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Discipline-specific Training Guide for Registration as a Professional Technologist in Civil Engineering

R-05-CIV-PT

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ECSA

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DEFINITIONS

Alternative Route: An applicant who aspires to become registered in a Candidate or Professional Category but does not have the accredited or recognised qualifications and who proposes to meet the educational requirement through further study and assessment.

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

Benchmark Route: The normal process required to attain registration that consists of the completion of an accredited, recognised or evaluated equivalent qualification and a well-structured and effectively executed programme of training and experience for the category of registration.

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.

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

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

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

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

Management of engineering works or activities: The co-ordinated activities that are required are as follows:

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

(b) Operate engineering works safely and as 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.

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

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

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

Practice area – in the educational context: Synonymous with a generally recognised engineering speciality.

Practice area – at the professional level: A generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner through the path of education, training and experience.

Range statement: A context in which assessment may take place against an outcome and is expressed in terms of situations, activities, tasks, methods and forms of evidence.

Supervisor: A person who oversees and controls Engineering work performed by a Candidate.

ABBREVIATIONS

BDEA	Broadly defined engineering problem
BIFSA	Building Industries Federation South Africa
CESA	Consulting Engineers South Africa
CPD	Continuing Professional Development
DSTG	Discipline-specific Training Guide
ECSA	Engineering Council of South Africa
FIDIC	Conditions of Contract of the Fédération Internationale des Ingénieurs Conseils
GCC	General Conditions of Contract
JBCC	Joint Building Contracts Committee Incorporated
NEC	New Engineering Contract
SAFCEC	South African Forum of Civil Engineering Contractors
SAICE	South African Institution of Civil Engineering
TER	Training and Experience Report
TES	Training and Experience Summary
VA	Voluntary Association

