ECSA
ENGINEERING COUNCIL OF SOUTH AFRICA

An Effective Regulator Assuring Engineering Excellence

Discipline-specific Training Guide for Registration as a Professional Engineer, Professional Engineering Technologist, and Professional Engineering Technician in Mining Engineering

R-05-MIN-PE/PT/PN

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TABLE OF CONTENTS

INTRODUCTION

All persons applying for registration as a Professional Engineer, Professional Engineering Technologist or Professional Engineering Technician are expected to demonstrate the competencies specified in **R-02-STA-PE/PT/PN** through work performed at the prescribed level of responsibility, irrespective of the Applicant's discipline.

The *Training and Mentoring Guide for Professional Categories* (**R-04-T&M-GUIDE-PC**) provides key aspects of training, which are as follows:

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

It is therefore important to standardise the framework for all engineering disciplines to ensure that ECSA registration categories are aligned.

DEFINITIONS

Applicant means a person applying to ECSA for registration in any of the professional categories, according to Section 18 of the Engineering Profession Act, 46 of 2000.

Broadly defined engineering work is characterised by the following:

(a) It is constrained by available technology, time, finance, infrastructure, resources, facilities, applicable laws, standards and codes.

(b) It involves a variety of resources, including people, money, equipment, materials and technologies.

(c) It requires the resolution of occasional problems arising from interactions between wide-ranging or conflicting technical and engineering issues.

(d) It has significant risks and consequences in the practice and related areas.

(e) The practice area is located within a wider, complex context, requiring teamwork with other parties and disciplines.

(f) The scope of the practice area is linked to the technologies used and the changes due to the adoption of new technology into current practice.

Candidate means a person registered with the ECSA in a Candidate category of registration.

Competence/Competency is defined in **R-02-STA-PE/PT/PN –** *Competency Standard for Registration in Professional Categories* as **PE/PT/PN**.

Competency standard means a statement of competency required for a defined purpose.

Complex engineering work has several of the following characteristics:

(a) The scope of activities may encompass entire complex engineering systems or subsystems and may extend beyond previous experience, i.e., unfamiliar scenarios.

(b) The context of the activities is complex and requires identification and specification.

(c) It requires diverse and significant resources, including people, equipment, materials, technology and money.

(d) It encompasses significant and complex interactions among wide-ranging or conflicting technical, engineering and other issues.

(e) It has constraints and challenges with respect to time, finance, infrastructure, resources, facilities, applicable laws, standards and codes.

(f) It involves significant risks and consequences in a range of contexts, requiring responsibility and accountability in decision-making and judgement.

Engineering problem means a problem that is amenable to analysis and solution using engineering sciences and methods.

Engineering Professional means a person registered with ECSA as a Professional Engineer, Professional Engineering Technologist, Professional Engineering Technician or Professional Certificated Engineer.

Engineering science means a body of knowledge based on the natural sciences and the use of mathematical formulation, where necessary, that extends knowledge and develops models and methods to support its application to solve problems and provide the knowledge base for engineering specialisation.

Ill-posed problem means a problem in which the requirements are not fully defined or may be defined erroneously.

Management of engineering work or activities means the required coordination of activities to:

(a) direct and control engineering processes and systems, including commissioning, operation and decommissioning of equipment

(b) direct and control construction or results from construction or manufacturing operations

(c) maintain engineering works and equipment in a state in which these can perform their required function

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

(e) return engineering works, plant and equipment in an acceptable condition through the renewal, replacement or repair of worn, damaged or decayed parts.

Mentor means a person, ideally an Engineering Professional, who guides the competency development of an Applicant in the appropriate category.

Mine operations in the context of mining engineering means the following:

(a) The removal of economically beneficial minerals from natural deposits, waste or stockpiles by any surface or underground mining methods.

(b) Operations or activities conducted underground or on surface associated with or incident to the preparation, development, operation, maintenance, opening and reopening of an underground or surface mine, storage or stockpiling of mined materials, backfilling, sealing and other closure procedures related to a mine, or the movement, assembly, disassembly or staging of any mining equipment.

(c) Waste and fines (tailings) disposal, and the operation and maintenance of impoundments.

(d) The operation of any mine drainage system.

(e) Reclamation/rehabilitation activities.

Mine planning and design means the design and scheduling of mining operations to optimise the return on investment through capital investment, design and extraction scheduling leading to the preparation of the mineral product according to specifications. The three main elements of mine planning are typically long-term, medium-term and short-term planning. Inputs to the mine planning process may include geological model, geotechnical model, mining method and layouts, metallurgical model, extraction strategy, mining loss and dilution factors, cost of mining/processing and commodity value.

Mineral asset valuation means the valuation of a mineral asset that has been completed in accordance with an appropriate mineral asset valuation code, such as the SAMVAL Code, and approved by a competent valuator. The valuation of a mineral asset determines its monetary worth in the marketplace.

Occupational health, safety and environmental engineering means the discipline of Mining Engineering-related activities specialising in the safety, health and welfare of people engaged in the mining industry. The goals of occupational health, safety and environmental programmes include fostering a safe and healthy work environment (where environmental engineering may include mine ventilation, refrigeration, safety and occupational health).

Outcome at the professional level means a statement regarding the performance that a person must demonstrate to be judged competent.

Practice area means a generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner through following the path of education, training and experience.

Research and development means the practice of Mining Engineering activities whereby new technologies, systems and/or services can be applied to the mining industry in order to, among others:

(a) increase the efficiency of extraction, improve occupational health and safety and reduce costs

(b) develop fully mechanised mining systems that allow for efficiency and safety improvements

(c) develop mining systems completely independent of the use of explosives.

Rock Engineering is a branch of geotechnical engineering that focuses specifically on mining operations, including both rock and soil mechanics. It involves the determination and design of stable excavations in and/or on rock masses, including geotechnical work associated with tunnelling, stope stability, and pit slope, rock dump and tailings dam stability.

Supervisor means a person who oversees and controls engineering work performed by an Applicant.

Voluntary Association means an entity founded for the achievement of a common goal among its members. Examples of Voluntary Associations in the mining industry include the Southern Africa Institute for Mining and Metallurgy (SAIMM), South African National Institute of Rock Engineering (SANIRE) and the Association of Mine Managers of South Africa (AMMSA).

ABBREVIATIONS

BEng	Bachelor of Engineering
BEng (Tech)	Bachelor of Engineering in Technology
BSc (Eng)	Bachelor of Science in Engineering
BTech (Eng)	Bachelor of Technology in Engineering
C&U	Commitment and undertaking
CIMVAL	Canadian standards and guidelines for the valuation of mineral properties
CPD	Continuing professional development
DoR	Degree of responsibility
DSTG	Discipline-specific Training Guide
ECSA	Engineering Council of South Africa
HIRA	Hazard identification and risk assessment
HAZOP	Hazard and operability analysis
IDoEW	Identification of engineering work
IMVAL	International mineral property valuation standards
JORC	Joint Ore Reserves Committee; Australasian Code for reporting of exploration results, mineral resources and ore reserves
NDip	National Diploma
NI43-101	Canadian national instrument for the standards of disclosure for mineral projects
NQF	National Qualifications Framework
OHS	Occupational health and safety
PE	Professional Engineer
PGDip	Postgraduate Diploma
PN	Professional Engineering Technician
PT	Professional Engineering Technologist

TER	Training and Experience Report
TES	Training and Experience Summary
SAMREC	South African Code for reporting of exploration results, mineral resources and mineral reserves
SAMVAL	South African Code for reporting of mineral asset valuation
VA	Voluntary association
VALMIN	Australasian Code for the technical assessment and valuation of mineral and petroleum assets and securities for independent expert reports

BACKGROUND

Figure 1 illustrates the documents that comprise the Engineering Council of South Africa (ECSA) system for registration in professional categories. It also locates the current document.

