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SOUTH AFRICA

Discipline Specific Training Guide for Registration as a Professional Technician in Computer Engineering

R-05-COMP-PN

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DEFINITIONS

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

Dublin Accord: An ECSA agreement for the international recognition of Engineering Technicians qualifications and competencies.

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

Engineering science: A body of knowledge, based on the natural sciences and using mathematical formulation where necessary, that extends knowledge and develops models and methods to support its application, solve problems and 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 coordinated activities required 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 engineering works, plant and equipment to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts

(d) direct and control 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.

Mentor: A person willing to spend his/her time and expertise to guide the development of another person.

Outcome: At the professional level, it means a statement of the performance that a person must demonstrate in order to be judged competent.

Over-determined problem: A problem whose requirements are defined in excessive detail, making the required solution impossible to attain in all its aspects.

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.

R-01-POL-PC: Registration Policy in Professional Categories.

R-02-STA-PE/PT/PCE/PN: Competency Standard for registration as professional technician.

R-04-T&M-GUIDE-PC: Training and Mentoring Guide Document.

R-08-PN: Guide to the Competency Standard for registration as professional technician

R-03-PRO: Application and Assessment Process for registration as candidates and professionals.

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 who must be licensed through the Engineering Profession Act or a combination of the Engineering Profession Act and external legislation as having specific engineering competencies at NQF Level 5 related to an identified need to protect the public safety, health and interest or the environment, in relation to an engineering activity.

Voluntary Associations: Voluntary Associations recognised by ECSA Council in terms of section 36(1) of the Engineering Profession Act, 46 of 2000.

Well-defined Engineering Work: This work is characterised by the following:

(a) Scope of practice area is defined by techniques applied; change by adopting new techniques into current practice.

(b) Practice area is located within a wider, complex context, with well-defined working relationships with other parties and disciplines.

(c) Work involves familiar, defined range of resources (including people, money, equipment, materials and technologies).

(d) Requires resolution of interactions manifested between specific technical factors with limited impact on wider issues.

(e) Is constrained by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws.

(f) Has risks and consequences that are locally important but not generally far reaching.

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.

