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SOUTH AFRICA

Discipline-Specific Training Guide for Candidate Engineering Technologists in Mining Engineering

R-05-MIN-PT

REVISION No. 2: 25 July 2019

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ECSA

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DEFINITIONS

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 will require analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.

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

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

(i) to direct and control everything that is constructed or results from construction or manufacturing operations;
(ii) to operate engineering works safely and in the manner intended;
(iii) to 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;
(iv) to direct and control the engineering processes, systems, commissioning, operation and decommissioning of equipment; and
(v) to maintain engineering works or equipment in a state in which it can perform its required function.

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

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

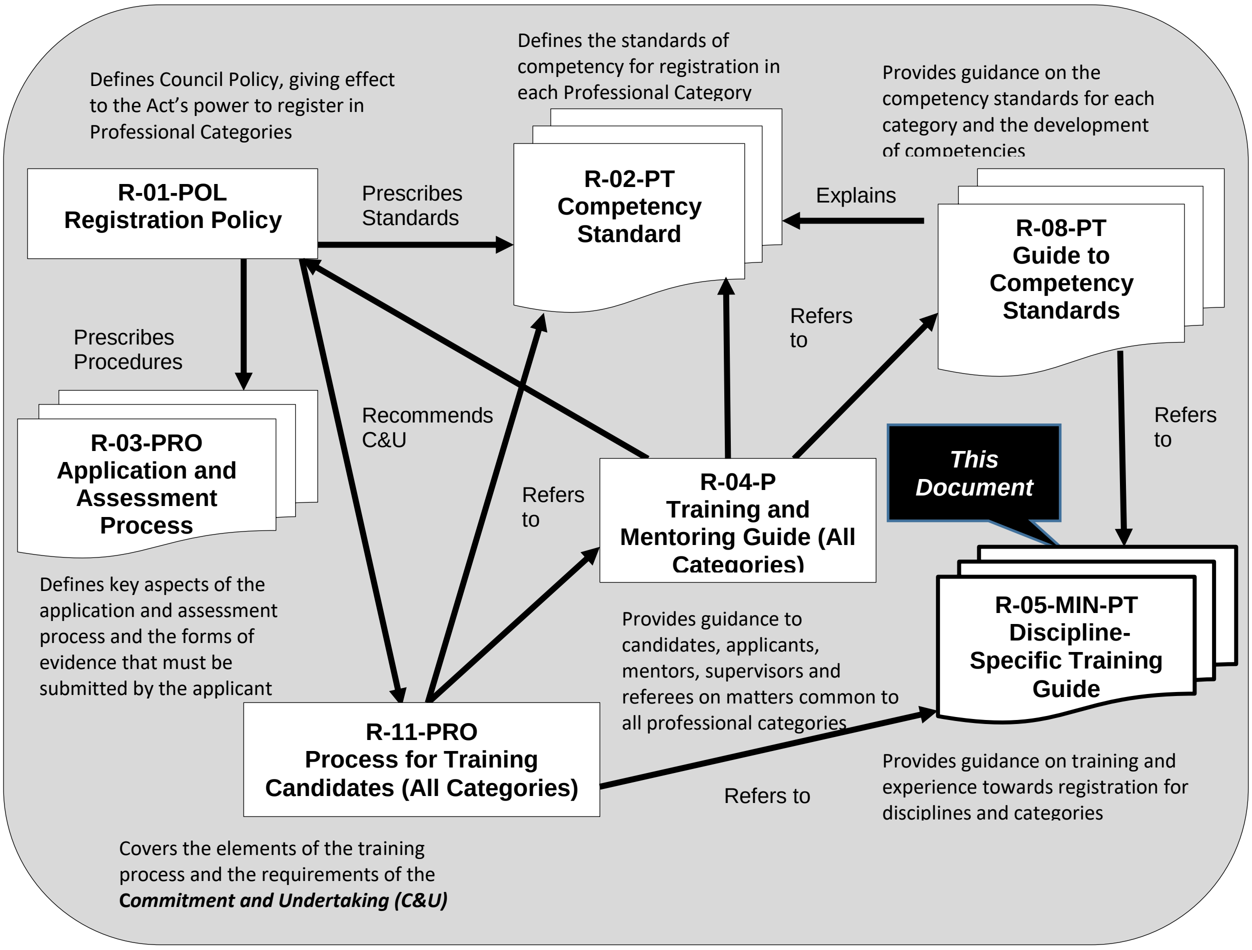
Practice area: A generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner by virtue of the path of education, training and experience followed

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

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

BACKGROUND

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



Documents defining the ECSA Registration System

1. PURPOSE OF THIS DOCUMENT

All persons applying for registration as a Professional Engineering Technologist are expected to demonstrate the competencies specified in document **R-02-PT** through work performed by the applicant at the prescribed level of responsibility, irrespective of the trainee's discipline.

This document supplements the generic Training and Mentoring Guide (document **R-04-P**) and the Guide to the Competency Standards for Professional Engineering Technologists (document **R-08 PT**). In document **R-04-P**, 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 second document (document **R-08-PT**) provides both a high-level and an outcome by outcome understanding of the Competency Standards that form an essential basis for this Discipline Specific Training Guide (DSTG).