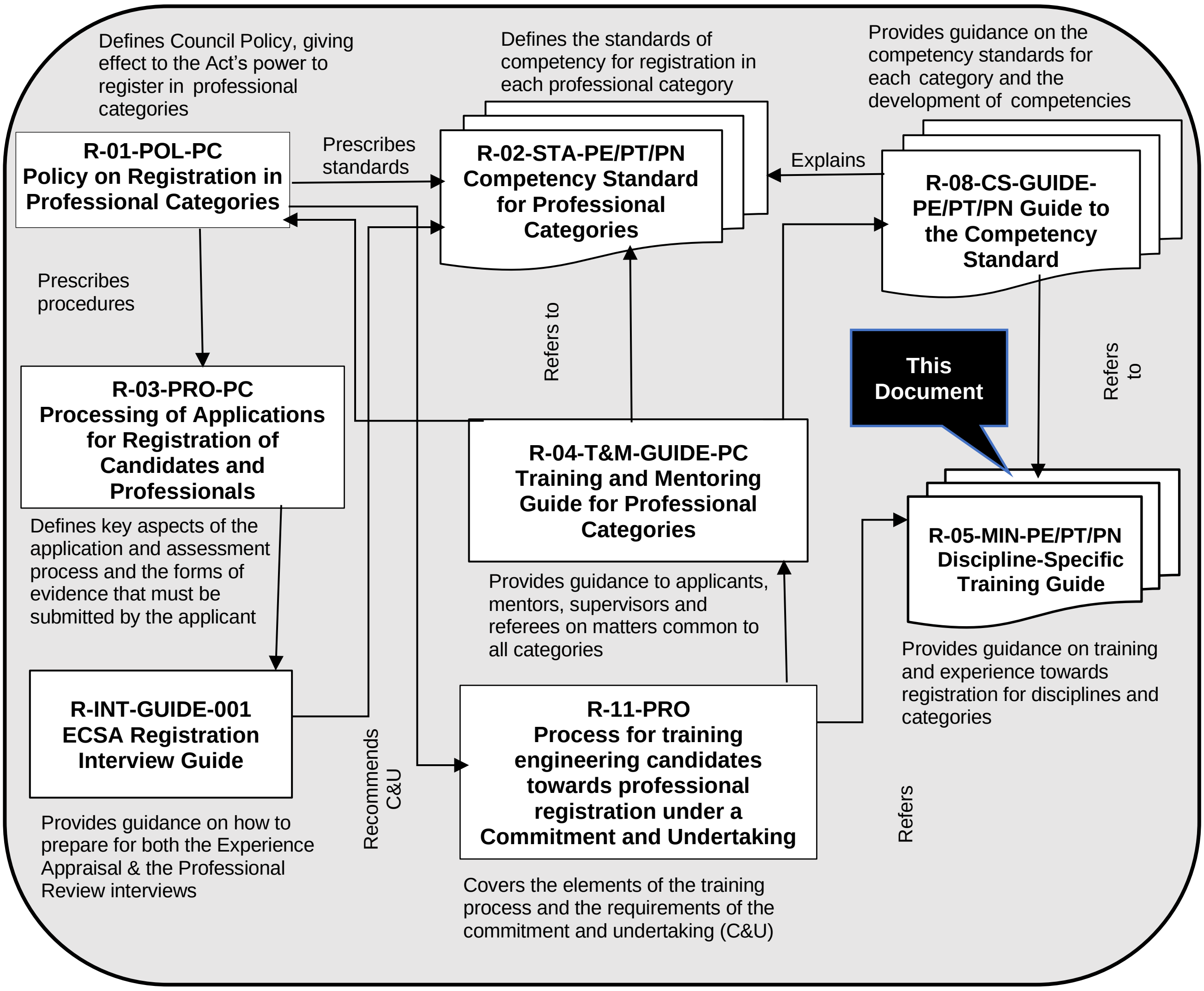


Figure 1: The ECSA registration system

1. PURPOSE OF THIS DOCUMENT

All persons applying for registration in a professional category are expected to demonstrate the competencies specified in **R-02-STA-PE/PT/PN:** Competency Standard for Registration in Professional Categories as PE/PT/PN through work performed at the prescribed level of responsibility, irrespective of the Applicant's discipline.

This document supplements the generic **R-04-T&M-GUIDE-PC**: Training and Mentoring Guide for Professional Categories and the **R-08-CS-GUIDE-PE/PT/PN**: Guide to the Competency Standards for Registration in Professional Categories. In **R-04-T&M-GUIDE-PC**, attention is drawn to the following sections:

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

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

This guide, **R-04-T&M-GUIDE-PC** and **R-08-CS-GUIDE-PE/PT/PN** are subordinate to the **R-01-POL-PC**: Policy on Registration in Candidate and Professional Categories, the *Competency Standard* (**R-02-STA-PE/PT/PN**) and the **R-03-PRO-PC**: Processing of Applications for Registration of Candidates and Professionals.

2. AUDIENCE

This DSTG is directed towards Applicants and their Supervisors and Mentors in the discipline of Mining Engineering. It is also applicable to engineers who have studied in related subdisciplines or practice areas but whose engineering work is primarily that of Mining Engineering and who wish to be assessed for professional registration based on their work/experience in the Mining Engineering environment. The guide is intended to support a programme of training and experience, incorporating elements of good practice.

The guide applies to persons who:

- have registered with ECSA as a Candidate Engineer, Technologist or Technician
- hold an ECSA-accredited qualification or an acceptable combination of accredited qualifications prescribed for the category
- have met the minimum education in a specific category through ECSA educational qualification evaluation or assessment
- have qualifications recognised by the Washington, Sydney, and Dublin Accords for which ECSA is a signatory
- hold a qualification or combination of qualifications recognised under an international academic agreement relevant to the category
- hold a qualification or a combination of qualifications that has been determined on a case-by-case evaluation to satisfy criteria for substantial equivalence to an accredited qualification for the category by virtue of:
    - the qualifications being awarded in a jurisdiction or a quality assurance system by ECSA; or
    - examination of detailed documentation on the qualifications reflecting substantial equivalence
- have embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) programme under the supervision of an assigned Mentor guiding the professional development process at each stage.

2.1 Persons registered as a Candidate

Candidate engineering practitioners are persons registered with ECSA after completing their relevant engineering qualification programme as accredited or substantially assessed to be equivalent by ECSA. Training and development can be done under a Commitment and Undertaking (C&U) Candidacy programme according to **R-11-PRO-PC** or through a training academy programme, as outlined in **A-01-POL**.

Training under a C&U programme or through a training academy is structured to align with the ECSA standard competency outcomes for the benefit of the Candidate. The Mentor, Supervisor or coach and Candidate must ensure that the training covers all developmental aspects aligned with the competency outcomes required for registration as an Engineering Professional.

2.2 Persons not registered as a Candidate and/or not trained under a C&U programme

Irrespective of the training and development path followed, all Applicants must present the same evidence of having met the ECSA-prescribed competency standards. Application for registration as an Engineering Professional is permitted without being registered as a Candidate and without training through a C&U programme. However, mentorship and adequate supervision are critical factors in ensuring effective development towards achieving the required competencies.

If the Applicant's employer does not offer a C&U programme, then he/she 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. A 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 and the ECSA registration requirements.

This DSTG is written for the recent graduate who is training and gaining experience towards professional registration. Mature Applicants may apply the guide retrospectively to identify possible gaps in their development.

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

3. TYPE OF ENGINEERING WORK

3.1 Mining Engineering (Organising Framework for Occupations)

The Mining Engineer applies engineering principles to the discovery, evaluation, planning, development, operation, closure and reclamation of mines in a safe, sustainable, profitable and socially and environmentally acceptable way.

Mining Engineering comprises the principal subdisciplines of Mining Engineering, Rock Engineering and Mine Ventilation Engineering.

- **Mining Engineering** includes the evaluation and assessment of the economic extraction of mineral reserves, including mine planning and design, development, operation, closure and reclamation of mines in a safe, sustainable, cost-efficient, profitable and environmentally and socially acceptable way. It also includes managing mineral reserves, training mining engineers, providing consultancy services and academic research, where applicable.
- **Rock Engineering** is a branch of geotechnical engineering which focuses specifically on mining operations and includes both rock and soil mechanics. It involves the determination and design of stable excavations in and/or on rock masses, including geotechnical work associated with tunnelling, stope stability, and pit slope, rock dump and tailings dam stability.
- **Mine Ventilation Engineering** primarily includes engineering applications for the design, implementation, operation and control of the mining environment to meet the required standards of occupational health and safety (OHS), from project definition to mine closure.

3.2 Typical tasks performed by a Mining Engineer

Tasks performed by Mining Engineers include the following:

- All levels of studies (such as conceptual, pre-feasibility, bankable and definitive feasibility studies), life-of-mine extraction strategies and business plans based on leading practice standards for mining ventures.
- Design, planning and scheduling of mines for the extraction of metals and minerals, incorporating Mining Engineering, Rock Engineering, Mine Ventilation Engineering and OHS aspects and infrastructural support services.
- Establishment and operation of mines with due regard to legislation, operational controls and standards, OHS and site-specific and socio-political requirements.
- Fundamental and operational research to identify new technologies, mining methods and operating systems to improve safety and health, productivity, sustainability and social responsibility.
- Education and training of Mining Engineers.

3.3 Typical practice areas for Mining Engineers

Mining Engineers generally concentrate on one or more of the following practice areas:

- Operation of mines
- Rock Engineering
- Mine Ventilation Engineering and OHS
- Mine planning and design
- Mineral asset valuation
- Education and training of Mining Engineers
- Consultancy work.

3.3.1 Mining Engineering: Mine operations

In mine operations, the Mining Engineer has, where necessary, legal and core qualifications and is assisted by interdisciplinary specialists. However, the Mining Engineer must demonstrate competency in:

- mine design, production, planning and scheduling
- resource planning, utilisation and optimisation
- mine logistics, ore clearance and infrastructure services
- mine technical services, including geology, mineral evaluation, Mine Ventilation Engineering, Rock Engineering and OHS
- sustainable development regarding energy conservation, climate change, air pollution, water usage, pollution and conservation, biodiversity and waste and hazardous substance management
- enterprise risk management
- social responsibility
- operations research and development
- project execution and management.

3.3.2 Rock Engineering

In the field of Rock Engineering, the Mining Engineer must demonstrate competence in:

- the basic mining process, including mine design, programming and scheduling and OHS
- rock engineering designs and specifications applicable to mine layouts and mining methods, including stability of underground and surface mine excavations, support design and installation, rock dumps, tailings dams and other mining-related geotechnical structures
- rock engineering hazard and risk assessment (HIRA) and amelioration
- support and training of subordinates and mine production personnel in the Rock Engineering aspects of safe mining
- project design and execution principles
- laboratory testing of soil and rock samples
- hydrogeological assessment and modelling
- research and development.

3.3.3 Ventilation Engineering

In the field of OHS and environmental engineering, the Mining Engineer must demonstrate competence in:

- the basic mining process, including mine design, programming, scheduling and OHS
- mine ventilation and climate-control designs and specifications for mine layouts and mining methods, including fan and refrigeration plant design and installation, ventilation controls, mine cooling and the removal of gases, fumes and dust
- routine monitoring of air quality and quantity, and occupational hygiene measurements
- occupational health HIRA and amelioration
- design and maintenance of emergency procedures
- project design and execution principles
- research and development.

3.3.4 Mine planning and design

In mine planning and design, the Mining Engineer must demonstrate competence in:

- the engineering criteria of mine design, including those relating to geology, Rock Engineering, Ventilation Engineering and OHS
- design and planning of mines and mine layouts and the impacts on production levels, considering Rock Engineering and Ventilation Engineering requirements, logistics, ore clearance, mine services, equipment requirements and productivity
- understanding the application of various mine design and software packages
- mineral resource management, including the conversion of mineral resources to mineral reserves, as described in applicable mineral resource and reserve estimation codes such as SAMREC, JORC and NI43-101
- life-of-mine: long- medium- and short-term production forecasting
- mine business cycles, including strategic and the tactical mine design and planning process
- mining value chain, business optimisation and value engineering
- risk identification and amelioration
- project design and execution principles.