BACKGROUND

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

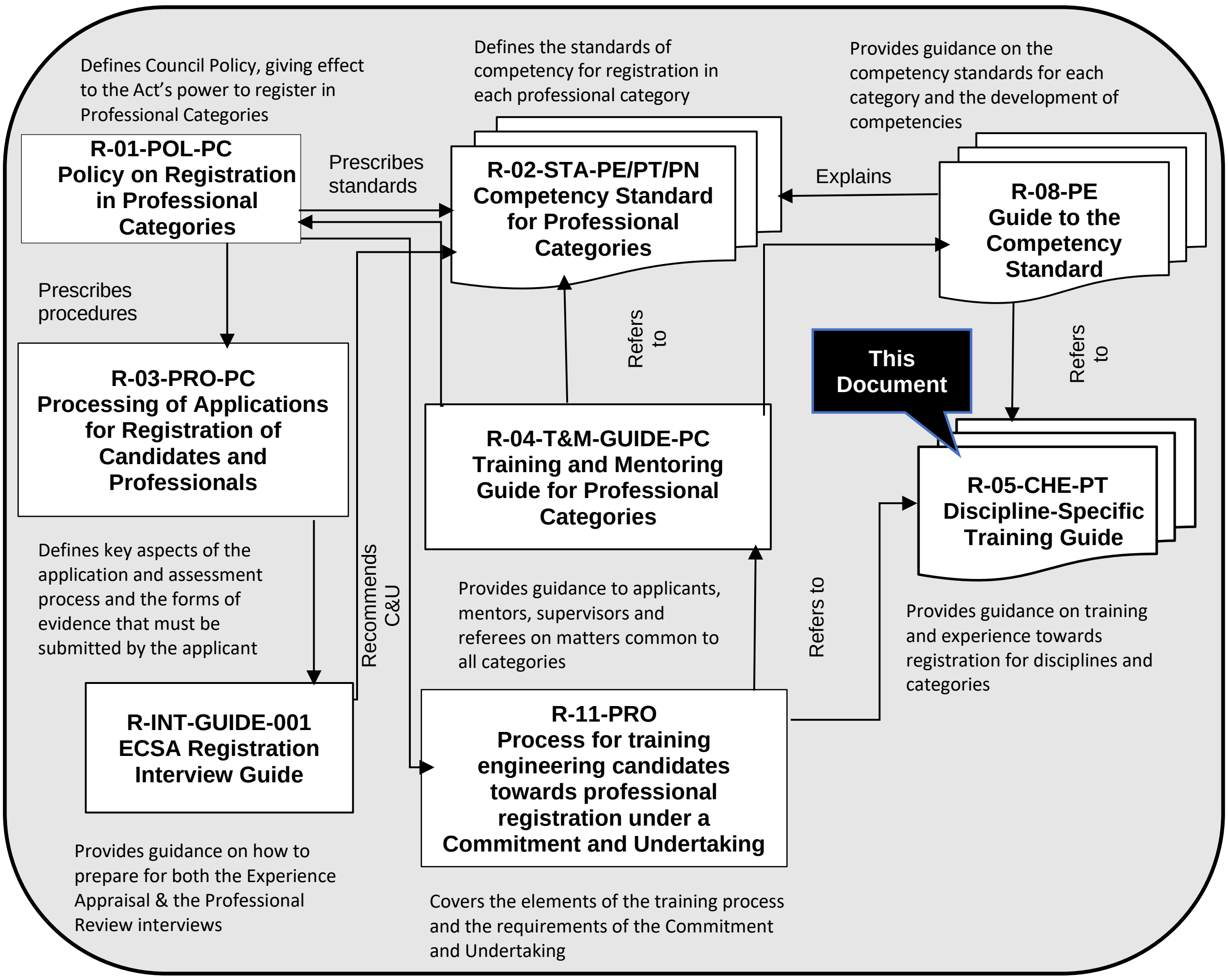

Figure 1: Documents defining the ECSA Registration System

1. PURPOSE OF THIS DOCUMENT

This document presents the critical training components towards registration as a Professional Engineering Technologist in the discipline of Civil Engineering. All persons applying for registration as Professional Engineering Technologists are expected to demonstrate the competencies specified in document **R-02-STA-PE/PT/PN** through work performed at the prescribed level of responsibility, irrespective of the trainee's sub-discipline within Civil Engineering.

This document supplements the generic *Training and Mentoring Guide* (document **R-04-TM-GUIDE-PC**) and the *Guide to the Competency Standards for Professional Engineering Technologists* (document **R-08-PT**). In document **R-04-T&M-GUIDE-PC**, the development of an engineering professional is divided into three stages:

- **Stage 1:** Meet standard for engineering education.
- **Stage 2:** Meet the professional competency requirements for registration.
- **Stage 3:** Maintain competency through Continuing Professional Development (CPD) and observe the code of conduct.

In the above document, 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.

The 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* (document **R-01-POL-PC**), the *Competency Standard* (document **R-02-STA-PE/PT/PN**) and the application process definition (document **R-03-PRO-PC**).

2. AUDIENCE

This DSTG is directed towards Candidate Engineering Technologists and their supervisors and mentors in the discipline of Civil Engineering. The guide is intended to support a programme of training and experience through incorporating good practice elements.

This guide applies to persons who:

- have completed the following stage 1 education requirements:
    - Accredited Bachelor of Engineering Technology (BEng Tech) in Civil Engineering qualification that has replaced the previous BTech (Engineering) Degree or a BTech (Eng) type qualification and Advanced Diploma in Civil Engineering. The benchmark qualification is pegged at NQF level 7, in South Africa.
    - A qualification recognised under the International Engineering Alliance Sydney Accord, or
    - Through a qualification evaluation/assessment for substantial equivalence to a South African accredited BEng Tech in Civil Engineering
- are registered as a Candidate Engineering Technologist; and/or
- have embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) programme with a mentor guiding the professional development process at each stage
- have completed recognised equivalent educational requirements for registration as either a Professional Engineering Technologist, Professional Engineering Technician but are not registered with ECSA (Alternative Route Applicants).

The guide may also be applied in the case of a person moving into a candidacy programme at a later stage that is at a level below that required for registration in document **R-04-T&M-GUIDE-PC**.

3. PERSONS NOT REGISTERED AS A CANDIDATE AND/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 Technologist is permitted without being registered as a Candidate Engineering Technologist and without training under C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration.

If the trainee's employer does not offer C&U, the trainee should 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 should keep abreast of all stages of the development process.

This guide is written for recent graduates who are training and gaining experience towards registration. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development.

Applicants who have not enjoyed mentorship are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their applications for registration. The training programme's goal is to allow Candidates to develop their competency until they are able to demonstrate the outcomes at the required level on a sustained basis and to take responsibility for the work performed. Three key players in the training of Candidates are supervisors, mentors and referees. Table 1 of document **R-04-T&M-GUIDE-PC** summarises the roles of these players; they are described in terms of roles because an individual may perform more than one function.

4. ORGANISING FRAMEWORK FOR OCCUPATIONS (OFO)

Civil Engineering Technologist (Organising Framework for Occupations

Civil Engineering Technologists form a collective group of engineers who plan, design, organise and oversee the construction, operation, maintenance and management of civil engineering infrastructure.

Practising Civil Engineering Technologists generally concentrate in one or more of the following areas:

- Structural Engineering
- Geotechnical Engineering
- Water Engineering

- Transportation Engineering
- Roads Engineering
- Materials Science Engineering
- Coastal Engineering
- Municipal and Urban Engineering
- Forensic Engineering
- Environmental Engineering
- Construction and Management Engineering
- Railway Engineering
- Site development and Planning
- Surveying.

This is a multidisciplinary branch of engineering that focuses on the engineering of various systems, including the following:

- Structural systems: These include buildings, dams, bridges, roads, highways, runways, harbours and railways.
- Geotechnical systems: These include township services, earthworks, excavations, soil conservation and geotechnical processes.
- Transportation systems: These include the roads, railway, airport runways and all the combination of elements and their interactions, which produce the demand for travel within a given area.
- Hydraulic engineering systems: These include water resources and supply, pipelines, canals, water treatment, storm water and drainage, sewerage systems, sanitation waste disposal and coastal engineering.

