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Discipline Specific Training Guide (DSTG) for Registration as a Professional Technologist in Computer Engineering

R-05-COMP-PT

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ECSA

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DEFINITIONS

Broadly defined engineering work: This work is characterised by the following:

- Scope of practice area is linked to technologies used and changes by adoption of new technology into current practice.
- Practice area is located within a wider, complex context, requires teamwork and has interfaces to other parties and disciplines.
- It involves the use of a variety resources (including people, money, equipment, materials, technologies).
- It requires resolution of occasional problems arising from interactions among wide-ranging or conflicting technical, engineering or other issues.
- It is constrained by available technology, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws.
- It has risks and consequences in practice area and in related areas.

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 that is based on the natural sciences and 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.

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.

Management of engineering works or activities: The co-ordinated activities required are to:

(a) direct and control everything that is constructed or results from construction or manufacturing operations

(b) operate engineering works safely and in the manner intended

(c) return the engineering works, the plant and the equipment to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts

(d) direct and control the engineering processes, systems, commissioning, operation and decommissioning of equipment

(e) maintain engineering works or equipment in a state in which it can perform its required function.

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 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 safety, health and interest of the public and the environment in the performance of an engineering activity.

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.

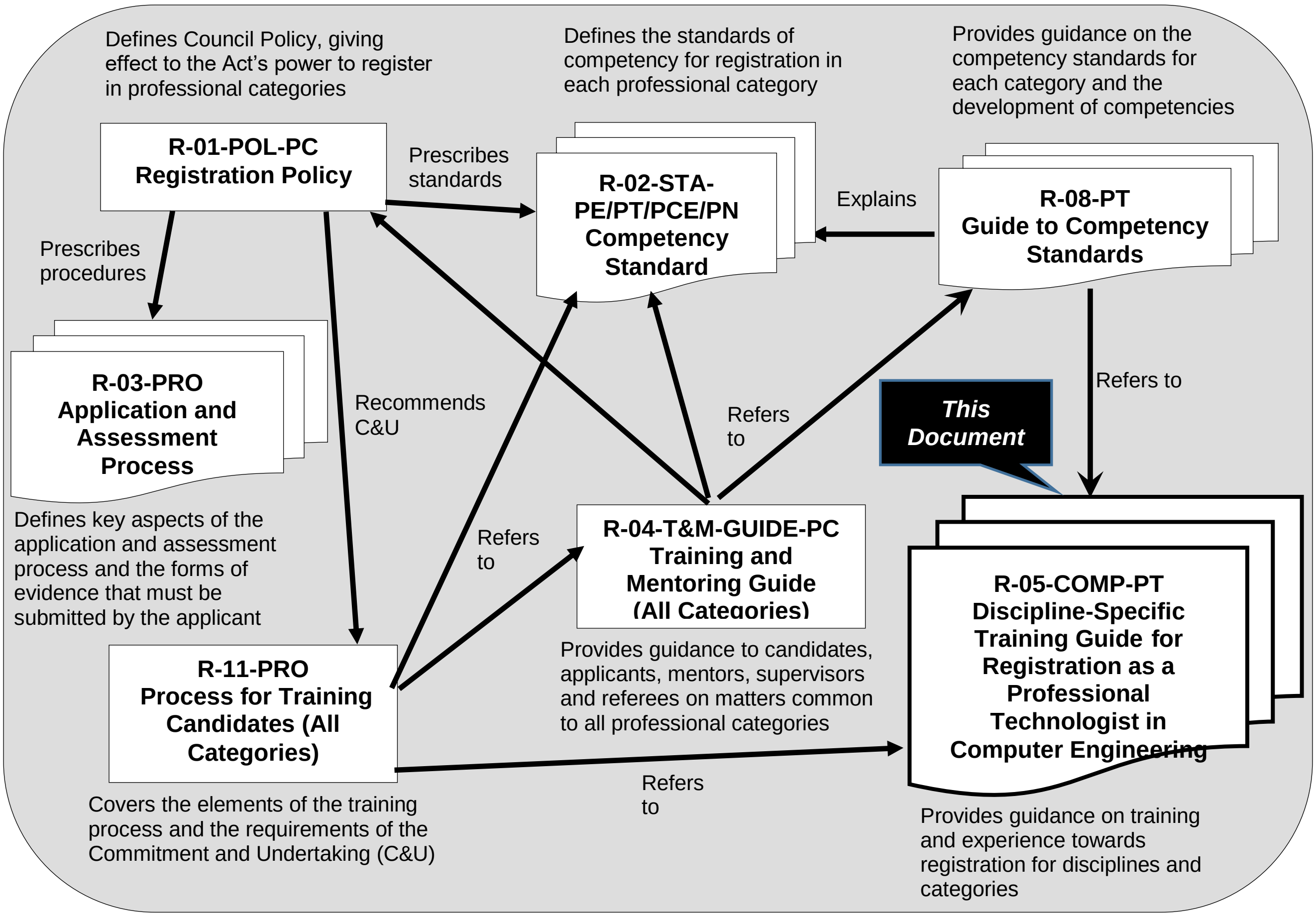

Figure 1: Documents defining the ECSA Registration System

1. PURPOSE OF THIS DOCUMENT

All persons applying for registration as Professional Engineering Technologists 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 trainee's discipline.

Document **R-02-STA-PE/PT/PCE/PN** supplements the generic *Training and Mentoring Guide* (document **R-04-T&M-GUIDE-PC**) and the *Guide to the Competency Standards for Professional Engineering Technologist* (document **R-08-PT**).

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).

