ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Discipline-specific Training Guideline and Requirements For Candidate Certificated Engineers			
Status: Approved By Council			
Document : R-05-PCE	**Rev C**	**17 August 2017**	

Background: ECSA Registration System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for registration in specified categories are shown in **Figure 1** which also locates the current document.

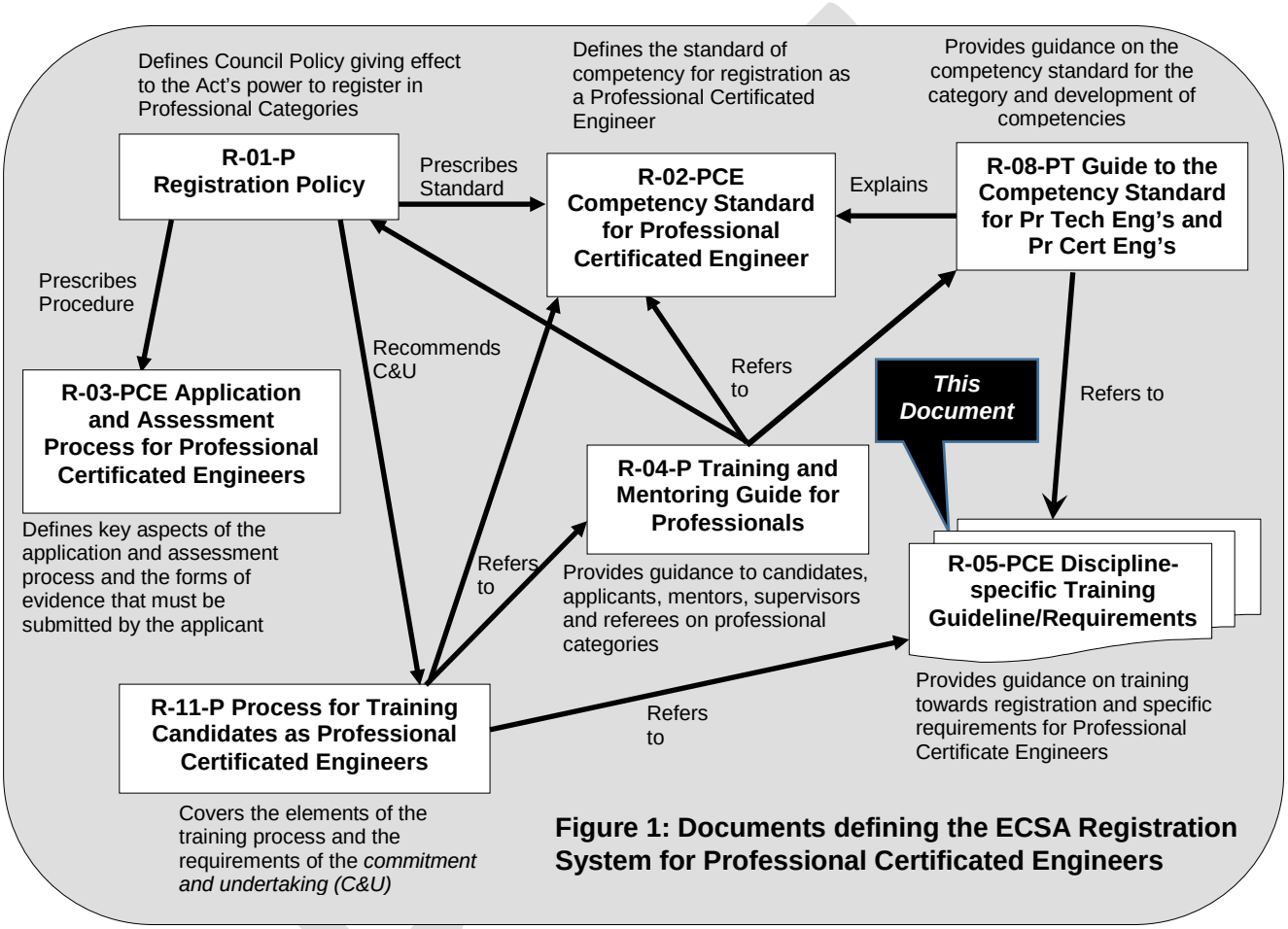


Figure 1: Documents defining the ECSA Registration System for Professional Certificated Engineers

1. Purpose of this document

All persons applying for registration as Professional Certificated Engineers are expected to demonstrate the competencies specified in document R-02-PCE at the prescribed level, irrespective of the type of certificate applicable, through work performed by the applicant at the prescribed level of responsibility. In addition, the Discipline Specific Requirements set out in 8.6 below must be met.