Value engineering comprises practices that are atypical and used to improve cost, schedule and/or reliability of capital projects. These practices are used primarily during early-stage planning, mainly facilitated by specialists from outside the project team, leading to formal, documented practices involving a repeatable work process.

Examples are technology selection, process simplification, waste minimisation, energy optimisation, process reliability modelling, customisation of standards and specifications, predictive maintenance, design to capacity and constructability.

3.3.5 Mineral asset valuation

In mineral asset evaluation, the Mining Engineer must demonstrate competence in:

- the basic mining process, including mine design, programming, scheduling and OHS
- appreciation of geological evaluation techniques and models, and interpretation of mine planning outcomes

- determination and classification of mineral resources and reserves, as described in applicable mineral resource and reserve estimation codes such as SAMREC, JORC and NI43-101
- mine economics with respect of commodity prices, capital and operating costs, cash flow, return on investment and business modelling
- technical and financial risk assessment of projects and operations
- project design and execution principles
- determining mineral asset value through valuation approaches described in various mineral asset valuation codes such SAMVAL, VALMIN, CIMVAL and IMVAL.

3.3.6 Research and development

In research and development, the Mining Engineer must demonstrate competence in the use of Mining Engineering knowledge to:

- improve mining safety and health performance
- improve operational efficiency and productivity, and reduce costs
- solve mine design, Rock Engineering and Mine Ventilation problems
- develop and/or apply new technologies for mining methods, layouts and machinery
- modernise and automate mines and mining methods.

3.3.7 Education and training

In education and training, the Mining Engineer must demonstrate competence in:

- training undergraduate and postgraduate Mining Engineering students
- performing the duties of a Supervisor as set out in **R-04-T&M-GUIDE-PC**
- performing the duties of a Mentor as set out in **R-04-T&M-GUIDE-PC**.

3.3.8 Consulting/consultancy work

Mining Engineers whose education, experience and training qualifies them to be a specialist in a unique competency may provide consulting services in one or more of the practice areas described above.

3.4 Nature and organisation of the industry

Mining Engineers may be employed in either the private or the public sector. In the private sector, Mining Engineers are typically involved in mine operations, consulting or contracting in supply and manufacturing organisations. Mining Engineering consultants are responsible for planning, designing, documenting and overseeing the construction of projects on behalf of their clients. Mining Engineering contractors are responsible for project implementation and their activities include planning, construction and labour and resource management. Mining Engineers working in supply and manufacturing companies are involved in the assembly, supply and quality control of equipment and machinery, and could be involved in research and development. An extension of the public sector includes government bodies, tertiary academic institutions and research organisations.

Depending on where the Applicant is employed, in-house opportunities may not be sufficiently diverse to develop the required competencies in groups A and B described in **R 02 STA PE/PT/PN**. For example, where opportunities for developing problem-solving competence (including design and development of solutions) and for managing engineering activities may not be available to Applicants, employers are encouraged to implement a secondment system. Such secondments are usually reciprocal in nature so that both employers and their respective employees mutually benefit from the exchange. Secondments between consultants and contractors and between the public and the private sectors are encouraged.

Problem-solving in the areas of design, operation, construction and research is the Mining Engineer’s core competency, requiring a logical process for engineers to apply their minds diligently to finding solutions to technical problems. This process involves analysing systems and integrating various elements of Mining Engineering through the application of basic and engineering sciences.

3.4.1 Diversity of mining

Owing to the diversity in the application of Mining Engineering within the South African mining industry, Mining Engineers can follow various routes to registration across multiple minerals/commodities (e.g., precious metals, precious stones, ferrous metals, base metals, industrial minerals and coal) in differing mining method environments (e.g., surface mining, quarrying, narrow tabular and massive ore body underground mining, and underground coal mining).

After qualification as a Mining Engineer, these routes to registration usually cover a period of operational experience that leads to specialisation in a particular field or sector of the South African mining industry. Typically, these fields include mining operations, mine planning and design, Rock Engineering, Ventilation Engineering and OHS, techno-economic evaluation, equipment selection, establishment and maintenance of mining infrastructure, provision of mining consulting services and education and training of Mining Engineers. The objective is for the Mining Engineer to become a well-rounded engineer.

4. DEVELOPING ENGINEERING COMPETENCIES

This section should be read in conjunction with **R-08-CS-Guide PE/PT/PN**.

Progression throughout the training period presented in **R-04-T&M-GUIDE-PC** and Table 5 (Section 5.1) refers to the progressive increase in the Degree of Responsibility (DoR) to which Applicants are exposed during their professional training.

If Applicants or Mentors are unsure whether the engineering work they are considering is complex, broadly defined, or well-defined, they should refer to **R-02-STA-PE/PT/PN** which provides detailed information on the characteristics and requirements of each level descriptor, defining the competencies required for each category.

4.1 Training for registration in a Professional Category

4.1.1 Outcome 1: Define, investigate and analyse engineering problems (Responsibility level E)

According to the ECSA outcomes, Engineering Professionals are expected to be able to define, investigate and analyse engineering problems by identifying systems and sub-systems in resolving problems and using data and information technologies where applicable. Depending on the category of professional registration, these are the following:

- Professional Engineer – complex engineering problems
- Professional Engineering Technologist – broadly defined engineering problems
- Professional Technician – well-defined engineering problems.

The engineering problem may be defined as a design requirement, an applied research and development requirement or a situation in an existing component, system or process. The analysis of engineering problems requires in-depth fundamental and specialised engineering knowledge, including the collection, organisation and evaluation of the information from all applicable sources, including investigation where appropriate (**Table 1**).

Table 1: Outcome 1 – Define, investigate and analyse engineering problems

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mine planning and design	• Integrate technical, economic, environmental and social data to identify options for resource depletion strategy. • Determine input parameters to conceptual and pre-feasibility studies to test project viability and identify optimal solutions.	• Within given technical, economic, environmental and social data, determine potential mining design criteria and operational options.	• Within given mine and operational design criteria, design mine layout and determine mining schedules and costs.
Mining operations	•	• Collect, organise and evaluate data to conduct conceptual, pre-feasibility and feasibility studies, and to prepare life of mine (LOM) plans. •	• Assist in collecting, organising and clarifying data to conduct conceptual, pre-feasibility and feasibility studies, and prepare LOM plans. • Assist in collecting, organising and clarifying data to prepare medium-term mining plans, budgets and operational optimisation studies
Rock engineering	• Determine input parameters to rock engineering design criteria for project and operational studies.	• Collect, organise and evaluate data to prepare medium-term mining plans, budgets and operational optimisation studies.	• Assist in collecting, organising and clarifying data for preparation of rock engineering design criteria. • Assist in collecting, organising and clarifying data for rock engineering design, such as failure modes, slope angles and support requirements.

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mine ventilation engineering	• Determine input parameters to mine ventilation engineering and occupational health design criteria for project and operational studies.	• Collect, organise and evaluate data for preparation of mine ventilation engineering and occupational health design criteria. • Collect and analyse data for mine ventilation engineering design, such as ventilation layouts, fan design, fire prevention and atmosphere management.	• Assist in collecting, organising and clarifying data for preparation mine ventilation engineering and occupational health design criteria. • Collect and analyse data for mine ventilation engineering design, such as ventilation layouts, fan design, fire prevention and atmosphere management
Mineral asset evaluation	• Assimilate data on geology and mineral resource, mine design, mine plan, mineral reserves, commodity prices, capital and operating costs, business modelling, technical and financial risk assessment, project design and execution principles	• Collect, organise and evaluate data on geology and mineral resource, mine design, mine plan, mineral reserves, commodity prices, capital and operating costs, business modelling, technical and financial risk assessment, project design and execution principles.	• Assist in collecting, organising and evaluating data on geology and mineral resource, mine design, mine plan, mineral reserves, commodity prices, capital and operating costs, business modelling, technical and financial risk assessment, project design and execution principles.

4.1.2 Outcome 2: Design or develop solutions to engineering problems (Responsibility levels C and D)

The solution to an engineering problem requires having detailed specifications that align with the required design and potential solutions or methods that can be used to approach and resolve the problem (**Table 2**). The preferred option is influenced by factors that best fit the solution, taking into consideration cost, practicability, innovation and any impact beyond the immediate requirements.

After the task is fully understood and interpreted, a solution to the problem can be developed. Synthesising a solution means “the combination of separate parts, elements and substances into a whole or into a system” by the following:

- The development (design) of more than one way to solve an engineering task or problem, including the cost and impact assessment for each alternative. The alternatives must meet the requirements set out by the design specifications, supported by theoretical calculations.
- In some cases, the Engineering Professional may not be able to support proposals with substantive calculation. The alternatives and particularly the recommended alternatives must be convincing.
- The final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc. for the execution of work.

Table 2: Outcome 2 – Design or develop solutions to engineering problems

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mine planning and design	• Identify options for resource depletion strategy. • Conduct conceptual and pre-feasibility studies to test project viability and identify optimal solutions.	• Conduct pre-feasibility and feasibility studies and prepare LOM plans.	• Design mine layout and determine mining schedules and costs. • Assist in carrying out conceptual, pre-feasibility and feasibility studies and LOM plans.
Mining operations		• Prepare medium-term mining plans, budgets and operational optimisation studies.	• Assist in carrying out medium-term mining plans, budgets and operational optimisation studies.
Rock engineering	• Determine rock engineering design criteria for project and operational studies.	• Operationalise rock engineering design criteria for rock engineering design, such as failure modes, slope angles, support requirements.	• Assist in operationalising rock engineering design criteria for rock engineering design, such as failure modes, slope angles and support requirements.
Mine ventilation engineering	• Determine mine ventilation engineering and occupational health design criteria for project and operational studies.	• Operationalise mine ventilation engineering and occupational health design criteria, such as ventilation layouts, fan design, fire prevention and atmosphere management.	• Assist in operationalising mine ventilation engineering and occupational health design criteria, such as ventilation layouts, fan design, fire prevention and atmosphere management.