This guide and the documents **R-04-P** and **R-08-PT** are subordinate to the Policy on Registration (document **R-01-POL**), the Competency Standard (document **R-02-PT**) and the application process definition (document **R-03-PT**).

2. AUDIENCE

This guide is directed towards candidates and their employers, supervisors and mentors in the discipline of Mining Engineering. It is also applicable to Engineering Technologists who study in related sub-disciplines or practice areas but whose engineering work is primarily Mining Engineering and who wish to be assessed for professional registration based on their work/experience in the Mining Engineering environment.

This guide is intended to support a programme of training and experience incorporating good practice elements and applies to persons who have

- demonstrated the required level of educational achievement by one of the mechanisms identified in document **R-01-POL** an accredited BTech (with prerequisite accredited National Diploma or equivalent) continues to be recognised as meeting the ECSA educational requirements;
- obtained a Sydney Accord recognised qualification or through evaluation/ assessment;

- registered as a Candidate Engineering Technologist; and
- embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) with a mentor guiding the professional development process at each stage.

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

All applicants for registration must present the same evidence of competence and be assessed against the same standards, irrespective of the development path followed. Application for registration as a Professional Engineering Technologist is permitted without being registered as a Candidate Engineering Technologist and without training under a C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration. A C&U indicates that the company is committed to mentorship and supervision and will make the necessary resources available to support the training and development of the Candidate or Engineering Technologist-in-Training.

If the trainee's employer has not signed a C&U with the ECSA, the trainee should establish the level of mentorship and supervision that the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The Voluntary Association for the discipline should be consulted for assistance in locating an external mentor. A mentor should be in place at all stages of the development process.

This guide 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 deficiencies in their professional development.

Applicants who have not enjoyed mentorship are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their application for registration.

The guide may be applied in the case of a person moving into a candidacy programme that is at a level below that required for registration (see Section 8.5 of this document) at a later stage.

4. MINING ENGINEERING

The Mining Engineering Technologist (MET) designs and prepares specifications for mineral extraction (Mining) methodology, processes and systems and the management of the operation of Mining Engineering processes for different types of mineral depositions and minerals.

4.1 Typical tasks performed by Mining Engineering Technologists

Typical tasks that a MET may perform include one or more of the following:

- Conduct broadly defined fundamental or operational research and advise on broadly defined occupational health and safety (OH&S) and environmentally responsible mineral excavation methodology, processes and systems
- Design and specify broadly defined mineral excavation (production) processes, apply required mining resources and mining technical support services, observe occupational health, safety and environmental considerations and verify quality assurance
- Review and validate the geological and resource model to ensure integrity
- Review and validate the geotechnical model and inputs to ensure integrity
- Develop mining equipment fleet requirements
- Analyse drilling and blasting requirements
- Select and quantify other minor mining equipment
- Provide estimates of the mining manpower requirements
- Provide mining cost estimates – Capital expenditures (CAPEX) and operating expenses (OPEX)
- Develop an End Destination Schedule for Waste
- Establish broadly defined production/operational control standards and procedures to ensure compliance with legislatorial and site-specific requirements
- Manage occupational health, safety and environmentally related hazards and accompanying risks
- Perform tests throughout the lifecycle stages and mineral excavation processes to determine the degree of control over variables identified during the broadly defined

strategic and tactical Mine Design and Planning processes

- Assist in the development of an appropriate site-specific Risk Management Policy and appropriate Procedures and Standards (Codes of Practice)
- Prepare Pre-Feasibility and Feasibility Reports and Life-of-Mine Exploitation Strategies and Plans, Business Plans and Bankable Documents based on site-specific assumptions, premises, constraints and best practice standards, for example, SAMCODES (i.e. SAMREC and SAMVAL)
- Convert mineral resources into mineral reserves
- Administer the Education and Training of Candidate MET Practitioners

4.2 Typical practice areas for Mining Engineering Technologists

Practising METs generally concentrate on one or more of the following practice areas:

- Mineral Excavations / Mining Operations
- Rock Engineers / Strata Control
- Occupational Environmental Engineering and Hygiene
- Mineral Asset Valuations (MAVs)
- Research and Development
- Development of a preliminary process flow control philosophy
- Undertaking of METSIM modelling and mass balance calculations
- Development of the preliminary process equipment list
- Development of a preliminary human resource plan
- Provision of process cost estimates (CAPEX and OPEX)
- Performance of Hazard and Operability Analysis (HAZOP) studies
- Participation in risk workshops
- Mine Planning and Design
- Education and Training of MET Practitioners
- Consultancy work

4.2.1 *Mining Engineering Technologists conducting mineral excavations / mining operations*

Mining Engineering Technologists whose training has been concerned predominantly with the production (mineral excavation) processes should obtain competency/experience in the following:

- **Production:** Mineral Excavation Processes including Occupational Health and Safety and Environmental Management
- **Production Programming and Scheduling:** To be captured in an appropriate Mining Plan
- **Project Work / Research and Development:** To be covered in a Project Report
- **Mining Technical Services:** Work Study, Survey and Mineral Evaluation, Ventilation Engineering and Occupational Hygiene, Rock Mechanics, Strata Control, Mineral Beneficiation, Geology, Grade Control and Administration, Integrated Environmental Management, Dewatering of open cast pit and underground (U/G) mine
- **Supervisory Experience:** Miner/Rockbreaker, Shift Supervisor, Mine Overseer or equivalent and preferably, a Subordinate Manager
- **Training and Development of METs:** Lecturer at Tertiary Institutions
- **Supervisor and Mentor Consultancy work:** Specialist consultancy services in one or more of the MET practice areas

4.2.2 *Rock Engineers / Strata Control*

Mining Engineering Technologists whose training has been concerned with Rock Engineering / Strata Control should obtain competency/experience in the following:

- **Production:** Mineral Excavation Processes, including Occupational Health and Safety and Environmental Management
- **Production Programming and Scheduling:** To be recorded in an appropriate Mining Plan
- **Basic Mining processes and procedures:** Mineral Excavation Processes, including OH&S, Support Installation and Rock Stability, Stability of Mining Excavations
- **Project Work / Research and Development:** To be covered in a Project Report
- **Rock Mechanics Design:** Optimisation of broadly defined mining layouts, Computer applications in Rock Mechanics, selection of occupationally safe Mining Methods, addressing Hazards and Risks related to OH&S and Stability of Mining Excavations
- **Supervision of Rock Mechanics:** Installation in a supervisory capacity (e.g. Miner/Rockbreaker, Shift Supervisor / Mine Overseer Equivalent), Monitoring and

Maintenance of Support Installations

- **Consultancy work:** Specialist consultancy services in one or more of the MET practice areas

4.2.3 *Occupational Environmental Engineering and Hygiene*

Mining Engineering Technologists whose training has been concerned with the ventilation of mines and occupational hygiene should demonstrate that they have obtained competency/experience in the following:

- **Basic Mining:** Mineral Excavation Processes including Occupational Health and Safety and Environmental Management
- **Project Work/Research and Development:** To be covered in a Project Report
- **Mine Environment Design and Specification:** Layouts, Refrigeration, Fan Specifications, Airflow, Occupational Environmental Control/Hygiene
- **Supervision of Ventilation:** Control and Monitoring of Air Controls, Dust, Fumes and Gases in a section of a mine, Installation of Fans, Air Conditioners, Management of Hazardous Substances and Pollution, etc.
- **Installation:** Fans, Air Controls, Brattices, etc.
- **Training and Development of Mine Environment Practitioners:** Lecturers at Tertiary Institutions, Supervisors and Mentors
- **Consultancy work:** Specialist consultancy services in one or more of the MET practice areas

4.2.4 *Mineral Asset Valuations*

Mining Engineering Technologists whose training has been concerned with the evaluation of mineral deposits should obtain competency/experience in the following:

- **Basic Mining:** Mineral Excavation Processes including Occupational Health and Safety and Environmental Management
- **Tonnage / Grade Estimates:** Sampling, Regression, Geostatistics, Kriging, Geology, Sedimentology on Evaluation process
- **Mine Planning and Design:** Impact of Mine layouts on the Evaluation Process, Rock

Mechanics, Hazard Identification and Risk Analysis (HIRA)

- **Survey:** Appreciation of survey techniques and interpretation of mine plans
- **Project Work / Research and Development:** To be covered in a Project Report
- **Economic Evaluation:** Costs, Revenue, Pay Limits, Life-of-Mine Calculations, Cash Flow Estimates, Return on Investment, Pre-Feasibility and Feasibility Studies, Bankable Documents and Business Planning
- **Geology:** Appreciation of geological analysis techniques and interpretation of well-defined geological models
- **Training and Development of MAV Practitioners**: Lecturers at Tertiary Institutions, Supervisors and Mentors
- **Consultancy work:** Specialist consultancy services in one or more of the MET practice areas and performance of bankable studies to assess the viability of the mine

4.2.5 *Research and Development*

Candidates must undertake well-defined research and developmental work that is predominantly of a Mining Engineering nature, and this work must include an in-depth application of the various aspects of Mining Engineering principles. Candidates must be involved in improvement projects that are necessary for mining operational efficiencies. In addition, applicants must develop the skills required to demonstrate the advanced use of broadly defined Mining Engineering knowledge in mining business optimisation through the following:

- Application of Mining Engineering principles in broadly defined mine design problems
- Use of applied Operations Research in Mineral Resource Management
- Mine-to-mill or resource to market optimisation
- Decision analysis techniques

4.2.6 *Mine Planning and Design*

Mining Engineering Technologists whose training has been concerned with the Planning and Design of mines should develop competency and gain experience in the following:

- Broadly defined mineral resource to mineral reserve conversion

- Broadly defined Mineral Resource, Geology, Geotechnical Engineering and Hydrology
- Broadly defined Mining Value Chain
- Broadly defined Mine Design and Mine Design criteria
- Technical risk analysis in mining
- Production forecasting
- Public reporting requirements, compliance with Codes
- Broadly defined planning horizons and planning cycles
- Multi criteria decision process and trade-off studies
- Planning integration
- Mining business optimisation
- Mineral Resource and Mineral Reserve Management
- Value engineering
- Geology
- Mining Operations
- Product Marketing
- Environmental Impact Assessments and Management Plans
- Completion of drilling, sampling, test work, etc., that may be required as an integral part of the Feasibility Study
- Acquisition of licences and permits required for the project

4.2.7 *Education and Training of Mining Engineering Technologists*

Education and Training enables METs to participate in the following:

- The education of Candidate METs and/or specialist Candidate METs
- The performance of Supervisors' duties as set out in document **R-04-P**
- The performance of Mentors' duties as set out in document **R-04-P**.