This guide and documents **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 Competency Standard for Registration in Professional Categories (document **R-02-STA-PE/PT/PCE/PN**) and the Process of Application 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 Computer Engineering, which comprises computer engineering (hardware and software), electronic engineering, telecommunications engineering, software engineering, computer hardware design engineering, network engineering, data security engineering, embedded systems engineering and machine learning engineering amongst others. This 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. Applicants must:

- hold a relevant academic qualification 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 Computer Engineering for at least three years after obtaining Advanced Diploma in Engineering or 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.

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 trainee's employer does not offer C&U, the trainee must establish the level of mentorship and supervision that 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 (VA) 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 the recent graduate who is 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 application for registration.

4. ORGANISING FRAMEWORK FOR OCCUPATIONS

Computer Technologist (Organising Framework for Occupations 215102)

Computer Engineering Technologists form a collective group of engineers who design, advise, plan, direct, implement, test, maintain and conduct research on computer hardware and software for computer based systems in electronic, electrical, telecommunications, information technology and other allied fields. Computer Engineering Technologists utilise computer science and electronic engineering knowledge to develop system software and hardware for control, management, performance aiding, monitoring of computing systems, products, components and processes.

Computer Engineering Technologists' functions include broadly defined tasks in research, planning, design, development, construction, operation and maintenance of software and firmware for software computing systems, hardware computing systems, embedded microcontrollers, operating systems, data security systems, imaging systems, robotic systems, information technology systems and artificial intelligence systems among others.

Specialised areas in which Computer Engineering Technologists may practise, include:

- Computer Engineering (hardware and software)
- Electronic Engineering
- Telecommunication Engineering
- Software Engineering
- Computer Hardware Design Engineering
- Network Engineering
- Data Security Engineering
- Embedded Systems Engineering
- Machine Learning Engineering.

4.1 Computer Engineering Technologist (hardware and software)

Computer Engineering Technologists conduct research and advise on the design and direct the implementation, maintenance and repair of computer-based systems, software and equipment. They study and advise on the technological aspects of computer- based systems, software, products and processes. They perform system analysis on computer-based systems and software and specify the systems required. They plan, design and monitor computer-based systems, software, networks and associated communication equipment.