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mineral asset evaluation	• Conduct mineral asset valuations for complex mineral resources, based on applicable codes and guidelines.	• Conduct mineral asset valuations for well-understood mineral resources, based on applicable codes and guidelines.	• Assist in conducting mineral asset valuations, based on applicable codes and guidelines.

4.1.3 Outcome 3: Comprehend and apply contextual knowledge (Responsibility level E)

Applicants should be able to provide evidence that they have comprehended and mastered the engineering principles and technologies for their practice area and that they can apply first-principle analytical thinking in demonstrating this competency. This includes the application of fundamental principles, practices and defensible assumptions, or previous techniques the Applicant has used to solve the problem (**Table 3**).

The theoretical knowledge gained in tertiary education should also be applied, in addition to knowledge of applicable engineering standards, codes of practice and legislation.

Applicants are expected to be aware of the requirements of the engineering profession and relevant VAs, and the functions and services that these associations render to members.

Table 3: Outcome 3 – Comprehend and apply contextual knowledge

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mine planning and design **Mining operations** **Rock engineering** **Mine ventilation engineering** **Mineral asset evaluation** **Consultancy** **Education and Training** **Research and Development**	• Comprehend and apply leading mining engineering technical knowledge, supplemented by legal, regulatory and locally relevant information. • Demonstrate the fundamental engineering principles, practices, assumptions or known techniques applied. • Recognise and reinforce teamwork of multiple interacting disciplines. • Demonstrate knowledge and application of engineering standards, codes of practice, legislation, regulations and finance. • Assimilate comprehensive technical, economic, environmental and social data in operations, studies, projects, research and development and/or education.	• Comprehend and apply established engineering practice, supplemented by regulatory and local knowledge. • Demonstrate the engineering principles, practices, procedures, methodologies and technologies applied. • Recognise areas of mining engineering that interact with other disciplines to reinforce teamwork. • Demonstrate knowledge and application of engineering standards, codes of practice, legislation, regulations and finance. • Apply relevant technical, economic, environmental and social data in operations, studies, projects, research and development and/or education.	• Comprehend and apply engineering procedures, processes, systems and methodologies, supplemented by regulatory and local knowledge. • Demonstrate the engineering principles, practices, procedures, methodologies and technologies applied. • Take guidance on areas of mining engineering that interact with other disciplines to foster teamwork. • Demonstrate knowledge and application of engineering standards, codes of practice, legislation and regulations. • Apply established technical, economic, environmental and social data in operations, studies, projects, research and development and/or education.

4.1.4 Outcome 4: Manage one or more engineering activities (Responsibility level D)

In business operations, Engineering Professionals may typically be given the responsibility to carry out projects:

- Resources are usually allocated based on availability and controlled by a work breakdown structure and schedule to meet deadlines. Quality, safety and environmental management are important aspects.
- The basic elements of management must be applied to the engineering work, as well as the maintenance of relationships (**Table 4**).
- Depending on the project, Applicants can be team leaders or team members, or they can supervise contractors.

The area in which Engineering Professionals work generally follows the conventional stages of the life cycle of a project or product:

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

The functions in which an Applicant should be competent when carrying out the various phases of a project include the following:

- Solving problems based on engineering and contextual knowledge.
- Implementing and operating engineering projects, systems, products and processes.
- Mitigating risk and impact.
- Clarifying the requirements of the project in terms of delivery, referring to the initial project specifications, and recording whether the results were obtained and, if not, the reason.

Table 4: Outcome 4 – Manage one or more engineering activities – Responsibility Level D

Typical engineering tasks / activities	Professional Engineer	Professional Engineering Technologist	Professional Engineering Technician
Mine planning and design **Mining operations** **Rock engineering** **Mine ventilation engineering** **Mineral asset evaluation** **Consultancy** **Education and Training** **Research and Development**	Manage team, processes, resources, priorities and relationships in: • conducting a complex project study or detailed engineering design (i.e., project manager or discipline lead) • solving complex mine design, rock engineering and ventilation engineering problems • developing new technologies for mining methods, layouts and machinery • modernising and automating operations.	Manage team, processes, resources, priorities and relationships in: • conducting an element of a complex project study or detailed design (i.e., discipline lead) • interpreting and evaluating mine design, rock engineering and ventilation engineering problems • evaluating and planning for new technologies in mining methods, layouts and machinery • evaluating and planning for the modernisation and automation of operations.	Manage team, processes, resources, priorities and relationships in: • conducting a sub-element of a project study or detailed design (i.e., discipline engineer) • clarify data and executing solutions to mine design, rock engineering and ventilation engineering problems • detailed design and execution of new technologies for mining methods, layouts and machinery • detailed design and execution in modernising and automating operations.

4.1.5 Outcome 5: Professional communication (Responsibility level C)

Other than technical skills, Applicants are expected to refine their ability to communicate clearly with others in the course of their engineering activities. This entails demonstrating that they are able to:

- write and/or edit clear, concise and effective technical, legal and editorially correct documentation for engineering systems, projects or research, using a structure and style that meet the communication objectives and are appropriate to the purpose and audience
- issue clear and concise instructions and/or guidance, cognisant of the audience and skill levels
- make presentations using structure, style, language, visual aids and supporting documents appropriate to the purpose and audience.

4.1.6 Outcome 6: Recognise and address social, cultural and environmental effects (Responsibility level B)

Engineering activities will likely have an impact on the social, environmental and cultural aspects of the areas in which these take place. Applicants should be able to recognise and address these impacts and, where there are negative effects, provide mitigating measures.

- Social effects encompass all issues that impact people and their livelihoods, directly or indirectly. Engineering activities may affect people's way of life, their political system, their health and wellbeing, and their personal and property rights.
- Environmental effects include the impacts on people's environment, such as air and water quality, exposure to dust, noise and vibration, adequacy of sanitation, emissions and waste, energy consumption, depletion of natural resources, heat and friction, wear and tear, corrosion and erosion, accidents and injuries, harmful effects on humans and animals, and the operation of hazardous machinery. This may also include the disruption of ecosystems, fauna and flora, and increased land temperatures.
- Cultural effects include people's customary beliefs, religion, language and norms, such as the ceremonies and customs of a particular group or society.

Risk and impact mitigation must include the probability and impact of the risks connected with the engineering activities. Mitigating measures may include environmental impact assessments, environmental impact management, community involvement and communication, barricading and warning signs and press releases.

4.1.7 Outcome 7: Statutory and regulatory requirements (Responsibility level E)

Meet relevant legal and regulatory requirements and protect the health and safety of persons and the environment during engineering activities by:

- identifying applicable legal, regulatory, environmental and health and safety regulations and standards
- demonstrating awareness of and applying these requirements using safe and sustainable processes, systems, materials and components
- seeking advice based on the Applicant's limits of competence.

Applicants are expected to have a working knowledge of the following regulations and Acts, as amended from time to time, and how the legislation affects their working environment:

- Engineering Profession Act, 46 of 2000, its rules and the Code of Conduct
- Occupation Health and Safety Act as amended by Occupation Health and Safety Act, 181 of 1993 (OHSA)
- Labour Relations Act, 66 of 1995
- National Environmental Act, 107 of 1988
- Environment Conservation Act, 73 of 1989 as amended by Environment Conservation Act, 52 of 1994 and Environment Conservation Amendment Act, 50 of 2003
- Water Services Act, 108 of 1997
- National Water Act, 36 of 1988
- Mine Health and Safety Act, 29 of 1996
- Minerals Act, 50 of 1991 and Regulations
- Minerals and Petroleum Resources Development Act, 28 of 2002
- Mining Charter
- Mandatory Codes of Practice as determined by the Department of Mineral Resources and Energy
- Applicable specifications and other related mining standards
- Chief Inspector of Mines: Directives/Instructions
- Chief Inspector of Mines: Guidelines.

All engineering work must be carried out in accordance with the norms of the profession, generally represented by national and international standards, industry standards, codes of practice and leading practice guidelines.

4.1.8 Outcome 8: Conduct engineering activities ethically (Responsibility level E)

Ethical behaviour involves the comprehension and application of professional ethics, responsibilities and norms of engineering practice within one's own limits of competence. This is typified by:

- knowledge of and compliance with the ECSA Code of Conduct for registered persons, with an understanding of how it relates to their area of practice
- identification of ethical problems and affected parties, and a systematic approach to resolving the issues
- recognition and avoidance of placing oneself in a position of a conflict of interest.

Applicants may be involved in engineering activities that include tender evaluations, adjudications and contract management. Ethical dilemmas such as tender fraud and corruption, bribery, favouritism, defamation, alcohol abuse, sexual harassment, absenteeism, fraudulent overtime and expense claims, fraudulent qualifications, misrepresentation of facts and overstating of compensation events may occur. Applicants are expected to identify ethical problems and affected parties, and apply the best solution to resolve the problem.

Most engineering projects are multidisciplinary in nature, with many role players performing speciality work that could result in individuals conducting engineering activities for which they have no education, training or competency. Thus it is imperative that Applicants familiarise themselves with ECSA's Code of Conduct, particularly regarding integrity and competency, as well as the health and safety of persons. Integrity and honesty are of paramount importance.

4.1.9 Outcome 9: Exercising sound engineering judgement (Responsibility level E)

Engineering Professionals are expected to exercise sound judgement in the course of engineering activities by considering several factors based on consequences and the regulatory requirements, policies and standards.

Applicants are therefore expected to demonstrate this competency by evaluating a situation in the absence of full evidence. It is required that Engineering Professionals thoroughly investigate, analyse and identify relevant factors and understand the risks associated with certain decisions.

In engineering activities, Applicants should apply their minds diligently through a logical process to find solutions to technical problems. This process involves the analysis of systems or the assembly of components, and the integration of various elements of Mining Engineering through the application of basic and engineering science. The extent of a project or task undertaken by an Engineering Professional is characterised by engineering system factors and their resulting interdependence.

Taking high risk decisions may lead to equipment failure, excessive installation and maintenance costs, damage to property and injury to persons. Evaluation includes engineering calculations to substantiate the decisions taken and the assumptions made.