4.2.8 *Consultancy work*

Consultancy work involves METs whose education, training and/or experience qualifies them to be recognised specialists in a unique competency area and to provide specialist consultancy services in one or more of the practice areas set out in Section 4.2.1 through to Section 4.2.7 of this document.

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

Mining Engineering Technologists may be employed in the private or the public sector. In the private sector, METs would typically be involved in consulting or contracting or be employed in supply or manufacturing organisations. The MET consultant is responsible for planning, designing, documenting and supervising the construction of projects on behalf of their clients. The MET contractor is responsible for project implementation, and activities include planning and construction, and labour and resource management. Those working in supply or manufacturing companies could be involved in research and development and would be involved in production, supply and quality control.

An extension of the public sector would include tertiary academic institutions and research organisations. Depending on where the candidate is employed, there may be situations where the in house opportunities are not sufficiently diverse to develop all the required competencies with reference to the Competency Standards noted in document **R-02-PT**. For example, the opportunity for developing problem solving competence (including design and developing solutions) and the opportunity for managing engineering activities may not both be available to the candidate. In such cases, employers are encouraged to implement a secondments system.

It is fairly common practice that where an organisation is not able 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. Such secondments are usually of a reciprocal nature so that both employers and their respective employees mutually benefit from each other. Secondments between consultants and contractors and between the public and private sectors should be possible.

Problem solving in the environments of design, operations, construction and research is the core function of the MET. Problem solving is a logical thinking process that requires Engineering Technologists to apply their minds diligently in bringing solutions to technically broadly defined problems. The process involves the analysis of systems or the assembly of mechanical components together with the integration of various elements of Mechanical

Engineering through the application of basic and engineering sciences.

5.1 Diversity of mining

Due to the diversity in application of Mining Engineering within the South African (SA) Mining Industry, METs can follow a range of routes to registration across multiple minerals/commodities (e.g. precious metals, precious stones, ferrous metals, coal) in different mining method environments (e.g. surface mining, narrow tabular U/G mining, massive U/G mining) and U/G coal mining.

These routes to registration usually cover a period of operational experience from graduation as a Candidate MET to specialisation in an application of Mining Engineering in a particular field or sector of the SA Mining Industry. Typically, these fields are mining operations, mine planning and design, rock engineering / strata control, occupational environmental engineering (ventilation), refrigeration engineering, techno-economic evaluation, equipment selection, establishment and maintenance of mining infrastructure, provision of mining consulting services and Education and Training of Engineering Technologists-in-Training.

Each field should have covered all the supplementary elements mentioned after each practice area The objective should be that the MET becomes a broadly rounded Engineering Technologist.

5.2 Engineering lifecycle considerations

Mining projects follow the typical Mining Value Chain. Mining Engineering Technologists should demonstrate sufficient and appropriate exposure and experience across the elements of the typical Mining Value Chain. Specific and appropriate exposure and/or experience should be demonstrated across the following five phases of the typical mining project lifecycle:

- Project Data Collection and Investigations
- Evaluation Planning and Design
- Construction and Mine Establishment
- Mining Operations (Mineral excavation/exploitation)
- Mine Decommissioning and Closure

6. DEVELOPING COMPETENCY: DOCUMENT R-08-PT

Applicants are required to demonstrate the insight and the ability to use and interface various design aspects through verifiable work carried out in the provision of engineered and innovative solutions to broadly defined practical problems experienced in their operating work environment. In addition, applicants must develop the skills required to demonstrate the advanced use of MET knowledge in optimising the efficiency of operations.

Applicants must provide evidence of adequate training and exposure in these activities through broadly defined project work carried out in the analysis of problems and the synthesis of solutions.

Applicants need to demonstrate that they have had an opportunity to apply their technical knowledge and engineering expertise gained through technical university education and practical work experience. In applying technical and scientific knowledge gained through academic training, the applicant must also demonstrate the financial and economic benefits of engineered solutions synthesised from scientific and engineering principles at the broadly defined engineering level.

What is a sufficiently broadly defined engineering problem?

The definition of broadly defined in broadly defined engineering problems can be summarised as follows:

*Composed of many **interrelated conditions**; require practical, first principle, **empirical judgement** to create a solution within a set comprising originally **largely undefined but some well-defined frequently encountered circumstances***

Candidate Engineering Technologists must obtain experience in solving a variety of problems in their work environment. The solution to these problems should involve the use of fundamental and advanced MET knowledge obtained at a university of technology. Problems that require a scientific and engineering approach in their solution may be encountered in any engineering work environment that consists of integrated engineering systems, equipment, machinery and mining infrastructure. From their early training years, candidates must actively seek opportunities to obtain experience in the area of synthesising solutions to real life engineering problems encountered in the workplace.