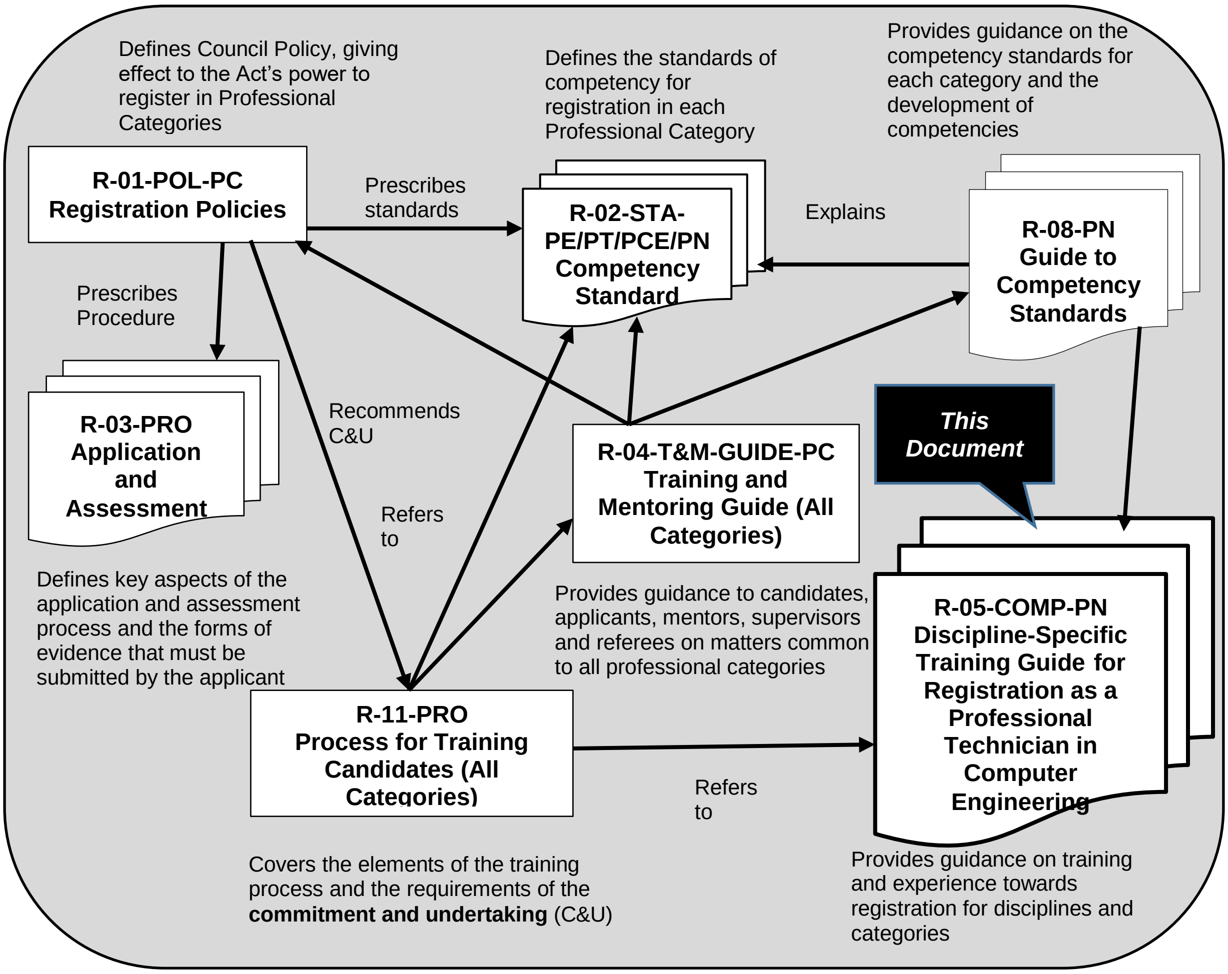

Figure 1: Document defining the ECSA registration system

1. PURPOSE OF THIS DOCUMENT

This guideline provides information about the requirements for registration as Professional Engineering Technician with ECSA. All persons applying for registration as Professional Engineering Technician 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 Technicians* (document **R-08-PN**).

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

- Duration of training and period of time working at level required for registration
- Principles of planning, training and experience
- Progression of training programme
- Documenting training and experience
- Demonstrating responsibility.

The second document (**R-08-PN**) 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 training guide and documents **R-04-T&M-GUIDE-PC** and **R-08-PN** are subordinate to the Policy on Registration (document **R-01-POL-PC**), the Competency Standard (document **R-02-STA-PE/PT/PCE/PN**) and the Application Process Definition (document **R-03-PRO**).

This guide further presents information that is relevant to all Candidate Engineering Technicians practising in variety of sub-computer engineering disciplines.

2. AUDIENCE

The DSTG is directed towards candidates and their supervisors and mentors in the Computer Engineering discipline, which comprises, computer engineering (hardware and software), electronic engineering, telecommunications engineering, software engineering, software engineering, computer hardware design engineering, network engineering, data security engineering, embedded systems engineering and machine learning engineering, among others. The guide is intended to support a programme of training and experience incorporating elements of good practice.

This guide applies to persons who have:

- completed the tertiary education requirements in computer engineering
  - by obtaining an accredited National Dip (Engineering), Dip (Eng Tech), Adv Cert (Engineering) type qualification from a recognised tertiary University in South Africa
  - by acquiring an ECSA-accredited qualification or a Dublin-Accord recognised qualification, or through evaluation/assessment.
- registered with ECSA as a Candidate Engineering Technician; and/or
- embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) programme under the supervision of an assigned mentor guiding the professional development process at each stage.

3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER C&U

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 Technician is permitted without being registered as a candidate technician or 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 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 applications for registration.

4. ORGANISING FRAMEWORK FOR OCCUPATIONS

Computer Engineering Technicians (Organising Framework for Occupations 215102)

Computer Engineering Technicians form a collective group of technical personnel who undertake well-defined tasks in designing, advising, planning, directing, implementing, testing, maintaining and conducting research on computer hardware and software for computer-based systems in electronic, electrical, telecommunications, information technology and other allied fields. Computer Engineering Technicians use 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 Technicians' functions include well-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 Technicians 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 Technician (hardware and software)

Computer Engineering Technicians conduct well-defined tasks involving research and advising on the design and participating in directing the construction/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 also participate in both system analyses on computer-based systems and software and specification of the systems required. Computer Engineering Technicians partake in the planning, designing and monitoring of computer-based systems, software, networks and associated communication equipment.

A Computer Engineering Technician may undertake tasks to solve **well-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.

4.2 Electronic Engineering Technician

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. 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, electric power control and robotics.

Electronic Engineering Technicians conduct well-defined tasks involving research and advising on the design and participate in directing 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 Technician may undertake tasks to solve **well-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 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 maintaining and repairing 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 detection and safety (safety integrity level – SIL rating) in plants and factories
- controlling robotics and processes of manufacturing plants
- increasing energy efficiency of photovoltaic cells.

4.3 Telecommunications Engineering Technician

Telecommunication Engineering Technicians conduct well-defined tasks involving research and advising on the design and participating in directing 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 also partake in planning, designing and monitoring telecommunication networks and associated broadcasting equipment.

A Telecommunication Engineering Technician may undertake tasks to solve **well-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.

4.4 Software Engineering Technician

Software Engineering Technicians conduct well-defined tasks involving research and advising on the design and participating in directing the development, maintenance and repair of software and software systems. They study and advise on the technological aspects of software. They partake in performance of system analyses on software and specification of the system requirements. Software Engineering Technicians also partake in the planning, designing and monitoring of software and associated software infrastructure.

A Software Engineering Technician may undertake tasks to solve **well-defined** engineering problems, which may include:

- conducting research and developing new or improved theories and methods related to Software Engineering
- advising on and designing 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.

4.5 Computer Hardware Design Engineering Technician

Computer Hardware Design Engineering Technicians conduct well-defined tasks involving research, designing, developing, implementing and testing 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 designing computers integrated into consumer devices like home appliances, cars and medical devices, to name a few. As technology evolves, these technical personnel 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 Technician may undertake tasks to solve **well-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.