Judgement is displayed in a number of ways:

- Engineering Professionals must assess design work against set criteria.
- Performing the work, despite numerous risk factors, needs good judgement and substantiated decision-making.
- Consequences are a result of the activities, such as extra cost due to unforeseen conditions, incompetent contractors or long-term environmental damage.
- Interested and affected parties with differing requirements that may be in conflict need sound management and judgement, such as the need for a service irrespective of environmental damage, local traditions and preferences.

Judgement is exercised in making decisions by considering the interactions between conflicting technical, engineering, social or other issues and their impact on stakeholders and affected parties, typified by:

- developing options and solutions or approaches that consider impacts, interrelationships with other disciplines, time, cost and other constraints, at times with incomplete information
- taking a holistic view of the solution while considering risks, their consequences and their implications.

4.1.10 Outcome 10: Responsibility in decision-making (Responsibility level E)

Having contextual knowledge affords Applicants an opportunity to demonstrate how they were able to make decisions and take responsibility for significant parts of one or more engineering activities. Seeking advice or guidance from experienced engineers and managers will assist Applicants in making informed decisions and assuming responsibility for those decisions.

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 found liable for loss or failure".

Taking responsibility for outcomes of significant parts of one or more engineering activities is typified by the following:

- Systematic gathering of relevant information and checking of facts and inputs required for the decision-making process.
- Making a decision, based on knowledge and experience, and seeking advice on matters falling outside the Applicant's education and experience.
- Keeping a record of the decision-making process and the reasons for the decision.
- Being held accountable for consequences, whether positive or negative.

4.1.11 Outcome 11: Professional development (Responsibility level D)

Applicants must demonstrate a commitment to initial and continuing professional development (CPD) by:

- adopting a plan for their professional development
- selecting appropriate professional development activities
- keeping records of professional development activities
- demonstrating independent learning ability through completing developmental activities.

Examples of entry-level professional development activities and programmes include:

- management principles and ethics
- introductory project management
- preparation of specifications
- negotiation skills

- introductory mining finance
- risk analysis and quality systems
- value engineering
- OHS
- mining-related conferences and short courses
- environmental impact management
- technical and business report writing
- introductory industrial and public relations
- presentation skills and public speaking.

Examples of intermediate professional development activities and programmes include:

- intermediate project management
- conditions of contract and value engineering
- preparation of standards and specifications
- negotiation skills
- intermediate mining finance
- risk analysis and quality systems
- OHS
- mining-related conferences and short courses
- engineering maintenance systems
- environmental impact management
- technical and business report writing
- intermediate industrial and public relations
- business presentation skills.

Examples of more advanced professional development activities and programmes include:

- post-graduate qualification in mining-related subjects, finance, marketing or business administration
- advanced business and project management
- advanced safety, health and environmental / sustainable development
- systems engineering

- digital technologies
- ECSA working groups to write or update governing documents
- advanced industrial relations and public relations.

Applicants must manage their own training independently by taking the initiative and being in charge of experiential development towards the appropriate level of Professional Registration.

5. FUNCTIONS PERFORMED

Mining Engineering forms an integral part of the broader engineering systems and infrastructure in technologically complex manufacturing, processing, mining, construction, product development and research environments. Special consideration in the discipline, sub-discipline or specialty must be given to the competencies specified in the following groups:

- Knowledge-based problem-solving (this should be a strong focus)
- Management and communication
- Identifying and mitigating the impacts of engineering activity
- Judgement and responsibility
- Independent learning.

5.1 Degree of Responsibility

The increase in the DoR that Applicants experience during their professional training is presented in **R-04-T&M-Guide-PC** and **Table 5**. It reflects the nature of the work, specific examples and outcomes appropriate to training in Mining Engineering.

Table 5 – Applicant's Progression through DoR

Degree of Responsibility	Nature of Work	Activities/duties to be undertaken during training
A: Being Exposed	The Applicant undergoes induction and observes processes and work of competent practitioners.	• Understand the business environment and the dynamics that shape the businesses and industries in which they operate. • Understand the business model, its key processes and critical outcomes. • Understand the value added by Mining and other Engineering Professionals in the business.

Degree of Responsibility	Nature of Work	Activities/duties to be undertaken during training
B: Assisting	The Applicant performs specific processes under close supervision.	• Develop insight and understanding of the different processes and systems in transforming inputs into goods and services. • Develop an appreciation of the resources available to Mining Engineering practitioners. • Obtain experience in the day-to-day operations of the business, with specific emphasis on productivity and quality measurements.
C: Participating	The Applicant performs specific processes as directed, with limited supervision.	• Gain first-hand experience of a broad range of Mining Engineering activities (e.g., mine design and re-engineering, planning and control, work study, value engineering, materials and information management, people management, logistics, specialists' inputs, tools and equipment, and quality assurance). • Note the problems and limitations of particular approaches, methods and techniques, with emphasis on cost/effort and relative benefit.
D: Contributing	The Applicant performs specific work with detailed approval of work outputs.	• Be involved in activities such as the planning of production, control of quality and costs, materials handling and workplace layout, activity-based costing, benchmarking, business case evaluation, process re-engineering, maintenance practice and procedures, and project management and system specification. Of particular importance is the economical use of people, materials and machines. • Give specific attention to human aspects concerning communication, interpersonal relationships and teamwork, training, cost analysis, cost control and profit accountability.
E: Performing	The Applicant works in a team without supervision, recommends work outputs and is responsible but not accountable.	• Assume escalating technical responsibility and increased co-ordination of the work of others. • Gain exposure to and develop skills in management areas such as labour relations, management accounting, business law and general business management, all of which are important for developing well-rounded Engineering Practitioners. • Seek assignments that require judgement, even if full information is unavailable, which provide opportunities of professional responsibility.

Applicants working at Responsibility Level E carry responsibility appropriate to that of a registered person, except that Applicants' Supervisors are accountable for their recommendations and decisions.

5.2 Applicant training programme

5.2.1 Leading practices

No ideal training programme structure or unique sequencing constitutes leading practice. The training programme for each Applicant depends on the available work opportunities at the time that the employer assigns to the Applicant.

It is suggested that Applicants work with their Supervisors and Mentors to determine appropriate projects to gain exposure to elements of the asset lifecycle and to ensure that their designs are constructable, operable and consider long-term costing and sustainability. A regular reporting structure should be in place, with suitable recording of evidence of achievement against the competency outcomes and levels of responsibility.

The training programme should enable the Applicant to progress through the levels of work capability described in **R-04-T&M-GUIDE-PC** so that, by the end of the training period, the Applicant exhibits a Level E DoR, where required, and is able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

5.2.2 Realities

The minimum experience required by ECSA for registration in a Professional Category is 3 years after graduating with a recognised qualification, as stipulated in section 2 of this DSTG. The likelihood, however, is that the period of training will be longer, determined by the availability of opportunities and the exposure to various functions in the actual work environment.

Irrespective of the route followed, the overriding consideration is that the Applicant must provide evidence of competence against the standard and provide objective evidence of meeting the eleven outcomes described in **R-08-CS-GUIDE-PE/PT/PN**.

5.2.3 Generalists, specialists, researchers and academics

R-08-CS-GUIDE-PE/PT/PN adequately describes what is expected of persons whose formative development has not followed a conventional path, such as academics, researchers and specialists.

Irrespective of the route followed, the overriding consideration is that the Applicant must provide evidence of competency against the standard.

5.2.4 Orientation requirements

For an Applicant starting a career with a company, the basic introduction to the company's functions is usually performed during the first months of employment. The induction process includes the following:

- Introduction to company safety regulations
- Code of conduct
- Staff code and regulations
- Typical functions and activities within the company
- Hands-on experience and orientation in each of the major divisions
- Overall mining operations and mining-related facilities.

5.2.5 Moving into or changing candidacy training programmes

This guide assumes that the Applicant enters a programme after graduation and continues with the programme until ready to apply for registration. It also assumes that the Applicant is supervised and mentored by persons who meet the requirements in **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 Applicant 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 or Mentor.
- On entering the new programme, the Mentor and Supervisor should review the Applicant's development while mindful of past experience and opportunities and the requirements of the

new programme. At a minimum, the Mentor and Supervisor should plan the next phase of the Applicant's programme.

6. CONCLUSION

To attain registration in a professional category, Applicants should be able to meet the educational requirements for the category and demonstrate competency against the prescribed standards for the registration category. Demonstrating competency is achieved by meeting the requirements for the 11 ECSA outcomes. Applicants and their Supervisors and Mentors must ensure that the training provided is geared towards achieving the ECSA competency outcomes. Focusing on one training aspect for the entire duration of training will not assist Applicants in achieving the necessary skills to demonstrate all the standard competency outcomes.

Development of the training plan is the responsibility of the Applicant who must ensure that it covers all aspects of the outcomes. It has been common practice that in situations where a department or organisation is unable to provide training in certain areas, secondments are arranged with other departments or organisations so that the Applicant is able to develop all the competencies required for registration. These secondments are usually reciprocal in nature and benefit the employee and the employer. Secondments between consultants and contractors and between the public and private sectors should be possible to allow Applicants to acquire the necessary competencies.

REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Rev 0 Draft A	12 Dec 2023	The DSTG has been amalgamated into one Discipline-specific Training Guide for Registration as a Professional Engineer, Technologist and Technician in Mining Engineering and to ensure that the DSTG clearly details how each outcome can be achieved.	RDDR BU
Rev 0 Draft B	13 Dec 2023	The review has included an introduction section and the document further indicates the type of engineering work the different categories should undertake. Section 3.1 to 3.4 Types of engineering work / Practice Area details were updated Section 4.1 to 4.11 Developing Competency: Document (**R-08-PE/PT/PN**) Under Training for Registration as a Professional Engineer, Professional Engineering Technologist, and Professional Engineering Technician has been revised to ensure that each training element is aligned to each outcome. Detailed descriptions of the typical activities and expectations for different types of engineering work; and as they apply to the 11 engineering outcomes. Additional tables were included to assist with separating the differences between the 3 registration categories where applicable.	Working group
Rev 0 Draft C	19 Jul 2024	Document revised by RI BU Registration BU and WG.	RI BU, Registration BU and WG
Rev 0 Draft D	21 Aug 2024	Document submitted to the IEA Task Team for alignment to the IEA changes	IEA Review Task Team

Revision number	Revision date	Revision details	Approved by
Rev 0 Draft E	11 Oct 2024	Reviewed and checked	Executive: RPSC
Rev 0	23 Oct 2024	Approval	RPSC

Discipline-specific Training Guide for

Registration in a Professional Category in Mining Engineering

Revision 0 dated 23 October 2024 and consisting of 44 pages, reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Regulatory Services & International Relations **(ERSIR)**.