Candidates are encouraged to familiarise themselves with the Mining and Minerals Sector in general by reading journals, joining relevant professional associations and attending conferences. This includes gaining knowledge of industry standards and specifications.

6.1 Contextual knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The Voluntary Associations applicable to the MET and their functions and services to members provide a broad range of contextual knowledge through the full career path of the Engineering Professional, from the Candidate Engineering Technologist to the registered Engineering Technologist.

Across all the routes to registration, the MET in training should demonstrate appropriate exposure and experience in the following:

- Mineral Excavation processes
- Mine Planning and Design
- Project execution
- Research and Development
- Supervision and Management
- Technical and Financial valuation
- Occupational Health and Safety and Environmental Impact Management, which should be done in one or more of the following sub-sectors/contexts of the SA Mining Industry:
  - U/G Narrow Tabular Hard Rock;
  - U/G Massive Hard Rock;
  - U/G Coal Mining; and
  - Surface Mining, including Open Pit, Open Cast and Quarrying operations.

6.2 Functions performed

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

- Group A: Knowledge-based problem-solving (this should be a strong focus)

- Group B: Management and communication
- Group C: Identifying and mitigating the impacts of the engineering activity
- Group D: Judgement and responsibility
- Group E: Independent learning

It is very useful to measure the progression of the candidate's competency by making use of the Degree of Responsibility, the Problem-Solving and the Engineering Activity scales, as specified in the relevant documentation. The degrees of responsibility defined in Table 4 of document **R-04-P** are presented below and in **Appendix B.**

A: Being Exposed	B: Assisting	C: Participating	D: Contributing	E: Performing

Degree of Responsibility E means performing at the level required for registration. This corresponds to the Range Statement in Outcome 10 in the Competency Standard (document **R-02-PT**), which requires the applicant to display responsibility 'for the outcomes of significant parts of one or more broadly defined engineering activities'.

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

6.3 Industry-related statutory requirements

Candidates are expected to have a working knowledge of at least the following mining-related legislations and how they affect their working environment:

- ECSA – Engineering Profession Act, No. 46 of 2000, its Rules and the Code of Conduct
- Labour Relations Act, No. 66 of 1995
- Environment Conservation Act, No. 73 of 1989, as amended by Act No. 52 of 1994 and Act No. 50 of 2003
- Water Services Act, No. 108 of 1997
- National Water Act, No. 36 of 1998
- Mine Health and Safety Act, No. 29 of 1996; Minerals Act, No. 50 of 1991 and

Regulations to the Minerals Act, 1991

- Mandatory Codes of Practice
- SANS and other relevant mining-related Standards
- Directives/Instructions issued by the Chief Inspector of Mines
- Guidelines issued by the Chief Inspector of Mines

Candidates are also expected to have in-depth knowledge of at least the following site- and mine-specific and mining-related standards and requirements:

- HIRA/HAZOP; Occupational Health and Safety Risk Management Programme; Managerial Instructions
- Mine- and site-specific Standards and Procedures
- List of recorded and significant Risks relating to OH&S; Working Guides
- Relevant Specifications of Original Equipment Manufacturer (OEM)

6.4 Recommended formal learning activities

Candidates may find many of the recommended formal learning activities presented below useful in developing the required competencies. The list is by no means extensive:

- Formally registered Continuing Professional Development (CPD) courses
- Project Management (basic)
- Value Engineering
- Negotiation Skills
- Engineering Finance
- Hazard Identification and Risk Assessment (HIRA, HAZOP)
- Quality Systems
- Environmental Impacts
- Project Schedule
- Writing technical papers
- Planning methodology and technique
- Presenting technical papers or lectures at organised events
- Public speaking
- Systems Engineering
- Mineral Resource, Geology, Geotechnical Engineering and Hydrology

- Ore Processing
- Process Water Supply
- Infrastructure
- Operational Readiness
- Security
- Manpower
- Project Planning
- Procurement Operations Plan / Subcontractor Operations Plan
- Permit and Licence acquisitions
- Financials
- Quality
- Inbound and Outbound Logistics
- Rehabilitation

7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best-practice programmes

Since professional development programmes (PDPs) should primarily be outcome-based, there is no ideal (prescribed) training programme structure or unique sequencing that constitutes best practice.

The training programme for each candidate will consequently depend on the work opportunities that are available at the time for the employer to assign to the candidate.

It is suggested that candidates work with their mentors to determine appropriate projects to gain the exposure and experience needed to comply with the desired outcomes. A regular reporting structure with suitable recording evidence of achievement against the competency outcomes and responsibility needs to be put in place.

The training programme should be such that the candidate progresses through the levels of work capability described in document **R-04-P** so that by the end of the training period, the candidate exhibits the Degree of Responsibility E and is able to perform individually and as a team member at the level of problem solving and engineering activity required for registration.