A Computer Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- conducting research and developing new or improved theories and methods relating to Computer Systems Engineering
- advising on and designing computer-based systems or components, systems equipment, software and distribution centres
- specifying production or installation methods, specifying materials, quality and safety standards and directing production and installation of computer-based products, software and systems
- supervising, controlling, developing and monitoring the operation and maintenance of computer-based systems, software, networks and equipment
- developing and implementing test procedures for computer-based systems, software, networks, programmes 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
- performing system analyses together with designing and developing 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, networks and equipment.

Practising Computer Engineering Technologists may concentrate on one or more of these areas:

- Computer System Engineering
- Computer System Design Engineering

- Systems Engineering
- Software Engineering.

4.2 Electronic Engineering Technologist

Electronic Engineering 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 are developed within many related fields, for example, solid-state physics, radio engineering, telecommunications, control systems, signal processing, systems engineering, computer engineering, instrumentation engineering, electric power control and robotics.

Electronic Engineering Technologists conduct research and advise on the design and direct the construction, maintenance and repair of electronic systems. They study and advise on the technological aspects of electronic engineering materials, products and processes.

An Electronic Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- 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
- supervising, controlling, developing and monitoring the operation and maintenance of electronic equipment and system;
- 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 maintaining and repairing existing electronic systems and equipment
- designing and developing signal processing algorithms and implementing these through appropriate choice of hardware and software
- designing, specifying and implementing control and instrumentation of plants and processes
- designing, specifying, controlling and monitoring of equipment for fire detection and safety (safety integrity level – SIL rating) in plants and factories
- controlling robotics and processes of manufacturing plants
- increasing energy efficiency of photovoltaic (PV) cells.

Practising Electronics Engineering Technologists may concentrate on one or more of the following areas:

- Communications Engineering (Army)
- Mechatronics Engineering
- Electronic Design Engineering
- Instrumentation Engineering
- Television Engineering
- Biomedical Engineering
- Clinical Engineering
- Aircraft Electronic Systems Engineering
- Electronic Warfare Engineering.

4.3 Telecommunications Engineering Technologist

Telecommunications Engineering Technologists conduct research and advise on the design and direct the construction, maintenance and repair of telecommunication systems and equipment. They study and advise on the technological aspects of the materials products or processes relating to Telecommunications Engineering. They plan, design and monitor telecommunication networks and associated broadcasting equipment.

A Telecommunications Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- conducting research and developing new or improved theories and methods relating to Telecommunications Engineering
- advising on and designing telecommunication devices or components, systems, equipment and distribution centres
- specifying production or installation methods, materials, quality and safety standards and directing production or installation of telecommunication products and systems
- supervising, controlling, developing and monitoring the operation and maintenance of telecommunication systems, networks and equipment
- determining the manufacturing methods for telecommunication systems and maintaining and repairing existing telecommunication systems, networks and equipment
- organising and directing the maintenance and repair of existing telecommunication systems, networks and 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 concentrate on one or more of the following areas:

- Broadcast Engineering
- Communications Engineering
- Fibre Optics Engineering
- Radio Frequency Design Engineering
- Radar Engineering
- Radio Engineering
- Radio and Telecommunications Engineering
- Mobile Radio Engineering
- Satellite Transmission Engineering
- Network Planning Engineering

- Microwave Engineering.

4.4 Software Engineering Technologist

Software Engineering Technologists conduct research and advise on the design and direct the development, maintenance and repair of software and software systems. Software Engineering Technologists study and advise on the technological aspects of software. They perform system analyses on software and specify the system requirements. They plan, design and monitor software and associated software infrastructure.

A Software Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- conducting research and developing new or improved theories and methods related to Software Engineering
- advising on and design of software systems
- specifying aspects of production or installation methods, and quality standards and directing production or installation work of software and developing and monitoring aspects of the operation and maintenance of computer software and systems
- implementing and improving control standards and procedures to ensure efficient functioning and software
- organising and directing maintenance and repair of existing software
- designing software and software systems
- determining maintenance and repair procedures of existing software and software systems
- performing research and advising on radar, telemetry and remote-control systems, microwaves and other electronic equipment
- developing procedures to test software and software components.