.... 2 December 2024

Business Unit Manager Date

.... 2024/12/02

Executive: RSIR Date

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

APPENDIX 1: TRAINING ELEMENTS

This appendix has been prepared to highlight the key elements of training requirements and mentoring that can be used to assist an Applicant in preparing for professional registration. It is recommended that an Applicant is supported by a Mentor, preferably ECSA-registered, who has adequate understanding of the context of the discipline and practice areas. The table below summarises the 11 outcomes where an Applicant should be able to demonstrate competence. Further details of these outcomes can be found in the following:

- Competency Standard for Registration in Professional Categories, **R-02-STA-PE/PT/PN**.
- Guide to Competency Standards for Registration as an Engineering Professional, **R-08-CS-PE/PT/PN**.

Table 6: Overview of outcomes

Group	Outcome	Description
Group A Engineering problem-solving	1	Define, investigate and analyse engineering problems.
	2	Design or develop solutions to engineering problems.
	3	Comprehend and apply contextual knowledge.
Group B Managing engineering activities	4	Manage one or more engineering activities.
	5	Communicate clearly while engaged in engineering activities.
Group C Risk and impacts mitigation	6	Recognise and address social, cultural and environmental effects of engineering activities.
	7	Meet legal and regulatory requirements and protect the health and safety of persons while engaged in engineering activities.
Group D Act ethically, exercise judgment and take responsibility	8	Conduct engineering activities ethically.
	9	Exercise sound judgement while engaged in engineering activities.
	10	Be responsible for making decisions on part or all of engineering activities.
Group E Professional development	11	Undertake continuing professional development to maintain and extend competence.

Table 7 below provides an indicative programme for developing the DoR for a newly qualified Mining Engineer. For more experienced Applicants, it may not be necessary to undergo such a development programme provided competence can be demonstrated in the 11 outcomes through a process of recognised prior learning and experience.

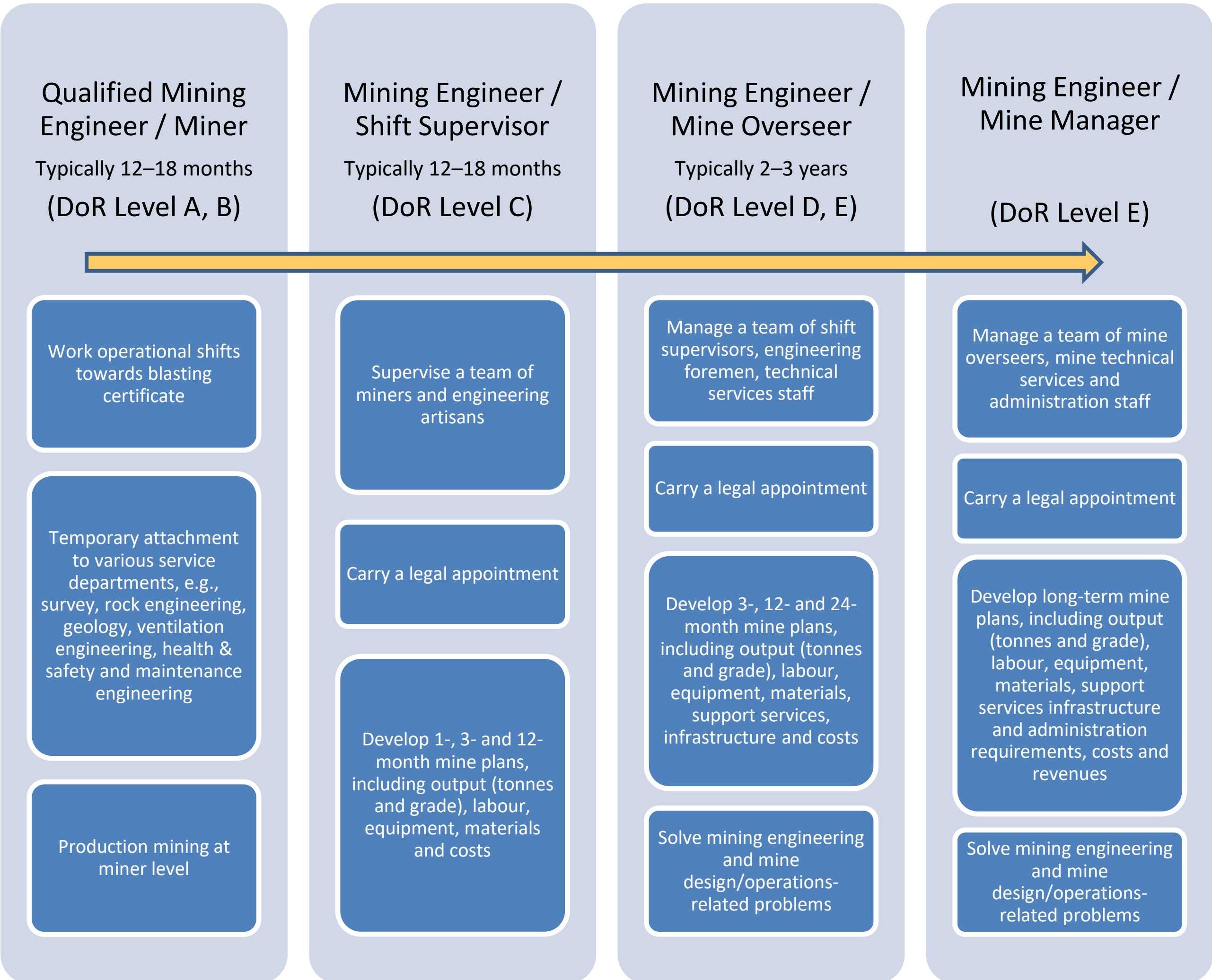
Table 7: Degree of Responsibility

Level Description	Nature of Work	Responsibility	Level of Support
A **Being Exposed**	Undergoes induction, observes processes and the work of competent practitioners	No responsibility, except to pay attention	Mentor explains challenges and types of solution
B **Assisting**	Performs specific processes under close supervision	Limited responsibility for work output	Supervisor/Mentor coaches and offers feedback
C **Participating**	Performs specific processes as directed, with limited supervision	Full responsibility for supervised work	Supervisor progressively reduces support, but monitors outputs
D **Contributing**	Performs specific work with approval of work outputs	Full responsibility to Supervisor for quality of work	Applicant articulates own reasoning and compares it with that of the Supervisor
E **Performing**	Works in a team without supervision, recommends work outputs, responsible but not accountable	Level of responsibility is appropriate to a registered person	Applicant takes on problem solving without support, at most with limited guidance

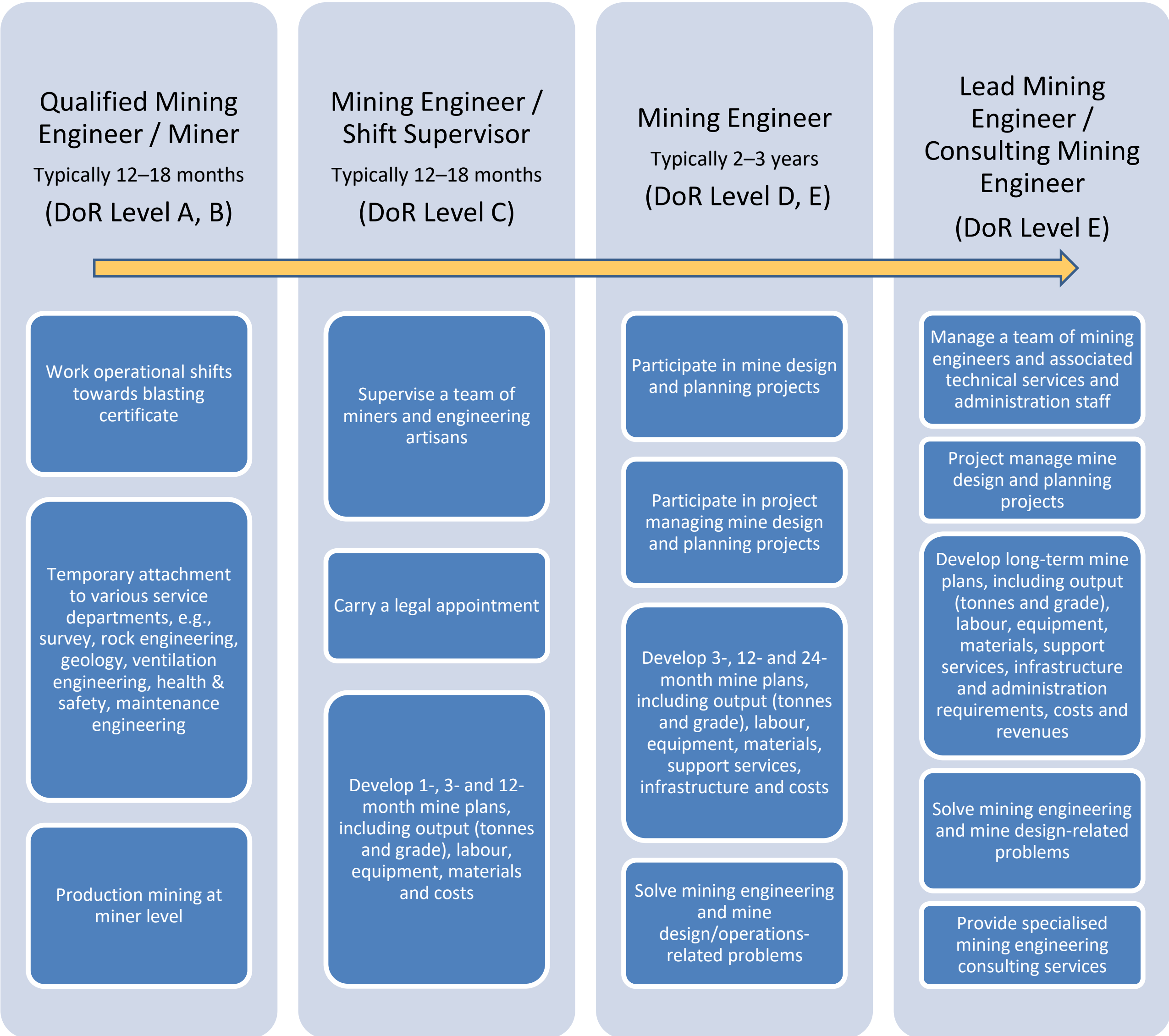
APPENDIX 2: EXAMPLES OF PROFESSIONAL DEVELOPMENT PROGRAMMES FOR A MINING ENGINEER