Depending on the nature and extent of the engineering-related work undertaken by the employer, it should be possible to develop candidate-specific PDPs that will provide opportunities to gain the necessary exposure and experience described in the phased approach in **Appendix A**. This guidance should be read in conjunction with the previous sections of this document.

Appendix B 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.

7.2 Orientation requirements

- Introduction to the company
- Company OH&S requirements
- Company Code of Conduct
- Company Staff Code and Regulations
- Typical functions and activities
- Hands on experience and orientation in each of the major company divisions
- Overall mining operations and mining-related facilities

7.3 Realities

Regardless of the discipline, it is generally unlikely that the period of training and development will be less than three years, which is the minimum period prescribed by the ECSA. The length of the candidate's individual PDP will be determined by the Recognition of Prior Learning (RPL) and the availability of opportunities in the actual work situation, among others.

It should also be appreciated that the envisaged period of three years for the individual PDP will most probably only accommodate exposure to experience in one of the following sub sectors / specialisation practice areas:

- U/G Thin Tabular Hard Rock Operations
- U/G Massive Hard Rock Operations

- U/G Coal Mining
- Surface Mining

In the case of candidates specialising in practice areas referred to in Section 4.2.2 through to Section 4.2.8, the recommended period for the candidate-specific PDP is five years.

Should the candidate require exposure to or experience in more than the initial sub-sector / specialisation practice area, this would have to be addressed through a supplementary PDP.

7.4 Considerations for generalists, specialists, researchers and academics

The document **R-08-PT** adequately describes what would be expected of persons whose formative development has not followed a conventional path, for example, academics, researchers and specialists.

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

7.5 Moving into or changing candidacy training programmes

This guide assumes that the candidate enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the candidate is supervised and mentored by persons who meet the requirements stipulated in document **R-04-P**. 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.
- On entering the new programme, the mentor and supervisor should review the candidate's development while considering past experience and opportunities and the requirements of the new programme. At minimum, the mentor and supervisor should plan the next phase of the candidate's programme.

REVISION HISTORY

Revision Number	Revision Date	Revision Details	Approved By
Rev 1	17 July 2014		Central Registration Committee
Rev 2	23 May 2019	Routine Review Approval	RPSC

The Discipline-Specific Training Guide for:

Candidate Engineering Technologist in Agricultural Engineering

Revision 2 dated 25 July 2019 and consisting 23 pages reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (RPS).

[signature] .... 01/10/2019 ....