Practising Software Engineering Technologists may concentrate on one or more of the following areas:

- Software Design Engineering
- Front-end Software Engineering
- Back-end Software Engineering

- Mobile Software Engineering
- Systems Engineering
- Solutions Architect.

4.5 Computer Hardware Design Engineering Technologist

Computer Hardware Design Engineering Technologists research, design, develop, implement and test computer systems and components such as processors, circuit boards, computer memory and storage systems, network equipment and graphics acceleration equipment like GPUs. They are also involved in the designing of computers integrated into consumer devices like home appliances, cars and medical devices to name a few. As technology evolves, these engineers are at the forefront of computer hardware development with the chief aim of improving performance and efficiency to realise the next generation of computer equipment.

A Computer Hardware Design Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- designing, developing and implementing computer hardware
- conducting research and developing new or improved theories and methods related to Computer Hardware Design Engineering
- advising on and designing computer hardware and computer systems
- Specifying aspects of production or installation methods, and quality standards, and directing production and deployment of computer hardware
- implementing and improving control standards and procedures to ensure efficient functioning of computer systems
- organising and directing maintenance and repair of existing systems
- determining maintenance and repair procedures of existing hardware systems
- developing procedures to test newly developed computer hardware.

Practising Computer Hardware Design Engineering Technologists may concentrate on one or more of the following areas:

- Computer Systems Design Engineering
- Integrated Circuit Design Engineering

- Microelectronic Engineering.

4.6 Network Engineering Technologist

Network Engineering Technologists are responsible for designing, planning, implementing, optimising, maintaining, monitoring and managing computer networks. These networks can be as small as company networks, but usually span across large areas (LANs, WANs and GANs). Network Engineering Technologists have comprehensive knowledge of network protocols and services such as TCP/IP, DNS, DHCP and firewalls, and are trained to configure switches, routers and wireless access points. They are able to administrate computer networks and related computing environments including systems software, applications software, hardware, and configurations. They are also able to perform disaster recovery operations and to ensure the protection of data from malicious attacks. They have a strong understanding of network infrastructure and network hardware. They also have superior fault-finding skills of network functions such as security, servers and routing.

A Network Engineering Technologist may undertake tasks to solve **broadly defined** engineering problems, which may include:

- conducting research and developing new or improved theories and methods related to Network Engineering
- designing, planning and deploying computer networks of any size and on any scale using appropriate technologies, protocols and equipment
- specifying aspects of production or installation methods, and quality standards, and directing production or installation work and monitoring aspects of the operation and maintenance of computer networks
- implementing and improving control standards and procedures to ensure efficient functioning of computer networks
- determining, organising and directing procedures for maintenance, repair and upgrading of existing computer networks
- developing procedures to test and troubleshoot computer networks.

Practising Network Engineering Technologists may concentrate on one or more of the following areas:

- Network Security Engineering
- Systems Engineering.

4.7 Data Security Engineering Technologist

Data Security Engineering Technologists conduct research and advise on the design and direct the implementation, maintenance and repair of data security and software systems. They study and advise on the technological aspects of data security. They also generate and implement secure network solutions that deliver security against cyberattacks, hackers and so forth. They continuously invigilate systems and networks to ensure functionality and try to prevent cybercrimes.

Data Security Engineering Technologists may undertake tasks to solve **broadly defined** engineering problems, which may include:

- designing, implementing, administering and improving all the security networks as well as systems in order to safeguard the complete data of an organisation
- administering the appraisal of an organisation's security obligations and determining best practices and standards
- conducting research and developing new or improved theories and methods related to Data Security Engineering
- advising on and designing broadly defined data security systems.
- specifying aspects of production or installation methods, and quality standards and directing broadly defined production or installation work of software and developing and monitoring aspects of the operation and maintenance of data security computer software and systems
- implementing and improving control standards and procedures to ensure efficient functioning of data security systems
- organising and directing maintenance and repair of existing software
- designing data security software and software systems
- determining maintenance and repair procedures of existing data security software and software systems
- developing procedures to test data security software and software components
- investigating, responding to and collaborating on any security breach within networks and systems

- conducting numerous tests on system vulnerability to evaluate stability as well as troubleshooting of incidences
- managing all communication between departments to ensure functionality

Practising Data Security Engineering Technologists may concentrate on one or more of the following areas:

- Network Engineering
- Data Security Engineering
- Web security Engineering
- Cyber security engineering.