This appendix provides some simplified examples of development programmes for Mining Engineers in the various practice areas, along with indicative (non-prescriptive) timeframes:

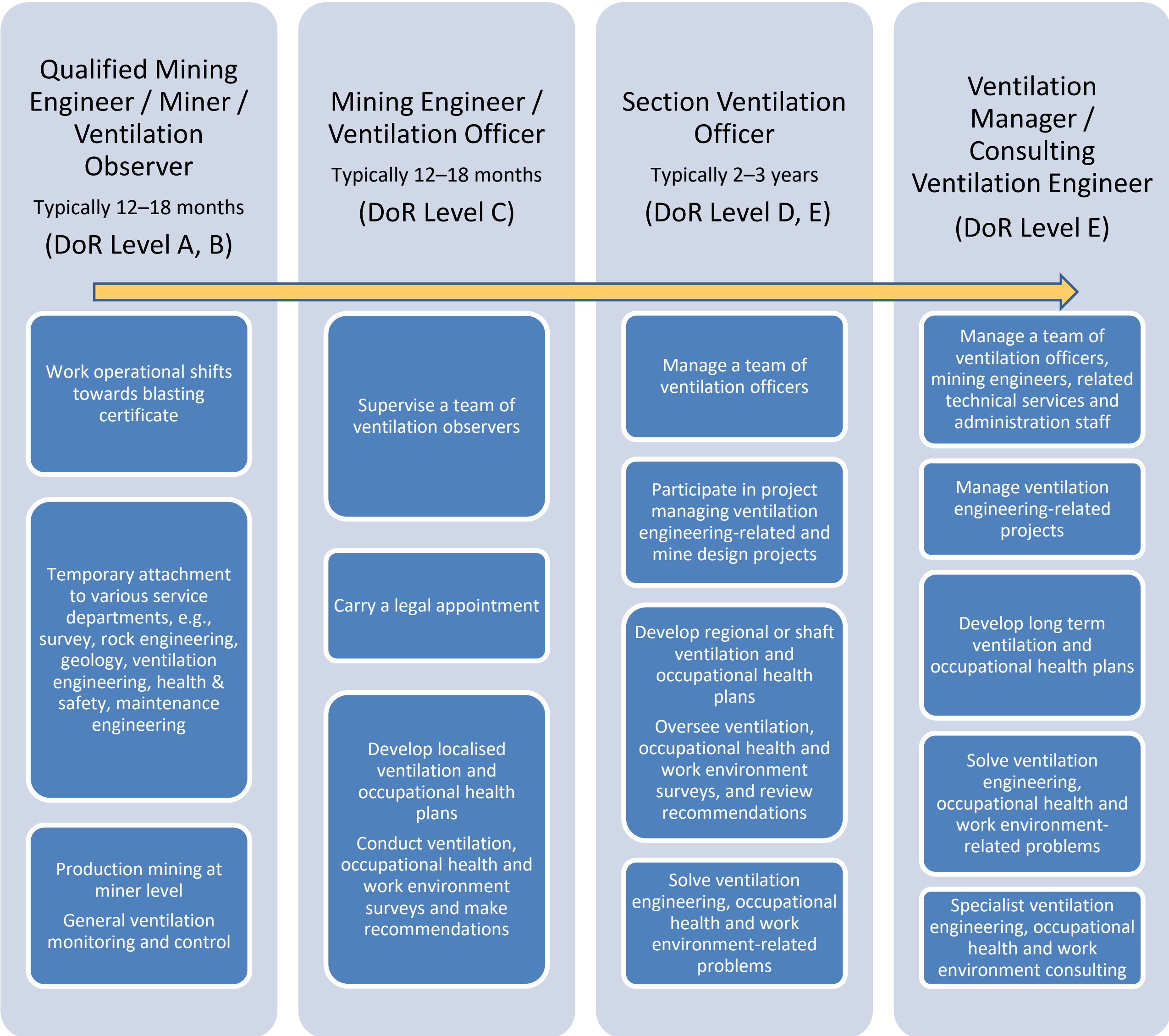
Example 1: Mining Engineer in a Mine Operations practice area



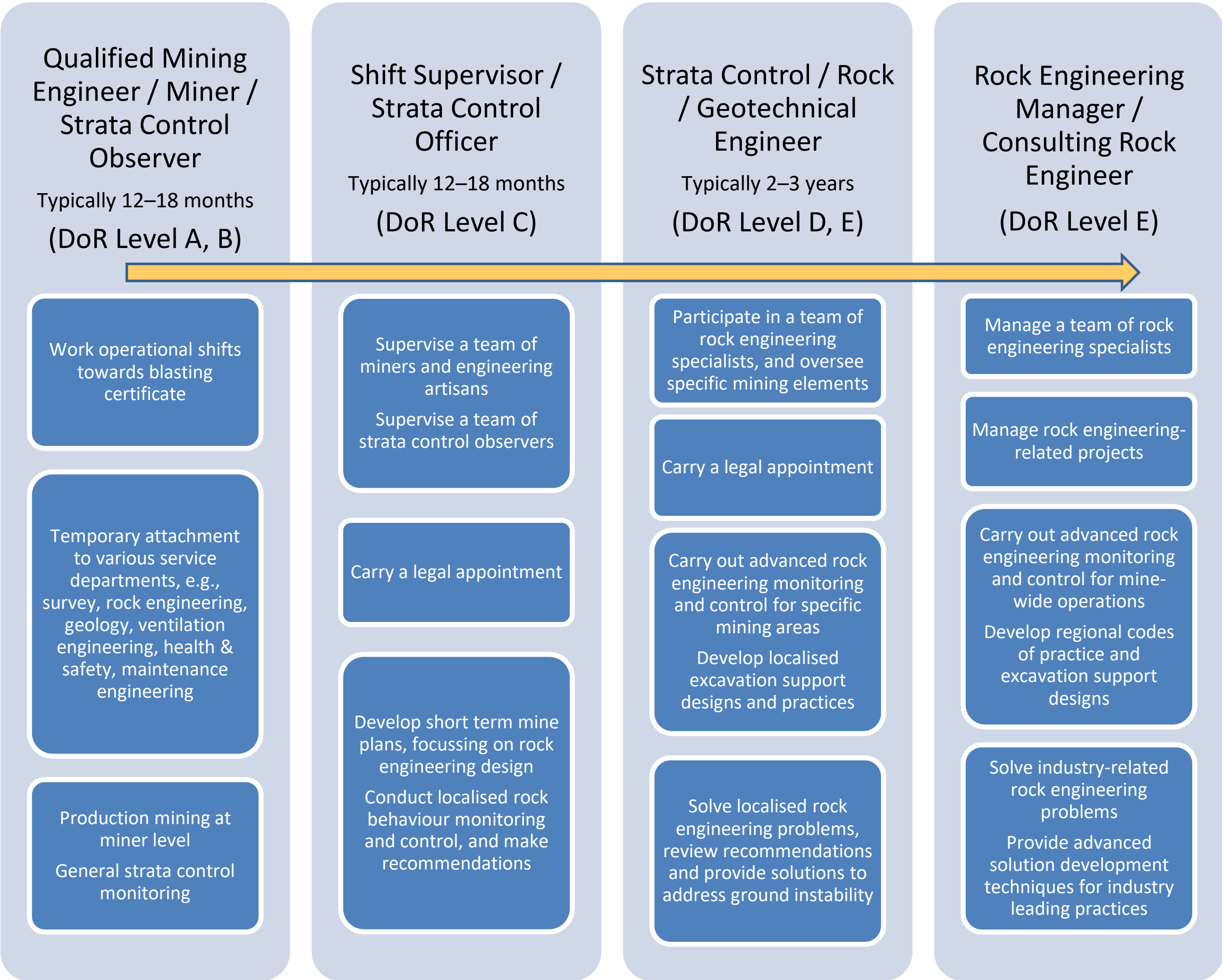
Example 2: Mining Engineer in a Mine Technical Practice area (planning, design, project management, consulting)