This document supplements the generic *Training and Mentoring Guide* R-04-P, *Guide to the Competency Standards for Professional Engineering Technologists and Professional Certificated Engineers* R-08-PT and *Process for Training Engineering Candidates towards Professional Registration* R-11-P.

In document R-04-P attention is drawn to the following sections:

7.3.2 Duration of training and period working at level required for registration
7.3.3 Principles of planning training and experience
7.3.4 Progression of Training programme
7.3.5 Documenting Training and Experience
7.4 Demonstrating responsibility

The second document R-08-PT (applicable to both R-02-PT and R-02-PCE) provides both a high-level and outcome-by-outcome understanding of the competency standards as an essential basis for this discipline-specific training guide and requirements document.

The third document R-11-P elaborates on the elements of the training process and the requirements of the Commitment and Undertaking.

This Guide and Requirements document, as well as R-04-P, R-08-PT and R-11-P, are subordinate to the Policy on Registration in Professional Categories, document R-01-P, the Competency Standard (R-02-PCE) and the application process definition (R-03-PCE).

2. Audience

In the first instance, the Guide and Requirements are directed to candidates and their supervisors and mentors in the seven Government Certificates of Competency. The Guide and Requirements are intended to support a programme of training and experience incorporating good practice elements.

In the second place, the Guide and Requirements are directed to the members of the engineering team comprising the following (See Table 1), and who:

Table 1: This table contains the different categories in the engineering team of registered practitioners accepting full responsibility for their area of work and adhering to ECSA's Code of Conduct. (EPA = Engineering Professions Act (No. 46 of 2000)) (Please refer to "Engineering Qualifications in the Higher Education Qualifications Sub-framework", document E-23-P, describing the future dispensation).

Category	Authority	Underpinning Knowledge	Area of Responsibility
Professional Engineer (EPA Section 18(1)(a)(i))	Educated, trained and experienced to carry out complex-defined engineering work.	Graduate Attributes acquired in education at NQF 8 level (560 credits)	Complex interaction between professions and disciplines. Justify work outside codes, standards and procedures.
Professional Certificated Engineer (EPA Section 18(1)(a)(iii))	Educated, trained and experienced to carry out broadly-defined engineering work	Graduate Attributes acquired in education towards obtaining the Government Certificate of Competency (GCC). Various pathways depending on base engineering qualification, offering exemption from writing some subjects in the GCC examinations.	Interaction with other professions and disciplines. Emphasis on working within the codes, standards and procedures in accordance with the legislative requirements. (OH&S Act, MH&S Act or Merchant Shipping Act). May be authorised to deviate from the standards and codes after performing risk assessment and mitigating the identified risks.
Professional Engineering Technologist (EPA Section 18(1)(a)(ii))	Educated, trained and experienced to carry out broadly-defined engineering work	Graduate Attributes acquired in education at NQF 7 level (420 credits)	Interaction with other professions and disciplines. Authorisation required to work outside codes, standards and procedures after conducting research and investigation.
Professional Engineering Technician (EPA Section 18(1)(a)(iv))	Educated, trained and experienced to carry out well-defined engineering work	Graduate Attributes acquired in education at NQF 6 level (280 to 360 credits)	Mostly working within a single discipline. Strict adherence to codes, standards and procedures. Repetitive work.
Specified Category Practitioner (EPA Section 18(1)©)	Educated, trained and experienced to carry out specifically-defined engineering work	Graduate Attributes acquired in education at NQF 5 level (140 credits)	Working within a single discipline in a specific field. May be legally responsible for work.