4.8 Embedded Systems Engineering Technologist

An embedded system is a subsystem of a larger system that contains hardware and software. These computing systems usually contain a number of chips and integrated circuits (ICs) that are programmed to perform a predefined function. Embedded Systems Engineering Technologists are responsible for the research, design, development, production, testing and deployment of embedded systems. They study and advise on the technological aspects of embedded systems to generate and implement solutions that deliver the functionality of embedded software systems. They also continuously invigilate systems and networks to ensure optimum functionality.

Embedded Systems Engineering Technologists may undertake tasks to solve **broadly defined** engineering problems, which may include:

- designing, implementing, administering and improving embedded systems
- managing embedded systems in terms of hardware and software
- administering the appraisal of embedded systems in an organisation and determining best practices and standards
- conducting research and developing new or improved theories and methods related to embedded systems
- advising on and designing embedded systems
- specifying aspects of production or installation methods, and quality standards, and directing production or installation work of software and developing and monitoring aspects of the operation and maintenance of embedded computer software and hardware systems

- implementing and improving control standards and procedures to ensure efficient functioning of embedded systems
- organising and directing maintenance and repair of existing systems.
- determining maintenance and repair procedures of existing embedded systems
- developing procedures to test embedded hardware and software systems.

Practising Embedded System Engineering Technologists may concentrate on one or more of the following areas:

- Embedded Software Engineering
- Electronic Design Engineering
- Computer Systems Engineering.

4.9 Machine Learning Engineering Technologist

Machine Learning is an integral division of Artificial Intelligence (AI). Its focus is on the development of algorithms that can autonomously learn from data, identify patterns and apply knowledge towards making decisions. It requires a proficient integration of programming languages, statistics, signal processing techniques, applied mathematics, neural network architectures, cloud applications and artificial intelligence, among other skills. Machine Learning Engineering Technologists have to be scientifically knowledgeable on the algorithms and statistical models that computer systems use towards effectively and independently executing a targeted task.

Machine Learning Engineering Technologists may undertake tasks to solve **broadly defined** engineering problems, which may include:

- designing, implementing, administering and improving machine learning systems
- managing machine learning in terms of software
- administering the appraisal of machine learning systems and determining best practices and standards
- conducting research and developing new or improved theories and methods related to machine learning systems
- advising on and designing machine learning systems

- specifying aspects of production or installation methods, and quality standards, and directing production or installation work of machine learning software and developing and monitoring aspects of the operation and maintenance of machine learning software systems
- implementing and improving control standards and procedures to ensure efficient functioning of machine learning systems
- organising and directing updating of existing machine learning systems
- developing procedures to test machine learning systems.

Practising Machine Learning Engineering Technologists may concentrate on one or more of the following areas:

- Robotics Engineering
- Computer Vision Engineering
- Data Engineering.

5. NATURE AND ORGANISATION OF THE INDUSTRY

Computer Engineering Technologists may be employed in either the private or the public sector. In the private sector, they would typically be involved in consulting or contracting or 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. Computer Engineering Technologists working in supply or manufacturing companies are 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. Computer 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 when 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 (developing and implementing solutions) may not be available to the Candidate. In such cases, employers are encouraged to put a secondment system in place.

It has been common practice that in situations where an organisation is unable to provide training in certain areas, secondments are arranged with other organisations so that the Candidate is able to develop all the competencies required for registration. These secondments are usually of a reciprocal nature and thus, both employers and employees mutually benefit. Secondments between consultants and contractors and between the public and private sectors should be possible.