4.6 Network Engineering Technician

Network Engineering Technicians are responsible for well-defined tasks that involve 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 Technicians are knowledgeable on 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 partake in the administration of computer networks and related computing environments, including systems software, applications software, hardware and configurations. They are also able to partake in disaster recovery operations and to ensure the protection of data from malicious attacks. They have a significant understanding of network infrastructure and network hardware. They also have suitable fault-finding skills of network functions such as security, servers, and routing.

A Network Engineering Technician may undertake tasks to solve **well-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.

4.7 Data Security Engineering Technician

Data Security Engineering Technicians perform well-defined tasks that involve research and advising on the design and participating in directing the implementation, maintenance and repair of data security and software systems. They study and advise on the technological aspects of data security. Data Security Engineering Technicians partake in generation and implementation of 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.

A Data Security Engineering Technician may undertake tasks to solve **well-defined** engineering problems, which may include:

- designing, implementing, administering and improving all the security networks and systems 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 well-defined data security systems
- specifying aspects of production or installation methods, and quality standards, and directing well-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 and collaborating on any security breach within networks and systems
- conducting numerous tests on system vulnerability to evaluate stability, and troubleshooting incidences
- managing all communication among departments to ensure functionality.

4.8 Embedded Systems Engineering Technician

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 that are programmed to perform a predefined function. An Embedded Systems Engineering Technician is responsible for well-defined tasks involving 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 continuously invigilate systems and networks to ensure optimum functionality.

An Embedded Systems Engineering Technician may undertake tasks to solve **well-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 for existing embedded systems
- developing procedures to test embedded hardware and software systems.

4.9 Machine Learning Engineering Technician

Machine Learning is an integral division of Artificial Intelligence (AI). It focuses 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 AI, among other skills. Machine Learning Engineering Technicians have to be suitably knowledgeable on the algorithms and statistical models that computer systems use towards effectively and independently executing a targeted task.

A Machine Learning Engineering Technician may undertake tasks to solve **well-defined** engineering problems, which may include:

- designing, implementing, administering and improving machine learning systems
- managing machine learning in terms 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.

5. NATURE AND ORGANISATION OF THE INDUSTRY

Computer Engineering Technicians may be employed in either the private or the public sector. In the private sector, Computer Engineering Technicians are typically involved in consulting and contracting or they are employed by manufacturers of equipment or suppliers of services for the engineering sectors. Engineering consultants are concerned with planning, designing, documenting and supervising the construction of projects on behalf of clients. Engineering contractors are responsible for project implementation and their activities include planning, construction and labour and resource management. Computer Engineering Technicians working in supply or manufacturing companies are primarily involved in production, supply and quality control but could also be involved in research and development.

The public sector is responsible for service delivery although in some departments, design and construction is also carried out. Computer Engineering Technicians are required at all levels of the public sector, including national, provincial and local government level, state-owned enterprises and public utilities. The public sector is largely engaged in planning, specifying and overseeing the implementation, operation and maintenance of computer infrastructure. Extensions of the public sector include tertiary academic institutions and research organisations.

There may be employment situations where the in-house opportunities are insufficiently diverse to develop all the competencies required for the groups noted in the document **R-02-STA-PE/PT/PCE/PN**. For example, opportunities to develop problem-solving competence (designing and developing solutions) and to manage engineering activities (constructing and implementing solutions) may not be available to the Candidate. In such cases, employers are encouraged to establish a secondment system.

It has been common practice that 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 well-defined engineering problems. Ultimately, the applicant must be able to demonstrate different options for developing a solution. Computer Engineering Technicians assist in the design of products and generating plans, networks and systems. They must be able to demonstrate their ability to investigate a product or equipment failure.

5.2 Location of training in overall engineering life cycle and functions performed

The area in which Computer Engineering Technicians work generally follows the conventional stages of the life cycle of the project, product or process, which are as follows:

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

Candidates are not expected to change their places of employment to work in all the areas listed above. Candidates, however, must ensure that in the area in which they are employed, tasks are undertaken that provide experience in all the generic engineering competencies of problem-solving, implementation and operation, risk and impact mitigation and management of engineering activities.

A schema is presented in **Appendix A** below 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 and 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 include the types of evidence of performance that would be appropriate at each line and record-keeping of the evidence.

5.3 Process design

Process design, the process followed during the life cycle of a project, must include System Engineering. Candidates must include the cycles in which they have been involved and their contributions.

5.4 Risk and impact mitigation

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

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

5.5 Implementation/Commissioning

Computer Engineering Technicians must partake in installation, testing and commissioning the necessary equipment or system for the desired result. This process must include all actions taken during construction (quality). This can refer to a project quality plan. During commissioning, Candidates must clearly indicate their contributions. Stated contributions can also refer to the commissioning plan.

5.6 Operation and maintenance

Candidates must outline the stated operation requirements of the project and state the percentage of the plant that is available for implementing the project. They must also state the maintenance philosophy and substantiate it.

6. DEVELOPING COMPETENCY: ELABORATING ON SECTIONS IN THE GUIDE RELATING TO COMPETENCY STANDARDS (DOCUMENT R-08-PN)

6.1 Contextual knowledge

Candidates are expected to be aware of the engineering profession, the VAs applicable to their area of speciality, their functions and any services rendered to their members.

6.2 Functions performed

Candidates/applicants must demonstrate that during their training period, they have mastered the competencies defined in document **R-08-PN** to a satisfactory level. From the reports submitted as part of the application for registration (i.e. Training and Experience Reports [TERs] and the Engineering Report [ER]), Candidates should demonstrate that the 11 Outcomes have been met.