1. Completed the education requirements by the Benchmark Pathway in Table 2.

Table 2: Minimum duration of education, training and experience towards registration:

Pathway	Qualification	Post Qualification Total Training and Experience in the Specific Sub-discipline	Post Qualification Experience (part of total) with Legal Appointment
Benchmark Route	1. Electrical Engineer's Certificate of Competency issued in terms of the Mines Health and Safety Act 2. Electrical Engineer's Certificate of Competency issued in terms of the Occupational Health and Safety Act 3. Mechanical Engineer's Certificate of Competency issued in terms of the Mines Health and Safety Act 4. Mechanical Engineer's Certificate of Competency issued in terms of the Occupational Health and Safety Act 5. Manager's Certificate of Competency (Metalliferous) issued in terms of the Mines Health and Safety Act 6. Manager's Certificate of Competency (Coal) issued in terms of the Mines Health and Safety Act 7. Chief Marine Engineer Officer Class 1 Certificate of Competency issued in terms of the Merchant Shipping Act	3 years	1 year

Notes:

a. Training and experience must incorporate legal requirements stipulated in laws, regulations and standards applicable.

b. Training and experience must incorporate practical requirements executed to meet any legal requirements applicable to the particular legal appointment.

c. A legal appointment, which requires the possession of a Government Certificate of Competency, as a **Manager** or as an **Engineer** in terms**, of Regulation 2.6.1, or Regulation 2.13.1, 2.13.3.1 and 2.13.3.2** respectively of the Mines Health and Safety Act, 1996 (Act No. 29 of 1996), or if appointed in terms of **Section 3.1(a), 4.1 or 2(a)** where they are required in terms of their appointment to assume the responsibilities of the **Regulation 2.6.1 appointee requiring a GCC**, or as an **Engineer** in terms of **Regulation GMR 2.1 or 2.7** of the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) or as a **Chief Engineer Officer – Foreign Going** on a vessel with a registered power of no less than 3 000 kW in terms of the Merchant Shipping Act, 1951 (Act No. 57 of 1951), or in terms of any Act which preceded or superseded any of the Acts mentioned above, and which demonstrates the applicant's competence to implement and manage the provisions of these Acts, and ensure the safe operation and maintenance of plant and equipment.

d. Experience gained in operations, maintenance, appropriate processes and systems, trouble shooting and problem solving, failure analysis and incident investigations, construction and commissioning, training and project management, provided that at least two (2) of the required three (3) years of experience are directly concerned with the installation, operation and/or maintenance of machinery which requires sound engineering judgement, ability to work in a team, sound communication skills and management and which demonstrates the applicant's competence at the required level of a certificated engineer over the full three year period.

e. In the case of marine engineers, as an alternate to the specified experience above, the following will be considered:

Experience gained as the appointed Chief Marine Engineer Officer for five (5) years, on a variety of vessels with registered power of no less than 2 200 kW plus at least six (6) months experience in an acting capacity as Supervising Marine Engineer, with proven continuing updating of competence during this period, will be considered in lieu of the experience specified above.

2. Registered as a Candidate Certificated Engineer;

3. Embarked on a process of acceptable training under a registered **Commitment and Undertaking (C&U)** with a Mentor guiding the professional development process at each stage.

3. Persons not registered as a Candidate or not Training under a C&U

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

If the trainee's employer has no C&U, the trainee should establish the level of mentorship and supervision the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The recognised Voluntary Association (VA) for the particular certificate should be consulted for assistance in locating an external mentor. A mentor should be in place at all stages of the development process.

This Guide and Requirements are written for the recent graduate who is training and gaining experience toward registration. Mature applicants for registration may apply the Guide and Requirements retrospectively to identify possible gaps in their development.

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

The Guide and Requirements may be applied in the case of a person moving into a candidacy programme at a later stage that is at a level below that required for registration (**Section 8.5**).

4. Training Objectives

To achieve ECSA registration the trainee's employer should design the training program to achieve the following:

4.1 Expose the applicant to experience and training enabling him or her to apply engineering theory acquired during educational development to practical workplace situations for the prescribed period required.

4.2 Incorporate an increasing level of responsibility to enable the applicant to submit evidence in the training and experience reports of achieving the duration and level detailed in **Section 8.1**.