Typical tasks that Civil Engineering Technologists may undertake include the following:

- Research – conducting research and developing broadly defined new or improved theories and methods related to Civil Engineering.
- Design – advising on and designing broadly defined infrastructure such as bridges, dams, harbours, roads, airports, railways, canals, pipelines, treatment works, waste-disposal and flood control systems and residential, commercial, industrial, retaining structures and other buildings.

- Procurement – determining and specifying broadly defined construction methods, materials and quality standards and directing construction work.
- Safety and environment – assisting in establishing control systems to ensure efficient functioning of infrastructure and safety and environmental protection.
- Operations – organising and directing the maintenance and repair of existing civil engineering infrastructure.
- Technical support – analysing the behaviour of founding material when subjected to super-imposed loading.
- Quality control and management – analysing the stability of structures and testing the behaviour and durability of materials used in their construction.
- Construction – executing the design elements according to the specifications and approved construction drawings.
- Finance management – preparing the budget, control line items in the budget and proper financial control.
- Project management and contract management – project management, administration and contract management.

More specialised sub-disciplines in which Civil Engineering Technologists may practise include:

- Structural Engineering
- Geotechnical Engineering
- Water Engineering
- Transportation Engineering
- Environmental Engineering
- Urban Engineering
- Construction Engineering including Site Supervision and Control.

5. TRAINING IMPLICATIONS OF THE NATURE AND ORGANISATION OF THE INDUSTRY

Civil Engineering Technologists may be employed in either the private or the public sector.

In the private sector, Civil Engineering Technologists are typically involved in consulting and contracting in supply and manufacturing organisations. Civil Engineering consultants are responsible for planning, designing and documentation and supervising the construction of projects on behalf of their clients. Civil Engineering contractors are responsible for project implementation and their activities include planning, construction, quality control and labour and resource management. Technologists working in supply and manufacturing companies are involved in production, supply and quality control but could be involved in research and development.

The public sector is responsible for service delivery and is usually the client. However, in some departments, design and construction are also carried out. Civil Engineering Technologists are required at all levels of the public sector, including national, provincial and local government levels, state-owned enterprises and public utilities. The public sector largely handles planning, specifying and overseeing implementation of infrastructure projects in addition to engaging in operations and maintenance of infrastructure and managing new development applications. An extension of the public sector includes tertiary academic institutions and research organisations.

Depending on where the applicant is employed, there may be situations where the in-house opportunities are insufficiently diverse to develop all the required competencies listed in groups A and B in document **R-02-STA-PE/PT/PN**. For example, the opportunities for developing problem-solving competence (including design and the development of solutions) and for managing engineering activities (including implementing and constructing solutions) may not be available to the applicant. In such cases, employers are encouraged to implement a secondment system

It is fairly common practice that in situations where organisations are unable to provide training in certain areas, secondments are arranged with other organisations so that Candidates are able to develop all the competencies required for registration. These secondments are usually of a reciprocal nature so that both employers and their respective employees mutually benefit from the other party. Secondments between consultants and contractors and between the public and the private sector should be possible.

A generic scheme is presented for the outcomes applicable to all disciplines. Applicants must demonstrate competence in these outcomes during the various phases of a project or task:

- Solving engineering problems based on broadly defined engineering and contextual knowledge
- Managing engineering activities
- Impacts of engineering activity
- Exercise judgement, take responsibility and ethical behaviour during an engineering activity
- Professional development after graduation.

5.1 Investigation

Applicants interpret and clarify requirements leading to an agreed definition of the problem to be addressed; identify interested and affected parties and their expectations; gather, structure and evaluate adequate information relating to the problem; perform a structured analysis; evaluate the result of the analysis and revise or refine as required; and document, report and convey outcomes to the requesting party. They identify problems or hazards and analyse the causes of problems in a systematic manner using applicable techniques, tools, data analysis, numerical modelling and route cause analyses.

5.2 Process design

Applicants propose potential approaches to the solution, conduct a preliminary synthesis following selected approaches, evaluate potential solutions against requirements and wider impacts, present reasoned, economical and contextual engineering arguments for the selected option, fully develop the chosen option, evaluate the resulting solution and document the solution for approval and implementation.

This is the systematic process of conceiving and developing materials, procedures, components, systems and processes to serve useful purposes. Design involves a transformation from an initial requirement to produce the documented instructions on how to realise the end product. In determining a solution, barriers must be overcome. A design assignment, therefore, is an engineering problem that involves sub-problems that must be addressed utilising first principles and adhering to the norms, and where applicable, providing the justification required to work outside the norms.

5.3 Risk and impact mitigation

Engineering activities deliver benefits to society and the economy in the form of infrastructure, services and goods. Engineering involves the harnessing and control of natural forces or the use and control of complex information. The actions inherent in engineering activity have accompanying risks. These risks must be mitigated to a level that is acceptable to the affected parties. The management of risk accompanying engineering activity is the very rationale for regulation of the profession.