It is useful to measure the progression of Candidates' competency by using the degree of responsibility as shown in **Table 1** below. The degree of responsibility shows the gradual increase in responsibility to which Candidate Technicians are exposed during their professional training. The aim is to get the applicant/candidate at responsibility level E prior to applying for professional registration.

Table 1: Degree of responsibility

Level	Nature of Work	Responsibility	Level of Support
A: Being Exposed	The Candidate/applicant undergoes induction, observes processes, work of competent practitioners.	No responsibility, except to pay attention.	Mentor explains challenges and forms of solution.
B: Assisting	The Candidate/applicant performs specific processes, under close supervision.	Limited responsibility for work output.	Supervisor/Mentor coaches, offers feedback.
C: Participating	The Candidate/applicant performs specific processes as directed with limited supervision.	Full responsibility for supervised work.	Supervisor progressively reduces support, but monitors outputs.
D: Contributing	The Candidate/applicant performs specific work with detailed approval of work outputs.	Full responsibility to supervisor for quality of work.	Applicant/candidate articulates own reasoning and compare it with those of supervisor.
E: Performing	The Candidate/applicant works in team without supervision, recommends work outputs, responsible but not accountable.	Level of responsibility to supervisor is appropriated to a registered person.	Applicant/candidate takes on problem solving without support, at most limited guidance.

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 for an applicant to be registered as professional engineering technician, each outcome should meet the responsibility level as indicated in **Appendix A**.

6.3 Statutory and regulatory requirements

Candidate Engineering Technicians or persons willing to register as a Professional Engineering Technician 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 ECSA rules and Code of Conduct

- Occupation Health and Safety Act, 85 of 1993 as amended by Act 181 of 1993 (latest revision used)
- Factory Regulations
- Machinery and Works Regulations
- Labour Relations Act, 66 of 1995
- Environment Conservation Act, 73 of 1989, as amended by Act 52 of 1994 and Act 50 of 2003
- Mine Health and Safety Act, 29 of 1996
- Industry-specific work instructions and specifications
- 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 applicable Acts.

6.4 Desirable formal learning

The following list of structured learning activities is by no means exhaustive being purely a sample of some useful courses:

- Project Management
- Conditions of Contract \ Value Engineering – NEC, JBCE, etc.
- Standards
- Preparation of specifications
- Negotiation Skills
- Engineering Finance
- Risk Analysis
- Quality Systems
- Occupation Health and Safety
- Discipline-specific courses
- Management
- Report Writing
- Planning Methods
- System Engineering

- Industrial Relations
- 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. The training programme for each Candidate depends on the available work opportunities the employer assigns to the Candidate.

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

The training programme should be such that Candidates progress through the levels of work capability (described in document **R-04-T&M-GUIDE-PC**) to ensure that by the end of the training period, 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. The nature of work, degrees of responsibility and level of support are in **Table 1** above as per **R-04-T&M-GUIDE-PC** and in **Appendix A** below.

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

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

Examples of VIPs 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 Realities

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

Generally, irrespective of the discipline, it is unlikely that the period of training will be less than three years for Candidates with a Dip (Engineering), Dip (Eng Tech), or four years for candidates with an Adv Cert (Engineering), the minimum time required by ECSA. In most cases, it will be longer, determined among others by the availability of functions in the actual work situation.

7.3 Generalists, specialists, researchers and academics

The overriding consideration is that irrespective of the route followed, the applicant must provide evidence of competency against the standard.

7.4 Multi-disciplinary exposure

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

7.5 Orientation requirements

The following orientation requirements should be undertaken, as indicated in **Appendix A**: Training Elements:

- Introduction to company safety regulations
- Company code of conduct
- Company staff code and regulations
- Typical functions and activities within the company
- Hands-on experience and orientation in each of the major company divisions.

7.6 Moving into or changing candidacy training programmes

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

- The candidate must complete the Training and Experience Summary and the Training and Experience Reports (TERs) for the previous programme or the unstructured experience. Regarding the latter, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant supervisor or mentor.
- On entering the new programme, the mentor and supervisor should review 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

7.7 Activities undertaken under training

Table 2 below shows different activities that the Candidates or applicants undertake during progression on different responsibility levels.

Table 2: Progression throughout the training period

Degree of Responsibility	Activities or duties to be undertaken under training
A: Being Exposed	• Understand the business environment and the dynamics that shape the business and industries it operates in. • Understand the business model, its key conversion processes and critical outcomes. • Understand the value added by Electrical Engineering Technicians and by other professions in the business.
B: Assisting	• Develop insight and understanding of the different well-defined processes and systems in the transformation of inputs into goods and services • Develop an appreciation of the numerous resources at the disposal of the electrical technician. • Obtain experience in the day-to-day operations of the business, to gain insight and understanding of the different broadly-defined processes and systems in the transformation of inputs into goods and services, with specific emphasis on productivity and quality measurements.
C: Participating	a) Gain first-hand experience of a broad range of broadly defined industrial engineering activities, for example, process design and re-engineering, planning and control, work study, value engineering, materials and information management, people management skills, logistics, specialists' inputs, tools and equipment and quality assurance. • The problems and limitations of particular well-defined philosophies, methods and techniques should be noted, with emphasis on cost / effort and relative benefit.
D: Contributing	• Involvement in the planning of production, the control of quality and costs of process study and work study and good materials handling and workplace layout, activity-based costing, bench marking, business cases, process re-engineering, maintenance practice and procedures, project management and system specification, all working together in the economic use of people, materials and machines, is of particular importance. • Specific attention should also be given to human aspects concerning communication, interpersonal relationships and teamwork, training and cost analysis, budget control and profit accountability. These should proceed in parallel, applying well-defined industrial engineering techniques and by using computers in problem solving.
E: Performing	• Assume increasing well-defined technical responsibility and increasingly co-ordinate the work of others. • Exposure to and development of skill in management areas such as in labour relations, management accounting, business law and general business management are important to develop a fully rounded industrial