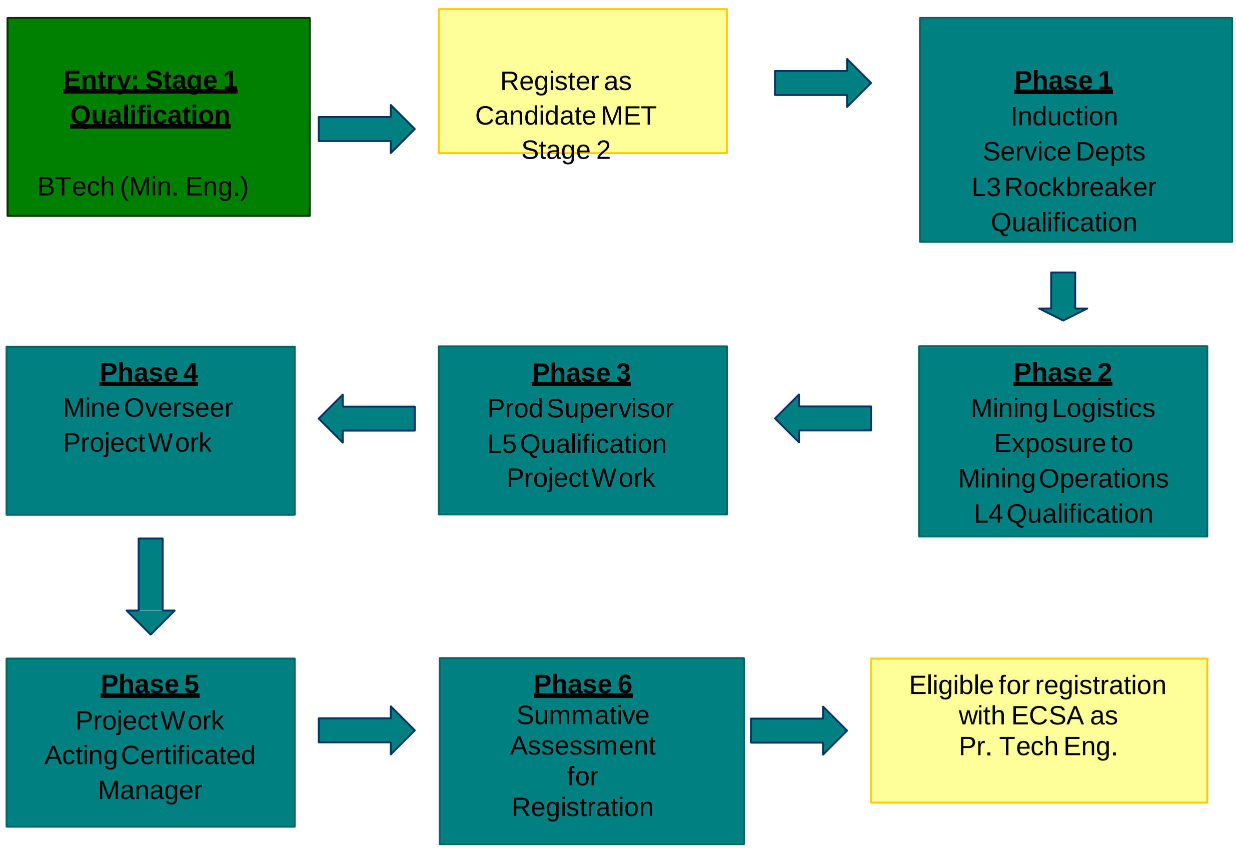
Business Unit Manager Date

[signature] .... 8/10/19 ....

Executive: RPS Date

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

Appendix A: Phased approach for Professional Development Programmes



Appendix B: Training elements

Synopsis: A Candidate Engineering Technologist should achieve specific competencies at the prescribed level during his/her 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 to all engineering work performed after professional registration regardless of the level of responsibility at any particular stage of an engineering career:

1. Confirm clear understanding of instructions/briefs from client or engineering problems encountered during project and clarify if necessary;
2. Use theoretical training to systematically synthesise solutions and alternative solutions or approaches to the problem by analysing designs against requirement, select the best and present to the client;
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 and affected parties;
10. Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain and evaluating shortcomings; and
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 Appendix D.	Discipline Specific Training Guides (DSTG) gives context to the purpose of the Competency Standards. Professional Engineering Technologists operate within the nine disciplines recognised by ECSA. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given in Clause 4 of the specific Discipline Specific Training Guideline. DSTG's are used to facilitate experiential development towards ECSA registration and assist in compiling the required portfolio of evidence (Specifically the Engineering Report in the application form). NOTE: The training period must be utilised to develop the competence of the trainee 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 R-02-PT Section 3, at the level defined for each outcome. Required contexts and functions may be specified in the applicable Discipline Specific Guidelines.

Level Descriptor: *Broadly-defined engineering activities (BDEA)* have several of the following characteristics:

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

Activities include but are not limited to: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; manufacture or construction; engineering operations; maintenance; project management; research; development and commercialisation.

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)

The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.

Level Descriptor: B*DEA* in the various disciplines are characterised by several or all of:

a) *Scope* of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation;
b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on complex activities and problems. *Broadly defined activities* in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team;
c) The bulk of the work involves familiar, defined range of *resources,* including people, money, equipment, materials, but new technologies are investigated and implemented;
d) Most of the impacts in the sub-discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of *broadly-defined* non-standard engineering principles;
e) The work packages and associated parameters are *constrained* by operational context with variations limited to different locations only. (Cannot be covered by standards and codes).
f) Even locally important minor risks can have far reaching consequences.

Activities include but are not limited to: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management. For Engineering Technologists, research, development and commercialisation happen more frequently in some disciplines and 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:* (a) require coherent and detailed engineering knowledge, underpinning the technology area; *and one or more of:* (b) are ill-posed, under- or over specified, require identification and interpretation into the technology area; (c) encompass systems within complex engineering systems; (d) belong to families of problems which are solved in well-accepted but innovative ways; *and one or more of:* (e) can be solved by structured analysis techniques; (f) may be partially outside standards and codes; must provide justification to operate outside; (g) require information from practice area and sources interfacing with practice area that is complex and incomplete; (h) involves a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties; *and one or both of:* (i) requires judgement in decision making in practice area, considering interfaces to other areas; (j) have significant consequences which are important in practice area, but may extend more widely.	(a) coherent and detailed engineering knowledge for Engineering Technologists means the problem encountered cannot be solved without the combination of all the relevant detail including engineering principles applicable to the situation; (b) the nature of the problem is not immediately obvious, and further investigation to identify and interpret the real nature of the problem is necessary; (c) the problem is not easily recognised as part of the larger engineering task, project or operation and may be obscured by the complexity of the larger system; (d) 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 includes 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 take note that although their actions might only 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 in defining engineering problems leading to an agreed definition of the problems to be solved. 1.2 Performed or contributed in investigating engineering problems including collecting, organising and evaluating information. 1.3 Performed or contributed in analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results	To perform an engineering task an engineering technologist will typically receive an instruction from a senior person (customer) to do a specific task, and must: 1.1 Make very sure 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 The engineering problem and related information must be 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.
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 Clause 4 of the specific Discipline Specific Training Guideline.**