Applicants should be given the opportunity to study, analyse and recommend measures for:

- social/cultural impacts
- community/political considerations
- environmental impact
- sustainability analysis
- regulatory conditions
- potential ethical dilemmas.

To show competency in impact analysis and mitigation, the following should be done:

- Identify interested and affected parties and their expectations.
- Identify interactions between engineering considerations and social-cultural and environmental factors.
- Identify environmental impacts of the engineering activity.
- Identify sustainability issues.

- Propose and evaluate measures to mitigate the negative effects of engineering activity.
- Communicate with stakeholders.
- Adopt measures to mitigate the negative effects of engineering activities.

5.4 Engineering project management

Candidates should demonstrate the ability to manage an engineering activity. Project managers serve the team, communicate with the management and are accountable for the complete process. Project planning is an important role in construction and engineering activity. A good plan and strategy can help overcome overheads, reduce required budgets, achieve timely deliveries and maintain quality standards. While engineering management is more than project management, project management in itself is in most cases supportive of engineering activity but does not represent the level of demonstration of performance at broadly defined engineering.

Engineering project management must not be only concerned with the accuracy of design but also with the fit-for-purpose, functionality and sustainability thereof, while simultaneously creating economic value for the organisation. Generically, projects follow a certain project life cycle: initiating, planning, executing, monitoring and controlling. The nature of these projects may differ in degree and complexity. Ideally, Candidates should indicate knowledge of at least one of the four broad categories within project engineering management: technical competencies, financial competencies, managerial competencies and leadership competencies.

5.5 Implementation

Project Engineers must install, test and commission the necessary equipment or system for the desired result. This process must include all actions taken during construction. This can refer to a project quality plan. During commissioning, Candidates must clearly indicate their contributions. Stated contributions can also refer to the construction methodology plan, process, procedures, systems, commissioning plan, quality management plan, monitoring strategy and processes formulated to execute an engineering design or engineering solution.

5.6 Production

Candidates must state the requirement of the project in terms of delivery. They must refer to the initial production requirements for the project. They must also state whether they obtained results and if not, why they were unsuccessful. Production also entails manufacturing of components and design of engineering and construction materials.

5.7 Operations and maintenance

Candidates are required to state the operation requirements of the projects. They must also state the percentage of the plant that is available to implement the project and the maintenance philosophy, optimise utilisation of assets and substantiate what they have provided. These may include routine and preventative maintenance strategies.

6. DEVELOPING COMPETENCY: DOCUMENT R-08-PT

6.1 Contextual knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The VAs applicable to Civil Engineering Technologists and their functions and services to members provide a broad range of contextual knowledge for Candidate Civil Engineering Technologists. To achieve this objective, Candidates should have acquired at least 3 years' minimum experience in Civil Engineering activities. Candidates should demonstrate that they have been actively involved in Civil Engineering environment at appropriate level and broadly defined, and have participated in executing practical work to the extent that they have learnt sufficient detail regarding civil engineering principles and procedures to be able to solve engineering problems, manage, recognise impacts, identify ethical issues, exercise judgement and take responsible decisions in the workplace.

The ECSA Registration Committee reviews the Candidate's portfolio of evidence at the completion of the training period, against the 11 outcomes as outlined in **Appendix A**. Applicants are expected to possess knowledge of the following topics:

General appreciation of engineering procedures applicable to Civil Engineering

Read the information brochures provided by:

- South African Institution of Civil Engineering (SAICE)
- Consulting Engineers South Africa (CESA)
- South African Forum of Civil Engineering Contractors (SAFCEC) Discuss the procedures with your mentor at a quarterly interview.

Relationships between organisations

Display a working knowledge of the roles of organisations and the interaction between organisations such as:

- ECSA
- SAICE
- CESA
- SAFCEC
- Building Industries Federation South Africa (BIFSA)
- Construction Industry Development Board (CIDB)

Knowledge of Conditions of Contract

Display a working knowledge of the Conditions of Contracts used in Civil Engineering such as:

- General Conditions of Contract (GCC) of the SAICE
- Conditions of Contract of the Fédération Internationale des Ingénieurs Conseils (FIDIC) (International Federation of Consulting Engineers)
- New Engineering Contract (NEC)
- Joint Building Contracts Committee Incorporated (JBCC)

Structure of organisation in which applicant is employed

- Study all available organisation charts.

- Write a report on the management structure of the organisation/project team, defining your roles and responsibilities.

6.2 Functions performed

A conventional path to registration usually involves Candidates carrying out the functions described in Table 1 below. Generally, these functions generally relate to the section regarding ‘producing an asset’ but can also relate to the section ‘use of an asset’.

In regard to the section ‘producing an asset’, the functions are expanded from the conventional sequence of an engineering project, which comprises conceive, design, implement and operate, and usually the applicant will experience the functions in this order.

In regard to the section ‘use of an asset’ in which the work involves operations and maintenance, Candidates may experience the functions differently although the functions may be similar.