Degree of Responsibility	Activities or duties to be undertaken under training
	engineering technologist. • Assignments that require well-defined judgment to be made, even when full information is not available leading to a position of professional responsibility is of great value and should be pursued.

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 Technicians in Computer Engineering

Revision 0 dated 13 April 2021 and consisting 30 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards **(RPS)**.

.... 15/04/2021

Business Unit Manager — Date

.... 19/04/2021

Executive: RPS — Date

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

APPENDIX A: TRAINING ELEMENTS

Synopsis: Candidate Technicians should achieve specific competencies at the prescribed level during their development towards professional registration and at the same time should accept 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 the engineering career:

1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical training to develop possible solutions, thereafter 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 to the ECSA 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.

Well-defined engineering work is usually restricted to applying standard procedures, codes and systems (i.e. work that was done before).

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

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
1. Purpose This standard defines the competence required for registration as a Professional Engineering Technician.	Discipline-Specific Training Guides (DSTGs) give context to the purpose of the Competency Standards. Professional Technicians operate within the nine disciplines ECSA recognises. Each discipline can be further divided into sub-disciplines and finally, into specific workplaces as demonstrated in Clause 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 presented below at a Responsibility Level E (i.e. Performing). Refer to Section 7.1 of the specific DSTG.
2. Demonstration of Competence Competence must be demonstrated within well-defined engineering activities (defined below) by the 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 DSTG.	Engineering activities can be approximately divided into: • 5% Complex (Professional Engineers) • 5% Broadly defined (Professional Technologists) • 10% Well-defined (Professional Technicians) • 15% Narrowly well-defined (Registered Specified Categories) • 20% Skilled workman (Engineering Artisan) • 55% Unskilled workman (Artisan Assistant) The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.
Level Descriptor: Well-defined engineering activities (WDEA) have several of the following characteristics: a) Scope of practice area is defined by techniques applied; change is by adopting new techniques into current practice. b) Practice area is located within a wider, complex	**Level Descriptor:** WDEA in the various disciplines are characterised by several or all the following: a) Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Techniques applied are largely well established and change by adopting new techniques into current practice is the exception.

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
context, with well-defined working relationships with other parties and disciplines. c) Work involves a familiar, defined range of resources, including people, money, equipment, materials and technologies. d) Activities require resolution of interactions manifested between specific technical factors with limited impact on wider issues. e) Activities are constrained by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, and applicable laws. f) Activities have risks and consequences that are locally important but are generally not far reaching. ***Activities*** include design; planning; investigation and problem resolution; improvement of materials, components, systems and processes; manufacture and construction; engineering operations; maintenance; project management; research; development; and commercialisation.	b) Practice area varies substantially with unlimited location possibilities, resulting in the additional responsibility of identifying the need for complex and/or broadly defined advice to be included in the well-defined working relationships with other parties and disciplines. c) The bulk of the work involves a familiar, defined range of resources that includes people, money, equipment, materials and technologies. d) Most of the impacts in the sub-discipline are on wider issues and although occurring frequently, are well-defined and can be resolved by following established procedures. 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 design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; and project management. For Engineering Technicians, research, development and commercialisation happen more frequently in some disciplines and are seldom encountered in others.

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
3. Outcomes to be satisfied	**Explanation and Responsibility Level**
Group A: Engineering Problem-Solving	
Outcome 1: Define, investigate and analyse well-defined engineering problems.	**Responsibility Level E** Analysis of an engineering problem means the 'separation into parts, possibly with comment and judgement'.
Well-defined engineering problems have the following characteristics: a) can be solved mainly by practical engineering knowledge underpinned by related theory *and one or more of:* b) are largely defined but may require clarification c) are discrete, focused tasks within engineering systems d) are routine, frequently encountered, may be unfamiliar but in a familiar context *and one or more of:* e) can be solved by standardised or prescribed ways f) are encompassed by standards, codes and documented procedures; authorisation required to work outside limits g) information is concrete and largely complete but requires checking and possible supplementation	a) A practical problem for Engineering Technicians means the problem encountered cannot be solved by artisans because theoretical calculations and engineering decisions are necessary to substantiate the solution proposed. b) Further investigation to identify the nature of the problem is seldom necessary. c) The problem is discrete, meaning it is *individually distinct* and easily recognised as part of the larger engineering task, project or operation. d) It is recognised that the problem occurred in the past or the possibility exists that it may have happened before; it definitely and possibly occurred in the past therefore it is not a new problem. e) The problem does not require the development of a new solution (determine how the problem was previously solved). f) Encompassed means *encircled:* The standards, codes and documented procedures must be obtained to solve the problem, and authorisation from the Engineer or Technologist in charge must be obtained to waive the stipulations. g) The responsibility lies with the Engineering Technician to check that the information received regarding the problem encountered is correct and is added to as necessary to ensure the correct and complete execution of the work.