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 and to investigate and analyse broadly defined engineering problems. Ultimately, the applicant must be able to demonstrate different options to develop a solution. Engineering Technologists involved in the design, implementation and deployment of products 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 Engineering Technologists practising in this area in a dilemma. If a 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 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 a 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.

5.4 Engineering project management

The areas in which Computer Engineering 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, implementation, operation, risk and impact mitigation and management of engineering activities.

A schema is presented in Appendix A 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 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.

5.5 Implementation/Commissioning

In the commissioning of equipment or systems, the applicant must demonstrate an understanding of the engineering concepts utilised in the system:

- How the equipment functions.
- The reason the equipment was acquired.
- The impact that these concepts will have on the business.

5.6 Operations and maintenance

In the maintenance environment, Candidates or persons wishing to register must demonstrate:

- the engineering and financial implications involved
- why the equipment is maintained at the prescribed intervals
- 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 VAs applicable to the Computer Engineering fraternity and the functions and services rendered by the associations to their 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 making use of the Degree of Responsibility, the Problem Solving and the Engineering Activity scales as specified in document **R-04-T&M-GUIDE-PC**.

Appendix A has been developed against the Degree of Responsibility Scale. Activities should be selected to ensure that 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 Code of Conduct of the ECSA
- 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 1995
- 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.

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 applicable to their work environment.

6.4 Desirable formal learning

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

- Project Management
- Conditions of Contract\Value Engineering – NEC, JBCE, etc.
- Standard Specifications
- Preparation of Specifications
- Negotiation Skills
- Engineering Finance
- Risk Analysis and Quality Systems

- Occupation Health and Safety
- Discipline specific courses
- Environment Impacts Management
- Technical and Business Report Writing
- Planning Methods
- System Engineering
- Industrial Relations
- Business presentation skills/public speaking.

7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best practice

There is no ideal training programme structure or unique sequencing that constitutes best practice. Each Candidate's training programme for 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, which will ensure that Candidates' designs are feasible, implementable, sustainable and have a considered life cycle costing. 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 **R-04-T&M-GUIDE-PC**) to ensure that by the end of the training period, they exhibit Responsibility Level E and are able to perform individually and as team members 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 among 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 three years, which is the minimum time required by the 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. Regarding 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

Revision number	Revision date	Revision details	Approved by
Rev. 0 Draft A	07 September 2020	First Draft	Working Group
Rev. 0 Draft B	12 October 2020	Final Draft	Working Group
Rev. 0 Draft C	21 October 2020	Review by the Executive	Executive: RPS - EL Nxumalo
Rev. 0 Draft D	02 November 2020	Stakeholder Consultation	RPS & Stakeholder Relations
Rev 0 Draft E	29 January 2021	Review and recommendation for approval.	Executive: RPS - EL Nxumalo
Revision. 0	13 April 2021	Approval	RPSC

The Discipline-Specific Training Guide for:

Candidate Engineering Technologist in Computer Engineering

Revision 0 dated 13 April 2021 and consisting of 28 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards Generation (**RPS**).

.... 15/04/2021

Business Unit Manager — Date

.... 19/04/2021

Executive: **RPS** — Date

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

APPENDIX A: TRAINING ELEMENTS

Synopsis: Candidate Engineering Technologists 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 employer's training and development programme and develop 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, 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 Engineering Technologist.	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. 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 Responsibility Level E, i.e., Performing. (Refer to 7.1 in the specific DSTG.)
2. Demonstration of competence 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. **Level Descriptor:** Broadly defined engineering activities (BDEA) 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, has interfaces with other parties and disciplines.	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. **Level Descriptor:** BDEA in the various disciplines are characterised by several or all of: 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

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
c) Involve the use of a variety resources, including people, money, equipment, materials, technologies. d) Require 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, applicable laws. f) Have significant risks and consequences in the practice area and in related areas. **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.	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. 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, 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:	

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
a) require coherent and detailed engineering knowledge, underpinning the technology area *and one or more of:* b) are ill-posed, under- or over-specified, require identification and interpretation into the technology area c) 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:* d) can be solved by structured analysis techniques e) may be partially outside standards and codes f) must provide justification to operate outside g) require information from practice area and sources interfacing with practice area that is complex and incomplete h) involves 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 that are important in	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. 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 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. h) 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. 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) 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.