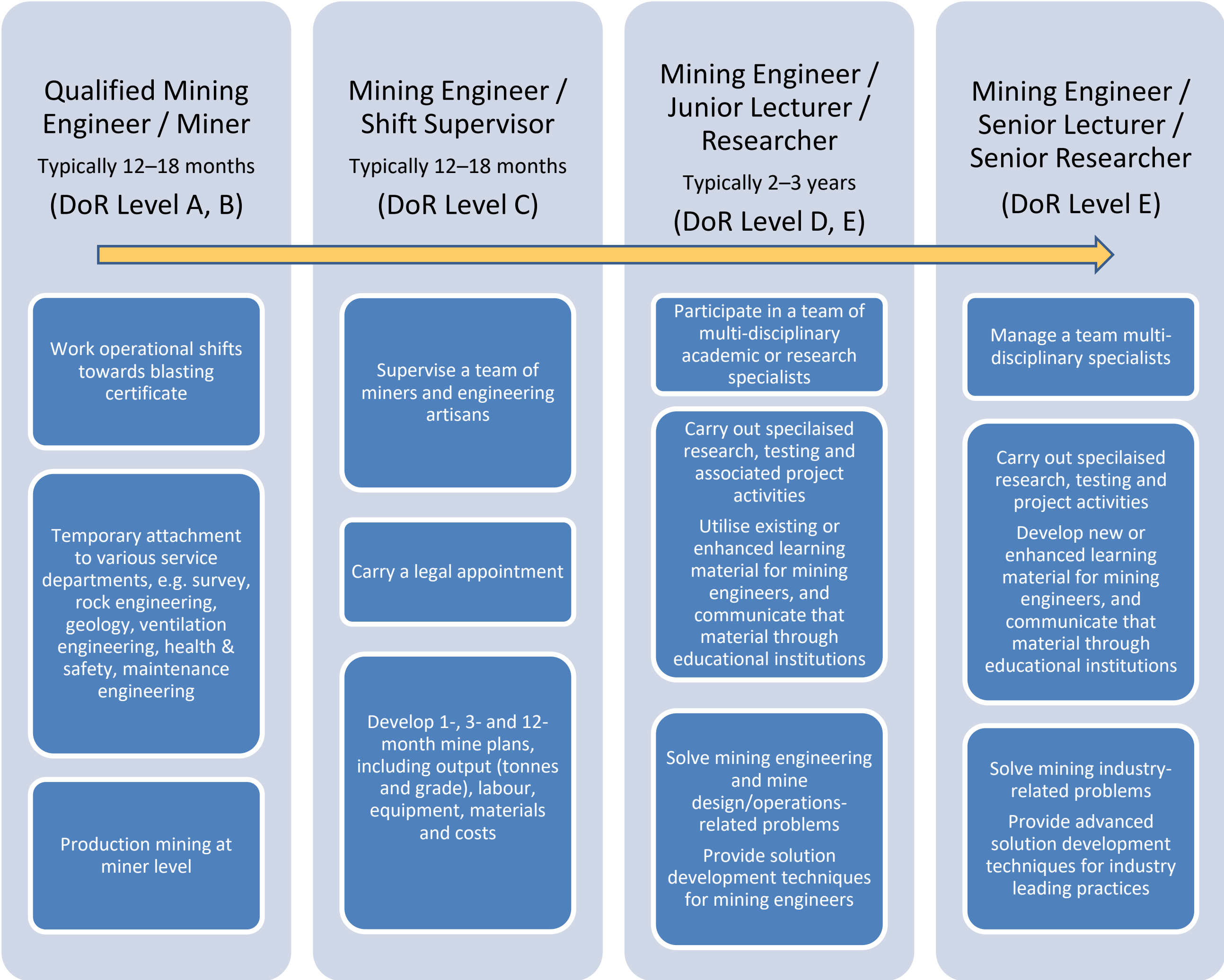
Example 3: Mining Engineer in a Mine Ventilation Engineering practice area



Example 4: Mining Engineer in a Rock Engineering practice area



Example 5: Mining Engineer in an Academic practice area



APPENDIX A: TRAINING ELEMENTS

Synopsis: Applicants 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.

Complex, Broadly-defined and Well-defined engineering work is usually characterised by the application of engineering 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 Engineer, Technologist and Technician**. 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. The **Engineer, Technologist and Technician** operate within the 12 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 the specific DSTG)
2. Demonstration of competence Competence must be demonstrated within Complex, broadly defined and Well-defined *engineering activities,* defined below, by integrated performance of the outcomes defined at the level defined for each outcome. Required contexts and functions may be specified in the applicable DSTG. **Level Descriptor:** Complex engineering activities (**CEA**), Broadly-defined engineering activities (**BDEA**), and Well-defined engineering activities (**WDEA**) 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.	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:** Complex engineering activities (**CEA**), Broadly-defined engineering activities (**BDEA**), and Well-defined engineering activities (**WDEA**) 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.

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. 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.	b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on **CEA, *BDEA and WDEA*** activities and problems. **CEA, *BDEA and WDEA*** 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; 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 **Engineers, Technologists and Technicians**, 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 *Complex, broadly defined and Well-defined,* engineering problems	**Responsibility Level E** Analysis of an engineering problem means the 'separation into parts possibly with comment and judgement'. Complex, *Broadly, Well-defined* means: 'not minute or detailed' and 'not kept within narrow limits'.
Complex, Broadly-defined and Well-defined engineering problems have the following characteristics.	

a) They require coherent and detailed engineering knowledge, underpinning the technology area; and one or more of the following: 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) Involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties. *and one or both of:* i) Require judgement in decision-making in practice area, considering interfaces to other areas. j) Have significant consequences which are important in practice area but may extend more widely.	Coherent and detailed engineering knowledge for **Engineer, Technologist and Technician** means the problem encountered cannot be solved without the combination of all the relevant detail including engineering principles applicable to the situation. a) The nature of the problem is not immediately obvious, and further investigation to identify and interpret the real nature of the problem is necessary. b) 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. c) It is recognised that the problem can be classified as falling within a typical solution requiring innovative adaptation to meet the specific situation. d) Solving the problem needs a step-by-step approach adhering to proven logic. e) 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. f) The responsibility lies with the **Engineer, Technologist and Technician** to verify that some information received as part of the problem encountered may remain incomplete and solutions to problems may need justified assumptions. g) The problem handled by **Engineer, Technologist and Technician** may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, not maintainable, not sustainable, etc; the **Engineer, Technologist and Technician** will have to justify his/her recommendation. h) 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. i) **The Engineer, Technologist and Technician** 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:	To perform an engineering task an **Engineer, Technologist and Technician** will typically receive an instruction from a senior person (customer) to do a specific task, and must:

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.	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 **Complex, Broadly-defined and Well-defined** engineering problems	**Responsibility Levels C and D** Design means 'drawing or outline from which something can be made'. Develop means 'come or bring into a state in which it is active or visible'.
Assessment criteria: This outcome is normally demonstrated after 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:	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 Designed or developed solutions to **Complex, Broadly-defined and Well-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.	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 **Engineer, Technologist and Technician** 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 ***Complex, Broadly-defined and Well-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. **The Engineer, Technologist and Technician** 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 **Engineer, Technologist and Technician** 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.	Design work for **Engineer, Technologist and Technician** is based on B Eng, BTech, N Dip, theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel eiineering., **Engineer, Technologist and Technician** 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 Apply engineering principles, practices, technologies, including the application of, B Eng, BTech or B Eng (Tech) and N Dip, 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.	3.1 Calculations at B Eng, BTech or B Eng (Tech) and/or NDip, 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 **complex, broadly defined, well 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, **Engineer, Technologist and Technician** 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 **Engineer, Technologist and Technician** 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 ***Complex, Broadly-defined and Well-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 **Engineer, Technologist and Technician** 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, **Engineer, Technologist and Technician** can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
Outcome 5: Communicate clearly with others in the course of his/her broadly defined engineering activities.	**Responsibility Level C**
Assessment criteria: Demonstrates effective communication by: 5.1 Ability to write clear, concise, effective technical, legal and editorially correct reports shown. 5.2 Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident. 5.3 Oral presentations made using structure, style, language, visual aids	Refer to Range Statement for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
Range Statement for Outcomes 4 and 5: Management and communication in ***Complex, Broadly-defined and Well-defined*** *engineering* involves: a) Planning ***Complex, Broadly-defined and Well-defined*** activities b) Organising ***Complex, Broadly-defined and Well-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' **The Engineer, Technologist and Technician** write specifications for the purchase of materials and/or work to be done, recommendations on tenders received, place orders and variation orders, write work

c) Leading ***Complex, Broadly-defined and Well-defined*** activities d) Controlling ***Complex, Broadly-defined and Well-defined*** activities.	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 ***Complex, Broadly-defined and Well-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 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown. 6.2 Measures taken to mitigate the negative effects of engineering activities evident.	6.1 Engineering impacts heavily on the environment, e.g., servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wildlife, dangerous rotating and other machines, demolishing of structures, etc. 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), 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 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

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.	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 **Engineer, Technologist and Technician** 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. e) Regulatory requirements are explicit for the context in general.	a) The impacts will vary substantially with the location of the task, e.g., the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex. It is identified and studied by the **Engineer, Technologist and Technician** before starting the work. b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirms or checks that the instructions are in line with regulations. The **Engineer, Technologist and Technician** is responsible to see that this is done, and if not, establish which regulations apply, and ensure that they are adhered to. Usually, the people working on site are strictly controlled.W.r.t. health and safety, but the **Engineer, Technologist and Technician** checks that this is done, but may authorise unavoidable deviation after setting conditions for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. c) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The **Engineer, Technologist and Technician** 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 **Engineer, Technologist and Technician** or other professional specialists must be consulted. It is the

	responsibility of the **Engineer, Technologist and Technician** 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 **Engineer, Technologist and Technician**.
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 ***Complex, Broadly-defined and Well-defined*** engineering activities	**Responsibility level E** Judgement means 'good sense: ability to judge'.
Assessment criteria: Judgement is displayed by the following performance: 9.1 Judgement exercised in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies.	9.1 The extent of a project given to a junior **Engineer, Technologist and Technician** 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 Factors taken into consideration given, bearing in mind, risk, consequences in technology application and affected parties.	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 **Engineer, Technologist and Technician** 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 ***Complex, Broadly-defined and Well-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.	10.1 All interrelated factors taken considered are indicative of professional responsibility accepted working on broadly defined activities. 10.2 The **Engineer, Technologist and Technician** does not operate on tasks at a higher level than, complex, broadly defined, well 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 Academic knowledge of at least B Eng, BTech N Dip, level combined with past experience used in formulating decisions.[1]	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 ***Complex, Broadly-defined and Well-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 **Engineer, Technologist and Technician** engineering**.**
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 **Engineer, Technologist and Technician** to manage his/her own experiential development. **Engineer, Technologist and Technician** 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) recording professional development strategy and activities, while displaying independent learning ability.	c) Developing a learning culture in the workplace environment of the **Engineer, Technologist and Technician** is vital to his/her success