It is useful to measure the progression of Candidates’ competency by using the scales of Degree of Responsibility, Problem Solving and Engineering Activity as specified in the relevant documentation. **Appendix A** was developed against the Degree of Responsibility scale. Activities should be selected to ensure that applicants reach the required level of competency and responsibility.

It should be noted that Candidates working at Responsibility Level E carry the responsibility appropriate to that of a registered person except that the Candidates’ supervisors are accountable for the Candidates’ recommendations and decisions.

Table 1: Functions

1	**ORIENTATION**
	Be exposed to, observe and understand a range of processes, material and products that are relevant to your employer and typical clients.
2	**DEVELOPING AN ENGINEERING BRIEF**
2.1	**Accurate identification and definition** • Take an active part in researching, compiling and assessing basic data and background information and determining the meaning and purpose of an assignment. This will probably be in a supporting role. • Record your involvement in a report to your mentor/supervisor and demonstrate the process by which the assignment was finally and properly defined.
2.2	**Systems approach** • It is generally accepted that to ensure a holistic (all encompassing) solution to a problem, all relevant aspects are to be taken into account. • In reports to your mentor/supervisor, record through your own experience how you were involved in adopting the wider approach in defining problems.
2.3	**Standards and codes** List the documents relating to National and International Standards, Codes of Practice and Environmental Requirements that you have used. In your reports to your mentor/supervisor, discuss the relevance of these documents to your work.
3	**DESIGNING A SOLUTION**
3.1	**Resolution of an engineering brief** This involves compiling all relevant data acquired during the investigation period and producing a statement of the analytical work completed. • Finding alternative solutions • Technical and financial evaluation of alternatives by, for example, assisting with a feasibility study covering aspects such as • Concepts and precedents • Sources of information • Estimates and budget quotations • Quick design methods • Writing, production and interpretation of feasibility reports • Briefs for detailed design In a report to your mentor/supervisor, indicate your preferred solution with justification, showing throughout the report (or in an accompanying statement) how this work contributed to the solution of the problem. Identify the major factors on which the solution depended for accuracy and completeness.

3.2	**Present the solution to a problem** • This involves producing documentation for the solution, including diagrams, charts and/or detailed drawings using acceptable standards. • In a report to your mentor/supervisor, present the example for discussion and approval.
3.3	**Choice of construction material in deciding on a solution** Read the supplier’s instructions for use of patent materials. Read SANS specifications on civil engineering materials (naturally occurring, processed, manufactured). List all references. Discuss the choice and the use of prescribed materials for a specific solution with your mentor/supervisor.
4	**DOCUMENTATION**
4.1	**Purpose of documentation** • This involves acquiring an appreciation that technical specifications are an essential part of the solution to the problem. Select or write a specification and/or amend an existing specification for a particular item of work. • Discuss a specification used in your work with your mentor/supervisor.
4.2	**Costing of solutions** Cost solutions to problems by taking off quantities and carrying out cost estimates. Present examples to your mentor for discussion and comment.
4.3	**Safety** State in a quarterly report which regulations apply and which safety criteria you have followed in the course of implementing solutions.
5	**IMPLEMENTATION**
5.1	**Know how all parties to a contract exercise their duties and responsibilities** In a report to your mentor/supervisor, demonstrate your knowledge of the duties and responsibilities of all parties to a contract. Discuss the practical application of the various documents forming a particular contract with your mentor/supervisor.
5.2	**Know the procedures for the issuing, receipt, registration and filing of work instructions, drawings and amendments** Gain practical experience of these procedures and demonstrate this experience in a report to your mentor/supervisor.
5.3	**Keep an accurate daily record of events and instructions** Keep an up-to-date and accurate daily diary for inspection by your mentor/supervisor.
5.4	**Read and co-ordinate drawings and/or implement work instructions** Be involved in the process on a day-to-day basis. Demonstrate your competence by the quality of your work.
5.5	**Participate in the dimensional control and accuracy of the work you are implementing or controlling**

	Demonstrate your competence by the quality of your work and discuss this process with your mentor/supervisor.
5.6	**Know the use, performance and cost of equipment, plant and/or labour resources** In a report to your mentor, present a list of all major items of which you have first-hand knowledge. Discuss your experience with your mentor/supervisor.
5.7	**Plan and programme sections of work and be involved in the monitoring and reporting of progress** Discuss the programme with your mentor/supervisor.
5.8	**Measure and record or independently check work done for payment purposes** • Take part in this work for the preparation of checking Interim Valuations and/or Final Accounts • Demonstrate your involvement to your mentor/supervisor.
5.9	**Have a critical approach towards safety matters in the implementation process and towards observance of safe working practices** • Know your responsibilities regarding safety and be familiar with the legislation relating to your particular work. Appreciate good safety practices relevant to your work by referencing your company safety manual. • Emphasise your involvement in safety matters in a report to your mentor/supervisor.