Competency Standards for Registration as a Professional Engineering Technician	**Explanation and Responsibility Level**
h) involve several issues (few of these impose conflicting constraints) and a limited range of interested and affected parties *and one or both of:* i) require practical judgement in the practice area in the evaluation of solutions and consideration of interfaces to other role players j) have consequences that are locally important but not far reaching (wider impacts are dealt with by others).	h) The problem handled by the Engineering Technician must be limited to well-known matters and preferably requires standardised solutions without possible complications. i) Practical solutions to problems include knowledge of the skills displayed by Practical Specialists and Engineering Artisans without sacrificing theoretical engineering principles and/or taking shortcuts to satisfy the parties involved. j) Engineering Technicians must realise that their actions may appear to be of local importance only but may develop into problems for which support from Engineers and Technologists may be needed to deal with the consequences.
Assessment Criteria: A structured analysis of well-defined problems typified by the following performances is expected: 1.1 State how you interpreted the work instruction received, checking with your client or supervisor that your interpretation is correct. 1.2 Describe how you analysed, obtained and evaluated further clarifying information and indicate if the instruction was revised as a result.	To perform an engineering task, an Engineering Technician will typically receive an instruction from a senior person (customer) to perform the task and must: 1.1 ensure that 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 that the instruction and information to do the work is complete and fully understood, including the engineering theory needed to understand the task and to carry out and/or check the calculations and the acceptance criteria; if needed, supplementary information must be gathered, studied and understood.
Range Statement: The problem may be part of a larger engineering activity or may stand alone. The design problem is amenable to solution by established techniques that are practised regularly by the candidate. Outcome 1 is concerned with the	**Please refer to Clause 4 of the specific DSTG.**

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
understanding of a problem; Outcome 2 is concerned with the solution.	
Outcome 2: Design or develop solutions to well-defined engineering problems.	**Responsibility levels C and D** Design means 'drawing or outline from which something can be made'. Develop means 'come or bring into a state in which it is active or visible'.
Assessment Criteria: This outcome is normally demonstrated after the problem analysis defined in Outcome 1. Working systematically to synthesise a solution to a well-defined problem typified by the following performances is expected. 2.1 Describe how you designed or developed and analysed alternative approaches to do the work. Impacts checked. Calculations attached. 2.2 State your final solution to perform the work – client or supervisor in agreement.	After the task received is fully understood and interpreted, a solution to the problem posed can be developed (designed). To synthesise a solution means 'to combine separate parts, elements, substances, etc. into a whole or into a system'. 2.1 The development (design) of more than one way to solve an engineering task or problem should always be done and include 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 In some cases, the Engineering Technician will be unable to support proposals with the complete theoretical calculation substantiating every aspect and must, in these cases, refer his/her alternatives to an Engineer or Technologist for scrutiny and support. The alternatives and the recommended alternative must be convincingly detailed to win customer support for the recommended alternative. Selection of alternatives may be based on tenders submitted with alternatives deviating from those specified.
Range Statement: The solution is amenable to established methods, techniques and procedures within the candidate's practice area.	Applying theory to *well-defined engineering* work is done in a way that has been used before. The process was probably developed by Engineers or Technologists in the past and documented in written procedures, specifications, drawings, models, examples, etc. Engineering Technicians must seek approval for any deviation from these established

Competency Standards for Registration as a Professional Engineering Technician	**Explanation and Responsibility Level**
	methods.
Outcome 3: Comprehend and apply knowledge embodied in established engineering practices and knowledge specific to the jurisdiction in which he/she practises.	**Responsibility Level E** Comprehend means to understand fully. The jurisdiction in which an Engineering Technician practises is given in Clause 4 of the specific DSTG.
Assessment Criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 State which NDip-level <u>engineering standard procedures and systems you used</u> to execute the work and how NDip-level theory was applied to understand and/or verify these procedures. 3.2 Provide <u>your</u> own NDip-level theoretical calculations and/or reasoning on why the application of this theory is considered correct (actual examples required).	Design work for Engineering Technicians mainly involves utilising and configuring manufactured components. The design work is repetitive and uses an existing design as an example. Engineering Technicians apply existing codes and procedures in their design work. Investigation is on well-defined incidents. Condition monitoring and operations mainly involve controlling, maintaining and improving engineering systems and operations. 3.1 The understanding of well-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge. Specific procedures and techniques applied to do the work accompanied by the underpinning theory must be given. 3.2 Calculations confirming the correct application and utilisation of equipment listed in Clause 4 of the specific DSTG must be done on practical *well-defined activities*. Reference must be made to standards and procedures used and how these were derived from NDip theory.
Range Statement: Applicable knowledge includes the following: a) Technical knowledge that is applicable to the practice area irrespective of location and is supplemented by locally relevant knowledge, for	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 and must include a comprehensive study of materials, components and projected customer requirements and expectations. b) Regardless of having a working knowledge of interacting disciplines, Engineering

