Controlling</th>
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<tbody>
<tr>
<td><strong>Planning</strong> broadly defined activities</td>
<td><strong>Organising</strong> broadly defined activities</td>
<td><strong>Leading</strong> broadly defined activities</td>
<td><strong>Controlling</strong> broadly defined activities</td>
</tr>
</tbody>
</table>

Engineering Technologists 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**

**Outcome 6:**

Recognise the foreseeable social, cultural and environmental effects of broadly defined engineering activities generally

**Explanation and Responsibility Level**

<table>
<thead>
<tr>
<th>Responsibility level B</th>
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</table>
| 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:
Subject: Discipline-Specific Training Guide for Registration as Professional Engineering Technologist in Electrical Engineering

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Outcome 7:
Meet all legal and regulatory requirements and protect the health and safety of persons in the course of their broadly defined engineering activities.

Assessment criteria:
7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity.
7.2 Identified applicable legal and regulatory requirements demonstrating awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.

Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include the following:

a) 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.

b) 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 Engineering Technologist seeks advice from knowledgeable and experienced specialists if the slightest doubt exist that safety and sustainability cannot be guaranteed.

Outcome 7:
Meet all legal and regulatory requirements and protect the health and safety of persons in the course of their broadly defined engineering activities.

Assessment criteria:
7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity.
7.2 Identified applicable legal and regulatory requirements demonstrating awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.

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. Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied.

b) 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 Engineering Technologist before starting the work.

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), compensation paid, etc.

6.1 Identified applicable legal and regulatory requirements for the engineering activity.
6.2 Identified applicable legal and regulatory requirements demonstrating awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.
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.
e) Regulatory requirements are explicit for the context in general.

<table>
<thead>
<tr>
<th>Group D: Exercise judgment, take responsibility, and act ethically</th>
<th>Explanation and Responsibility Level</th>
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<tbody>
<tr>
<td><strong>Outcome 8:</strong> Conduct engineering activities ethically.</td>
<td><strong>Responsibility level E</strong></td>
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</table>
| **Assessment Criteria:** Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: | Ethically means ‘science of morals; moral soundness’.
| 8.1 Converseance and operation in compliance with ECSA’s Rules of Conduct for registered persons confirmed | Moral means ‘moral habits; standards of behaviour; principles of right and wrong’. |
| Systematic means ‘methodical; based on a system’. 8.1 ECSA’s Code of Conduct, as per ECSA’s website, is known and adhered to. | |

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8.2 How ethical problems and affected parties were identified, and the best solution to resolve the problem selected.

Outcome 9:
Exercise sound judgement in the course of broadly defined engineering activities

Assessment criteria: Judgement is displayed by the following performance:
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.

Range Statement for Outcomes 8 and 9: Judgement in decision-making involves:
1) taking several risk factors into account
2) significant consequences in technology application and related contexts; or
3) 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 Engineering Technologist 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:
1) Getting the work done in spite of numerous risk factors needs good judgement and substantiated decision-making.
2) Consequences are part of the project e.g., extra cost due to unforeseen conditions, incompetent contractors, long-term environmental damage, etc.
3) 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 broadly 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 outside your area of competence.
10.3 Academic knowledge of at least BTech level combined with past experience used in formulating decisions.

Range Statement: Responsibility must be discharged for significant parts of one or more broadly defined engineering activity.

Note 1: Demonstrating responsibility would be 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.

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 Engineering Technologist.

CONTROLLED DISCLOSURE

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Range Statement: Professional development involves:

a) planning own professional development strategy
b) selecting appropriate professional development activities
c) recording professional development strategy and activities, while displaying independent learning ability.

a) In most places of work training is seldom organised by a training department. It is up to the Engineering Technologist to manage his/her own experiential development. Engineering Technologists 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 Engineering Technologist is vital to his/her success