6.3 Statutory

The typical activities of Civil Engineering Technologist outlined in the sections above have a direct public liability. The legislation listed in document **R-08-PT** also applies to Civil Engineering Technologists. However, this does not include all the industry-specific legislation and regulations that form part of contextual knowledge required of Civil Engineering Technologists. Candidates or applicants are expected to have a working knowledge of, among others, the following regulations and Acts and how they affect their working environment:

- Engineering Profession Act, 46 of 2000, its rules and specifically, the Code of Conduct
- Council of Built Environment Act, 43 of 2000
- Occupational Health and Safety Act, 85 of 1993 as amended by Occupational Health and Safety Act, No. 181 of 1993
- Mine and Health Safety Act, 29 of 1996, as amended
- National Building Regulations and Building Standards Act, 103 of 1977

- National Building Regulations and Building Standards Amendment Act, 49 of 1995
- Environment Conservation Act, 73 of 1989 as amended by Environment Conservation Act, 52 of 1994
- Environment Conservation Act, 50 of 2003
- Water Services Act, 108 of 1997
- Water Services Amendment Act, 30 of 2004
- National Water Act, 36 of 1998 as amended by National Water Act, 45 of 1999
- Labour Relations Act, 66 of 1995
- The Public Financial Management Act, 1 of 1999
- Municipal Finance Management Act, 56 of 2003

To demonstrate competency in regulatory aspects, the applicant should:

- identify the applicable legal, regulatory and health and safety requirements for engineering activity
- identify the risk and apply defined, widely accepted risk management strategies
- select sustainable materials, components, processes and systems
- communicate with parties involved in the legal and regulatory aspects of the work.
- maintain ethical standards.

6.4 Recommended formal learning

Applicants may find the formal learning activities presented in the following list useful in developing their competencies. The list is by no means extensive.

Discipline-specific courses relating to practice areas of:

- Report Writing
- Project Management
- Conditions of Contract
- Standard Specifications
- Preparation of Specifications
- Negotiation Skills

- Engineering Finance
- Risk Analysis
- Quality Systems
- Occupational Health and Safety
- Quality Systems
- Environment Impacts

6.5 Best Practice

Regardless of the discipline, it is generally unlikely that the period of training will be only 3 years, which is the minimum time ECSA requires. Typically, the period of training will be longer and determined by the availability of functions in the actual work situation and other criteria.

No ideal training programme structure or unique sequencing constitutes best practice. The training programme for each Candidate depends on the available work opportunities at the time that the employer assigns to the Candidate. Best practice programmes are programmes that address the development of the competencies needed for Candidates to be able to register successfully as Professional Engineering Technologists.

Candidates should work with their mentors/supervisors to determine appropriate projects to gain exposure to elements of the asset lifecycle and to ensure that their designs are constructable, operable and designed considering lifecycle costing and long-term sustainability. A regular reporting structure with suitable recording of evidence of achievement against the competency outcomes and levels of 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** so that by the end of the training period, Candidates exhibit a Level E Degree of Responsibility 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 and the degrees of responsibility defined in Table 4 of document **R-04-T&M-GUIDE-PC** are presented below:

A: Being Exposed	B: Assisting	C: Participating	D: Contributing	E: Performing
Undergoes induction, observes processes, work of competent practitioners	Performs specific processes under close supervision	Performs specific processes as directed with limited supervision	Performs specific work with detailed approval of work outputs	Works in team without supervision, recommends work outputs, responsible but not accountable
Responsible to supervisor	Limited responsibility for work output	Full responsibility for supervised work	Full responsibility to supervisor for immediate quality of work	Level of responsibility to supervisor is equivalent to a registered person but supervisor is accountable for applicant's decisions

Depending on the nature of the work undertaken by an employer, it may be possible to develop a training programme that provides opportunities for Candidates to undertake the work functions described in section 6.2 of Table 1 above. In certain cases, an employer may only cover some of the functions that are described in section 6.2 of Table 1. In such cases, the employer and Candidate should make appropriate arrangements as described in section 4.

6.6 Realities

No ideal training programme structure or unique sequencing constitutes best practice. Each Candidate's training programme depends on the work opportunities available at the time for the employer to assign to the Candidate. For ECSA registration in the fields in which Candidates are employed, applicants must ensure they undertake tasks that provide experience in the three generic engineering competence elements of problem investigation and analysis, problem solution and execution implementation**.**

Generally, irrespective of the sub-discipline, it is unlikely that the training period will be 3 years – the minimum time required by ECSA. Typically, it will be longer and determined among others by the availability of functions in the actual work situation.

Each Candidate effectively undertakes a unique programme where the various activities carried out at the discipline specific level are then linked to the generic competency requirements of **R-08-PT**.

6.7 Generalists, 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, specialists and those who have not followed a candidate training programme.

The overriding consideration is that, irrespective of the route followed, the applicant must provide evidence of competence against the prescribed standard **R-02-STA-PE/PT/PN**.

6.8 Moving into candidacy programmes

This guide assumes that Candidates enter a programme after graduation and continue with the programme until ready to submit an application for registration. It 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 (TES) and the Training and Experience Reports (TERs) for the previous programme or unstructured experience. In the latter case, 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 the requirements of the new programme. At minimum, the mentor and supervisor should plan the next phase of the Candidate's programme.