Outcome 2: Design or develop solutions to broadly-defined engineering problems	**Responsibility level 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 means "the combination of separate parts, elements, substances, etc. into a whole or into a system" by: 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 <u>the theoretical calculations to support each alternative must be done and</u> submitted <u>as an attachment</u>. 2.2 The Engineering Technologist will in some cases not be able to support proposals with the complete theoretical calculation to substantiate every aspect, and must in these cases refer his / her alternatives to an Engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified. 2.3 The best complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc., for the execution of work to meet customer requirements.
Range Statement: Solutions are those enabled by the technologies in the candidate's practice area.	Applying theory to do *broadly-defined engineering* work is mostly done in a way that has been used before, probably developed by engineers in the past, and documented in written procedures, specifications, drawings, models, examples, etc. Engineering Technologists must seek approval of any deviation from these established methods, but 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 **Clause 4 of the specific Discipline Specific Training Guideline.**
Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 Applied engineering principles, practices, technologies, including the application of BTech theory in the practice area. 3.2 Indicated working knowledge of areas of practice that interact with practice area to underpin team work. 3.3 Applied related knowledge of finance, statutory, safety and management.	Design work for Engineering Technologists is based on BTech theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel technology. Engineering Technologists develop and apply codes and procedures in their design work. Investigation would be on broadly-defined be incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations. 3.1 Calculations at BTech theoretical level confirming the correct application and utilisation of equipment, materials and systems listed in Clause 4 of the specific Discipline-Specific Training Guideline.must be done on *broadly-defined* activities. 3.2 The understanding of broadly-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team. 3.3 The ability to manage the resources within legal and financial constraints must be evident.
Range Statement: Applicable knowledge includes: (a) Technological knowledge that is well established and applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others. (b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork. (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.	(a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of systems, materials, components and projected customer requirements and expectations. New ideas, materials, components and systems must be investigated, evaluated and applied accompanied by complex theoretical motivation. (b) In spite of having a working knowledge of interacting disciplines, Engineering Technologists takes responsibility for the multi-disciplinary 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 to establish and maintain professional and business relationships evident.	In engineering operations Engineering Technologists will typically be given the responsibility to carry out projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 The basic elements of managements must be applied to broadly-defined engineering work. 4.3 Depending on the project, Engineering Technologists can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
Outcome 5: Communicate clearly with others in the course of his or her broadly-defined engineering activities	**Responsibility level C**
Assessment Criteria: Demonstrates effective communication by: 5.1 Ability to write clear, concise, effective technical, legal and editorially correct reports shown. 5.2 Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident. 5.3 Oral presentations made using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.	5.1 Refer to Range Statement for Outcome 4 and 5 below. 5.2 Refer to Range Statement for Outcome 4 and 5 below. 5.3 Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
Range Statement for Outcomes 4 and 5: Management and communication in *well-defined engineering* involves: (a) Planning *broadly-defined* activities; (b) Organising *broadly-defined* activities; (c) Leading *broadly-defined* activities and (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 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 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 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: 6.1 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown. 6.2 Measures taken to mitigate the negative effects of engineering activities evident.	6.1 Engineering impacts heavily on the environment e.g. servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wild life, dangerous rotating and other machines, demolishing of structures, etc. 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases, compensation paid, etc.

Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his or 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 save 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: (a) Requirements include both explicit regulated factors and those that arise in the course of particular work; (b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied; (c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used; (d) Safe and sustainable materials, components and systems; (e) Regulatory requirements are explicit for the context in general.	(a) The impacts will vary substantially with the location of the task, e.g. the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex, and 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 confirm or check that the instructions are in line with regulations. The Engineering Technologist is responsible to see to it that this is done, and if not, establishes which regulations apply, and ensure that they are adhered to. Usually the people working on site are strictly controlled w.r.t. health and safety, but the Engineering Technologist checks that this is done, but may authorise unavoidable deviation after setting condition for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. (c) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The Engineering Technologist needs to identify, analyse and manage any long term risks, and develop strategies to solve these by using alternative technologies. (d) The safe and sustainable materials, components and systems must be selected and prescribed by the Engineering Technologists or other professional specialists must be consulted. It is the responsibility of the Engineering Technologist to use his/her knowledge and experience to confirm that prescriptions by others are correct and safe. **(e)** Application of regulations associated with the particular aspects of the project must be carefully identified and controlled by the Engineering Technologist.

Group D: Exercise judgement, 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; **or** (b) significant consequences in technology application and related contexts; **or** (c) ranges of interested and affected parties with widely varying needs.	In Engineering about 5% of engineering activities can be classified as *broadly-defined* where the 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 by: (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 into consideration 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 consult professionals at engineer level if elements of the project to be done are beyond his/her education and experience (e.g. power system stability). 10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction, and corrective action if necessary, forms an important element. The calculations, for example fault levels, load calculations, losses, etc. are done to ensure that the correct material and components are utilised.
Range Statement: Responsibility must be discharged for significant parts of one or more *broadly-defined* engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Demonstrating responsibility would be under supervision of a competent engineering practitioner but 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 in regard to professional development evident.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a programme drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and be in charge of experiential development towards Professional Engineering Technologist level.
Range Statement: Professional development involves: (a) Planning own professional development strategy; (b) Selecting appropriate professional development activities; and (c) Recording professional development strategy and activities; while displaying independent learning ability.	(a) In most places of work training is seldom organised by some training department. It is up to the Engineering Technologist to manage his/her own experiential development. Engineering Technologists frequently end up in a ‘dead-end street’ being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely. (b) Preference must be given to engineering development rather than developing soft skills. (c) Developing a learning culture in the workplace environment of the Engineering Technologist is vital to his / her success. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.