4.3 Develop the engineering competency of the applicant to cover the eleven outcomes in the five major groups referred to in **Section 7.2 and Annexure A,** and the discipline specific requirements referred to **Section 8.6.**

5. Professional Certificated Engineers

Professional Certificated Engineers predominantly operate within the disciplines of mechanical, electrical and mining engineering. Their jurisdiction is regulated by the following Acts of South African Parliament:

Occupational Health and Safety Act, 1993 (Act No. 85 of 1993);
Mines Health and Safety Act, 1996 (Act No 29 of 1996); and
Merchant Shipping Act, 1951 (Act No. 57 of 1951),

and their responsibility as a "competent person" is designated by a letter of appointment by an employer and acknowledged with confirmation by the relevant government department after receipt of one or more of the following certificates:

[1] Electrical Engineer's Certificate of Competency issued in terms of the Mines Health and Safety Act (MH&S Act);
[1] Mechanical Engineer's Certificate of Competency issued in terms of the MH&S Act;

[2] Electrical Engineer's Certificate of Competency issued in terms of the Occupational Health and Safety Act (OH&S Act);
[2] Mechanical Engineer's Certificate of Competency issued in terms of the OH&S Act;
Manager's Certificate of Competency (Metalliferous) issued in terms of the MH&S Act;
Manager's Certificate of Competency (Coal) issued in terms of the MH&S Act;
[3] Chief Engineer Officer – Foreign Going Certificate of Competency issued in terms of the Merchant Shipping Act (MS Act).

[1] Previously also known as the Mines and Works Certificate.
[2] Previously also known as the Factories Certificate.
[3] Previously also known as the Chief Marine Engineer Officer Class 1 Certificate.

In addition to the legal responsibility stipulated in the above Acts and corresponding Regulations applicable to the "workplace", *engineering responsibilities* applicable to the discipline practiced are indicated as follows:

Mechanical Engineering

In *Mechanical Engineering,* Certificated Engineers undertake the planning, design (or development), construction, operation and maintenance of materials, components, machines plant and systems for lifting, hoisting and materials handling; turbines, pumps and fluid power; heating, cooling, ventilating and air-conditioning; fuels, combustion, engines, steam plant, petrochemical plant, turbines; automobiles, trucks, aircraft, ships and special vehicles; fire protection; nuclear energy generation, lifts and escalators; advise on mechanical aspects of particular materials products or processes; through the application of fundamental knowledge in engineering sciences: machine dynamics, material science, thermodynamics and fluid mechanics.

Typical *Mechanical Engineering* tasks that a Certificated Engineer may undertake include:

- Planning and development of plant, equipment and machinery for manufacturing, processing, mining, shipping, and other industrial purposes like the health sector, etc
- Maintenance and safe operation of steam, internal combustion and other non-electric motors and engines used in above-mentioned industries.
- Maintenance and safe operation of hulls, superstructures and propulsion systems of ships; mechanical plant and equipment for the release, control and utilization of energy, heating , ventilation and refrigeration systems, steering gear, pumps, pipe work, valves and other associated mechanical equipment
- Maintenance and safe operation of suspension systems, brakes, vehicle bodies and other components of on-road as well as off-road vehicles.
- Maintenance and safe operation of non-electrical parts of apparatus or products such as word processors, computers, precision instruments, cameras and projectors
- Implement measures and controls to ensure efficient functioning and safety of machines, machinery, tools, motors, engines, industrial plant, equipment or systems.
- Ensuring that equipment operation and maintenance comply with design specifications and safety standards

Practising Certificated Engineers who are legally appointed to perform *Mechanical Engineering* function generally in one or more of the following areas:

- Air-conditioning, Heating and Ventilation.
- Automotive Engineering.
- Diesel Engineering.
- Fluid Mechanics Engineering.
- Fire Protection and Detection.
- Incident Investigations and Failure Analysis.
- Machine Development.
- Engineering Maintenance Management.
- Mechanical Engineering, Mines.
- Mechatronics Engineering.
- Piping Engineering.
- Power Generation Engineering.
- Pressurised Vessels Engineering.
- Rotational Plant Engineering.
- Structural Steel Engineering.
- Thermodynamics Engineering.
- Transportation Systems Engineering.
- Ocean Going Vessels.

Electrical Engineering

Electrical Engineering Certificated Engineers conduct planning, design (or development), and direct the construction and operation of electronic, electrical and telecommunications systems, computer and software systems, components, motors and equipment. They organise and establish control systems to monitor the performance and safety of electrical and electronic components, assemblies and systems.

They perform some of the following broadly-defined functions: planning, design (or development), construction, operation and maintenance of materials, components, plant and systems for generating, transmitting, distributing and utilising electrical energy; electronic devices, apparatus and control systems for industrial systems, bio-medical, robotics and consumer products; computing, communication and software for critical applications, instrumentation and control of processes, through the application of electrical, electromagnetic and information technology.