- During candidacy, Alternative Route Candidates (refer to second paragraph in Section 2: Audience) must ensure they are conversant with the practical knowledge set out in form **ER-B18-EDR**, Educational Development Report (part of the Application for Registration form) and submit evidence in the form of an Engineering Report (**ER-B2.3**).

REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Rev 1	17 Jul 2014		Registration Committee or Professional Engineers
Rev 2	22 Sep 2017	Review in accordance with approved DSTG Framework	
Rev 2	9 Oct 2017	Approved by PDSGC	PDSGC
Rev 2	23 Oct 2017	Reviewed and checked by Cato	B Collier-Reed; TP Maphumulo, J
Revision 2	30 Jan 2018	Approval by PDSGC	PDSGC
Rev 2 Daft A	17 Jun 2022	Reviewed as per the 4-year routine review that includes: Definitions, Abbreviations, Investigation, Process design, Risk management and impact mitigation, Engineering Management, Implementation, Production; Operations and maintenance and to update document numbers in cases where the document number of referenced document have changed for consistency and to align with the internal document numbering requirements. The working group further added additional information under the following headings: Audience reworked to add the different type of qualifications and indicate the NQF level, Organising Framework for Occupations section expanded	Working Group
Rev 2 Daft B	22 June 2022	Reviewed submission from working Group	RDD&R BU and Registration BU
Rev 2 Daft C	28 June 2022	Final working group review	Working Group
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Rev 3	13 July 2022	Approval	RPSC

The Discipline-specific Training Guide for:

Registration as a Professional Engineering Technologist in Civil Engineering

Revision 3 dated 13 July 2022 and consisting of 28 pages was reviewed for adequacy by the Business Unit Assistant Manager and is approved by the Acting Executive: Research, Policy and Standards (RPS).

.... 03 August 2022

Business Unit Assistant Manager Date

.... 03 August 2022

Acting Executive: RPS Date

This 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 your employer's training and development programme and develop your own lifelong development programme within this framework.

Broadly defined engineering work is usually characterised by the application of novel technology deviating from standard procedures, codes and systems, 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. Definitions of terms having particular meaning within this standard is given in text in relevant section.	DSTGs give context to the purpose of the Competency Standards. 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 a 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 DSTG. **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, and has interfaces with other parties and disciplines. c) Involves a variety of resources, including people, money, equipment, materials and technologies. d) Requires resolution of occasional problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues.	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 the following: a) Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation. b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on 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.

e) Are constrained by available technology, time, finance, infrastructure, resources, facilities, standards and codes and applicable laws. f) Have significant risks and consequences in the practice area and in related areas.	c) The bulk of the work involves familiar, defined range of resources, including people, money, equipment, materials, but new technologies are investigated and implemented. d) Most of the impacts in the sub discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of broadly defined non-standard engineering principles. e) The work packages and associated parameters are constrained by operational context with variations limited to different locations only. (Cannot be covered by standards and codes.) f) Even locally important minor risks can have far reaching consequences.
Activities include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; manufacture or construction; engineering operations; maintenance; project management; research; development and commercialisation.	**Activities** include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management. For Engineering Technologists, research, development and commercialisation happen more frequently in some disciplines but are seldom encountered in others.
3. Outcomes to be satisfied:	**Explanation and Responsibility Level**
Group A: Engineering Problem Solving	
Outcome 1: Define, investigate and analyse *broadly defined* engineering problems	**Responsibility Level E** Analysis of an engineering problem means the 'separation into parts possibly with comment and judgement'. *Broadly* means 'not minute or detailed' and 'not kept within narrow limits'.
Broadly defined engineering problems have the following characteristics. They require coherent and detailed engineering knowledge, underpinning the technology area; and one or more of the following: a) Are ill-posed, under- or over-specified, require identification and interpretation into the technology area. b) Encompass systems within complex engineering systems; belong to families of problems which are solved in well-	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.

accepted but innovative ways. *and one or more of:* c) Can be solved by structured analysis techniques d) May be partially outside standards and codes; must provide justification to operate outside. e) Require information from practice area and sources interfacing with practice area that is complex and incomplete. f) Involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties. *and one or both of:* g) Require judgement in decision-making in practice area, considering interfaces to other areas. h) Have significant consequences which are important in practice area but may extend more widely.	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.
Assessment criteria: A structured analysis of broadly defined problems typified by the following performances is expected: 1.1 Performed or contributed to defining engineering problems leading to an agreed definition of the problems to be solved. 1.2 Performed or contributed to investigating engineering problems including collecting, organising and evaluating information. 1.3 Performed or contributed to analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results.	To perform an engineering task an engineering technologist will typically receive an instruction from a senior person (customer) to do a specific task, and must: 1.1 Ensure the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation. 1.2 Ensure the engineering problem and related information are segregated from the bulk of the information, investigated and evaluated. 1.3 Ensure that the instruction and information to do the work is fully understood and complete, including engineering theory needed to understand the task and acceptance criteria, and to carry out and/or check calculations. If needed supplementary information must be gathered, studied and understood. Concepts and assumptions must be justified by engineering theory and calculations, if applicable.