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
example, established properties of local materials. b) A working knowledge of interacting disciplines and codified knowledge in related areas: financial, statutory, safety, management. c) Jurisdictional knowledge regarding legal and regulatory requirements and prescribed codes of practice.	Technicians must appreciate the importance of working with specialists such as Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings and Electrical Engineers on communication equipment. The codified knowledge in the related areas means working to and understanding the requirements set out by specialists in the areas mentioned. c) Jurisdictional in this instance means 'having the authority', and Engineering Technicians must adhere to the terms and conditions associated with each task undertaken. The Engineering Technician may be appointed as the 'responsible person' for specific duties 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 *well-defined engineering* activities.	**Responsibility Level D** Manage means 'control'.
Assessment Criteria: The display of personal and work process management abilities is expected: 4.1 State how you managed yourself, priorities, processes and resources in carrying out the work (e.g. bar chart). 4.2 Describe your role and contribution in the work team.	In engineering operations and projects, Engineering Technicians are typically given the responsibility to carry out specific tasks and/or complete projects. 4.1 Resources are usually subdivided based on availability and are controlled by a work-breakdown structure and schedule to meet deadlines. Quality, safety and environmental management are important aspects. 4.2 Depending on the task, the Engineering Technician can be the team leader or a team member and can supervise appointed contractors.

Competency Standards for Registration as a Professional Engineering Technician	**Explanation and Responsibility Level**
Outcome 5: Communicate clearly with others in the course of his/her well-defined engineering activities.	**Responsibility Level C**
Assessment Criteria: Demonstration of effective communication. 5.1 State how you presented your point of view and compiled reports after completion of the work. 5.2 State how you compiled and issued instructions to entities working on the same task.	5.1 Refer to the Range Statement for outcomes 4 and 5. Presentation of point of view mainly occurs in meetings and discussions with immediate supervisor. 5.2 Refer to the Range Statement for outcomes 4 and 5.
Range Statement for outcomes 4 and 5: Management and communication in well-defined engineering involves the following: a) Planning well-defined activities b) Organising well-defined activities c) Leading well-defined activities d) Controlling well-defined activities. Communication relates to technical aspects and the wider impacts of professional work. Audience includes peers, other disciplines, clients and stakeholders. Appropriate modes of communication must be selected. The Engineering Technician is expected to perform the communication functions reliably and repeatedly.	a) Planning means ‘the arrangement for doing or using something; considering in advance’. b) Organising means ‘putting into working order; arranging in a system; preparing for’. c) Leading means ‘guiding the actions and opinions of; influencing; persuading’. d) Controlling means the ‘regulating, restraining, keeping in order; checking’. Engineering Technicians write or participate in writing specifications for the purchase of materials and/or for work to be done, make recommendations on tenders received, place orders and variation orders, write work instructions, report back 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

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
	and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report back on cost control, etc.
Group C: Impacts of Engineering Activity	**Explanation and Responsibility Level**
Outcome 6: Recognise the general foreseeable social, cultural and environmental effects of well-defined engineering activities.	**Responsibility Level B** Social means 'relating to people living in communities; relations between persons and communities'. Cultural means 'all the arts, beliefs, social institutions, etc. that are characteristic of a community'. Environmental means 'surroundings, circumstances, influences'.
Assessment Criteria: This outcome is normally displayed in the course of the analysis and solution of problems. 6.1 Describe the social, cultural and environmental impact of the engineering activity. 6.2 State how you communicated mitigating measures to affected parties and acquired stakeholder engagement.	6.1 Engineering significantly affects 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, and demolition of structures). 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 and compensation paid.
Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her well-defined engineering activities.	**Responsibility Level E**

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
Assessment Criteria: 7.1 List the major laws and regulations applicable to this particular activity and indicate how health and safety matters were handled. 7.2 State how you obtained advice in carrying out risk management for the work and elaborate on the risk management system applied.	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 may have standard procedures, instructions, drawings, and operation and maintenance manuals available. Depending on the situation (emergency, breakdown, etc.), these documents are consulted before commencing the work and during the activity. 7.2 It is advisable to attend a Risk Management (Assessment) course and to investigate and study the materials, components and systems used in the workplace. The Engineering Technician 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) Impacts to be considered are generally those identified within the established methods, techniques and procedures used in the practice area. b) Regulatory requirements are prescribed. c) Prescribed risk management strategies are applied. d) Effects to be considered and methods used are defined. e) Safe and sustainable materials, components and systems are prescribed. f) Persons whose health and safety are to be protected are both inside and outside the workplace.	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 a town will be entirely different to the impact of construction in a rural area). The methods, techniques and procedures will differ accordingly and are identified and studied by the Engineering Technician before starting the work. b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirms or checks that the instructions are in line with regulations. The Engineering Technician is responsible for ensuring that this is done, and if not, for establishing which regulations apply and ensuring adherence. Usually, the people working on site are strictly controlled w.r.t. health and safety, but the Engineering Technician checks that this is done. Tasks and projects are mainly carried out where contact with the public cannot be avoided, and safety measures such as barricading and warning signs must be used and maintained. c) Risks are mainly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. Risk-management strategies are usually implemented by more senior staff but are understood and applied by the Engineering