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
practice area but may extend more widely.	
Assessment criteria: A structured analysis of broadly defined problems typified by the following performances is expected: 1.1 Performed or contributed in defining engineering problems leading to an agreed definition of the problems to be solved. 1.2 Performed or contributed in investigating engineering problems including collecting, organising and evaluating information. 1.3 Performed or contributed in 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 involve the following: 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 The engineering problem and related information must be segregated from the bulk of the information, investigated and evaluated. 1.3 Ensure 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.
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 technologies known to the Candidate. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.	**Please refer to section 4 of the specific DSTG.**
Outcome 2: Design or develop solutions to broadly defined	**Responsibility level C and D** Design means "drawing or outline from which something can be made".

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
engineering problems	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 broadly 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 Engineering Technologist will in some cases not be able 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 *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, drawings, models, examples, etc. Engineering Technologists must seek approval of any deviation from these established methods, but must also initiate and/or participate in the development and revision of these norms.
Outcome 3:	**Responsibility level E**

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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.	Comprehend means "to understand fully". The jurisdiction in which an Engineering Technologist practices is given in **section 4 of the specific Discipline Specific Training Guideline.**
Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 Applied engineering principles, practices, technologies, including the application of BTech theory in the practice area. 3.2 Indicated working knowledge of areas of practice that interact with practice area to underpin teamwork. 3.3 Applied 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. 3.1 Calculations at BTech 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 broadly defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team. 3.3 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, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others. b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.	 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 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) 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

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
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.	roads, mechanical engineers on fire protection equipment, architects on buildings, electrical engineers on communication equipment, etc. c) 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	**Explanation and Responsibility Level**
Outcome 4: Manage part or all of one or more *broadly 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. 4.3 Knowledge of conditions and operation of contractors and the ability to establish and maintain professional and business relationships evident.	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	**Responsibility level C**

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
broadly defined engineering activities.	
Assessment criteria: Demonstrates effective communication by the following: 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 and supporting documents appropriate to the audience and purpose.	5.1 Refer to Range Statement for Outcome 4 and 5 below. 5.2 Refer to Range Statement for Outcome 4 and 5 below. 5.3 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 Broadly-*defined engineering* involves: a) Planning broadly defined activities b) Organising broadly defined activities c) Leading broadly defined activities d) Controlling broadly 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". 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

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
	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 *broadly 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 the following: 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 wild life, 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**

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
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 Engineering Technologist seeks advice from knowledgeable and experienced specialists if the slightest doubt exists 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. e) Regulatory requirements are explicit for the context in general.	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 Engineering Technologist 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 Engineering Technologist 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 Engineering Technologist 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 Engineering Technologist

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	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 Engineering Technologists or other professional specialists must be consulted. It is the Engineering Technologist's responsibility 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 Engineering Technologist.
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 the following: 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

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
	expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.
Outcome 9: Exercise sound judgement in the course of *broadly defined* engineering activities.	**Responsibility level E** Judgement means "good sense: ability to judge".
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.	9.1 The extent of a project given to a junior Engineering Technologist 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 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 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: 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

Competency Standards for Registration as a Professional Engineering Technologist	**Explanation and Responsibility Level**
	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[1].	10.1 All interrelated factors taken considered are indicative of professional responsibility accepted working on broadly defined activities. 10.2 The Engineering Technologist does not operate on tasks at a higher level than broadly 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 *broadly defined* engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Demonstrating responsibility would be under supervision of a competent engineering practitioner but the Candidate is expected to perform as if he/she is in a responsible position.	

Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
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 as follows: 11.1 Strategy independently adopted to enhance professional development evident. 11.2 Awareness of philosophy of employer in regard to 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 Professional Engineering Technologist level.
Range Statement: Professional development involves the following: 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 some 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. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.