3. Outcomes to be satisfied:	Explanation and Responsibility Level
Range statement: The problem may be a design requirement, an applied research and development requirement or a problematic situation in an existing component, system or process. The problem is one amenable to solution by 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 engineering problems	**Responsibility Levels C and D** Design means 'drawing or outline from which something can be made'. Develop means 'come or bring into a state in which it is active or visible'.
Assessment criteria: This outcome is normally demonstrated after a problem analysis as defined in Outcome 1. Working systematically to synthesise a solution to a broadly defined problem, typified by the following performances is expected: 2.1 Designed or developed solutions to 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 be unable to support proposals with the complete theoretical calculation to substantiate every aspect and must in these cases refer his / her alternatives to an engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified. 2.3 The best complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc. for the execution of work to meet customer requirements.
Range Statement: Solutions are those enabled by the technologies in the Candidate's practice area.	Applying theory to do *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 for any deviation from these established methods but must also initiate and/or participate in the development and revision of these norms.
Outcome 3: Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems or methodologies and those specific to the jurisdiction in which he/she practices.	**Responsibility Level E** Comprehend means 'to understand fully'. The jurisdiction in which an Engineering Technologist practices is given in section 4 of the specific DSTG.
Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 Apply engineering principles, practices, technologies, including the application of BTech or B Eng (Tech) theory in the practice area. 3.2 Indicate working knowledge of areas of practice that interact with practice area to underpin teamwork. 3.3 Apply related knowledge of finance, statutory, safety and management.	Design work for Engineering Technologists is based on BTech theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel technology. Engineering Technologists develop and apply codes and procedures in their design work. Investigation would be on broadly defined incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations. 3.1 Calculations at BTech or B Eng (Tech) theoretical level confirming the correct application and utilisation of equipment, materials and systems listed in section 4 of the specific DSTG must be done on broadly defined activities. 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.	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) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork. c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practice area, a selection of law of contract, health and safety, environmental, intellectual property, contract administration, quality management, risk management, maintenance management, regulation, project and construction management.	b) In spite of having a working knowledge of interacting disciplines, Engineering Technologists take responsibility for the multidisciplinary team of specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, architects on buildings, Electrical Engineers on communication equipment, etc. 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.	In Engineering operations Engineering Technologists are typically given the responsibility to carry out projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 The basic elements of managements must be applied to broadly defined engineering work. 4.3 Depending on the project, Engineering Technologists can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
Outcome 5: Communicate clearly with others in the course of his/her broadly defined engineering activities.	**Responsibility Level C**
Assessment criteria: Demonstrates effective communication by:	Refer to Range Statement for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.

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	
Range Statement for Outcomes 4 and 5: Management and communication in *well-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 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:	6.1 Engineering impacts heavily on the environment, e.g., servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wildlife, dangerous rotating and other machines, demolishing of structures, etc.

6.1 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.	6.2 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**
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 exist that safety and sustainability cannot be guaranteed.
Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include the following: a) Requirements include both explicit regulated factors and those that arise in the course of particular work. b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied. c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used. d) Safe and sustainable materials, components and systems.	a) The impacts will vary substantially with the location of the task, e.g., the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex. It is identified and studied by the 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. c) 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

e) Regulatory requirements are explicit for the context in general.	contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. d) 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 needs to identify, analyse and manage any long-term risks and develop strategies to solve these by using alternative technologies. e) 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 responsibility of the Engineering Technologist to use his/her knowledge and experience to confirm that prescriptions by others are correct and safe. f) 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: 8.1 Conversance and operation in compliance with ECSA's Rules of Conduct for registered persons confirmed 8.2 How ethical problems and affected parties were identified, and the best solution to resolve the problem selected.	Systematic means 'methodical; based on a system'. 8.1 ECSA's Code of Conduct, as per ECSA's website, is known and adhered to. 8.2 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.

Outcome 9: Exercise sound judgement in the course of *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 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 is under supervision of a competent engineering practitioner but is expected to perform as if he/she is in a responsible position.	
Group E: Initial Professional Development (IPD)	**Explanation and Responsibility Level**
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his or her competence.	**Responsibility level D**
Assessment criteria: Self-development managed typically: 11.1 Strategy independently adopted to enhance professional development evident. 11.2 Awareness of philosophy of employer regarding professional development evident.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a programme drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and being in charge of experiential development towards Engineering Technologist
Range Statement: Professional development involves: a) planning own professional development strategy b) selecting appropriate professional development activities	a) In most places of work training is seldom organised by a training department. It is up to the Engineering Technologist to manage his/her own experiential development. Engineering Technologists frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely.

c) recording professional development strategy and activities, while displaying independent learning ability.	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