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
	Technician. d) Effects associated with risk management are mostly well known if not obvious, and methods used to address these risks are clearly defined. e) Usually, the components and systems and the safe and sustainable materials are prescribed by Engineers, Technologists or other professional specialists. It is the responsibility of the Engineering Technician to use his/her knowledge and experience to check and interpret what is prescribed and to report if any dispute exists. f) Health and safety of the staff working on the task or project as well as persons affected by the engineering work should be considered.
Group D: Exercise judgement, take responsibility and act ethically	**Explanation and Responsibility Level**
Outcome 8: Conduct engineering activities ethically.	**Responsibility Level E** Ethics 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 such issues are expected. 8.1 State how you identified the ethical issues in addition to the affected parties and their interests and indicate the actions you took when a problem arose. 8.2 Confirm that you are conversant and in compliance with the ECSA Code of Conduct and	Systematic means ‘methodical; based on a system’. 8.1 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications and misrepresentation of facts. 8.2 The ECSA Code of Conduct as per the ECSA website is known and adhered to.

Competency Standards for Registration as a Professional Engineering Technician	**Explanation and Responsibility Level**
why this Code of Conduct is important in your work.	Applicable examples given.
Outcome 9: Exercise sound judgement in the course of *well-defined engineering* activities.	**Responsibility Level E** Judgement means 'good sense; ability to judge'.
Assessment Criteria: Judgement is displayed by the following performance: 9.1 State the factors applicable to the work and their interrelationship and indicate how <u>you</u> applied the most important factors. 9.2 Describe how <u>you</u> foresaw work consequences and evaluated situations in the absence of full evidence.	9.1 The extent of a project or task given to a junior Engineering Technician is characterised by the limited number of factors and their resulting interdependence. The Engineering Technician will seek advice if educational and/or experiential limitations are exceeded. Examples of the main engineering factors applied must be given. 9.2 Making risky decisions leads to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Give examples.
Range Statement for outcomes 8 and 9: Judgement in decision-making involves a) accounting for limited risk factors, some of which may be ill-defined b) accounting for consequences that are in the immediate work contexts; or c) accounting for an identified set of interested and affected parties with defined needs.	In engineering, approximately 10% of the activities can be classified as *well-defined* and for these, the Engineering Technician uses standard procedures, codes of practice, specifications, etc. Judgement must be displayed to identify any activity that falls outside the *well-defined* range (defined above): a) Advice is sought when risk factors exceed his/her capability. b) Consequences outside the immediate work contexts (e.g. long-term) are not normally handled. c) Interested and affected parties with defined needs outside the *well-defined* parameters

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
	are taken into account.
Outcome 10: Be responsible for making decisions on part or all of one or more well-defined engineering activities.	**Responsibility Level E** Responsible means 'legally or morally liable for carrying out a duty; caring for something or somebody while being in a position where one may be blamed for loss, failure, etc.'
Assessment criteria: Responsibility is displayed by the following performance: 10.1 Show how you used NDip theoretical calculations to justify decisions taken in carrying out the engineering work. Attach actual calculations. 10.2 State how you sought responsible advice on any matter falling outside your own education and experience. 10.3 Describe how you took responsibility for your own work and evaluated any shortcomings in your output.	10.1 The calculations (e.g. fault levels, load calculations, losses) are done to ensure that the correct material and components are used). 10.2 The Engineering Technician does not operate on tasks at a higher level than well-defined and consults professionals at engineer and/or technologist level if elements of the tasks to be done are beyond his/her education and experience (e.g. power system stability). 10.3 The Engineering Technician engages in 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 with corrective action taken, if necessary, forms an important element.
Range Statement: Responsibility must be discharged for significant parts of one or more well-defined engineering activities.	The responsibility is mainly allocated within a team environment and with an increasing designation as experience is gathered.
Note 1: Demonstration of responsibility is under the supervision of a competent engineering practitioner, but the Engineering Technician is expected to perform	

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
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/her competence.	**Responsibility Level D**
Assessment Criteria: Self-development is displayed by the following performance: 11.1 Provide the strategy that you independently adopted to enhance professional development (IPD report). 11.2 Be aware of the philosophy of the employer in regard to professional development.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives are established, a programme is drawn up (in consultation with the employer if costs are involved) and options that are open to expand knowledge into additional fields are investigated. 11.2 Record-keeping must not be left to the employer or any other person. Trainees must manage their own training independently, taking the initiative and being in charge of their experiential development towards Professional Engineering Technician level. Knowledge of the employer's policy and procedures on training is essential.
Range Statement: Professional development involves the following: a) Taking ownership of own professional development. b) Planning own professional development strategy. c) Selecting appropriate professional development activities. d) Recording professional development strategy and activities while displaying independent learning	a) This is the trainee's professional development, not the development of the organisation for which he or she works. b) In most places of work, training is seldom organised by a training department. Engineering Technicians must manage their own experiential development. Engineering Technicians frequently find themselves at a standstill and are left doing repetitive work. If self-development is not self-driven, success is unlikely. c) Preference must be given to engineering development rather than developing soft skills. d) Developing a learning culture in the workplace environment of the Engineering

Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
ability.	Technician is vital to his/her success. Information is readily available, and most senior personnel in the workplace are willing to mentor if approached.