Within the broad collective field of electrical engineering, certificated engineers are legally appointed to take responsibility in the following areas:

Electrical Power Engineering: covers electrical systems, components, motors and equipment, electrical engineering materials, products and processes.

Electronic Engineering: covers electronic systems, electronic engineering materials, products or processes.

Telecommunications Engineering: is a broad specialisation of electrical engineering encompassing the design, construction and management of systems that carry out the transmission, processing and storage of information as electrical or optical signals and the control services based on this capability.

Computer and Software Engineering: addresses the relationship and interactions between software, hardware and external systems in solving real engineering problems. Computer engineering concentrates its effort on the ways in which computing ideas are mapped into working physical systems.

Certificated Engineers often take dual legal responsibility for the safe operation and maintenance of mechanical and electrical engineering process and systems, for example Mechatronics Engineering - involving robotic, prosthesis and process control.

Practising Certificated Engineers (Electrical and/or Mechanical) may concentrate on one or more of the following electrical engineering areas:

Mining, Plant and Factories, Power Generation, Power Transmission, Power Distribution, Power Systems Protection, Metering, Illumination, Railway Signalling, Signalling and Communications, Control and Instrumentation, Product Development, Power Electronics, Electrical Drives, Energy Management, Infrastructure Maintenance, Construction Projects, Training, Ocean Going Vessels, etc.

Communications (Army), Mechatronics, Information, SCADA, Control, Instrumentation, Television, Bio-medical, Clinical, Fire and Safety, Rail Network Control, Electronic Warfare, Optimisation of control systems in process plants, etc.

Broadcasting, Digital Signal Processing Development, Communications, Fibre Optics, Radio Frequency Development, Radar, Radio, Radio and Telecommunications, Mobile Radio, Satellite Transmission, Signal Processing Systems, Communications Consulting, Communications Specialist (ICT), Telecommunications Consulting, Telecommunications Network Planning, Telecommunications Specialist, Microwave, etc.

Computer Hardware, Computer Systems Analysis, Computer Systems Design, Computer Communication Specialisation, Computer Network Development, Software Systems, etc.

Mining Engineering

Mining Engineering Certificated Engineers designs and prepares specifications for mineral-extraction (Mining) methodology, processes and systems and the management of the operation of mining engineering processes for different types of mineral resources and deposits.

Typical *Mining Engineering* tasks that a Certificated Engineer may undertake include:

- Conducting broadly-defined fundamental analysis of operational requirements to develop safe occupational health and safety and environmentally responsible mineral excavation methodologies, processes and systems;
- Developing, planning and specifying broadly -defined mineral excavation (production) processes, application of mining resources and mining technical support services required, occupational health, safety and environmental considerations and quality assurance;
- Establish broadly -defined production/operational control standards and procedures to ensure compliance with legislatory and site-specific requirements;
- Manage occupational health, safety and environmentally-related hazards and accompanying risks;
- Performing risk assessments throughout the life-cycle stages and mineral excavation processes to determine the degree of compliance to broadly -defined strategic and tactical Mine Design and Planning processes;
- Assist in the development of an appropriate site-specific Risk Management Policy, Procedures and Standards (Codes of Practice);
- Prepare Pre-Feasibility and Feasibility Reports and Life-of-Mine Exploitation Strategies and Plans, Business Plans and Bankable Documents based on site-specific assumptions, premises, constrains and best practice standards e.g. SAMCODES (i.e. SAMREC and SAMVAL);

- Converting mineral resources into mineral reserves; and
- Education and Training of persons working within their area of responsibilities.

Practicing Certificated Engineers who are holders of Mine Manager's Certificate of Competency generally concentrate on one or more of the following Mining Engineering practice areas:

Conducting Mineral Excavations/Mining Operations:

- Production: Mineral Excavation Processes including Occupational Health and Safety and Environmental Management.
- Production Programming and Scheduling: To be captured in an appropriate Mining Plan
- Project Work / Research and Development: To be covered in a project report.
- Mining Technical Services: Work Study, Survey and Mineral Evaluation, Ventilation.
- Engineering and Occupational Hygiene, Rock Mechanics, Strata Control, Geology, Grade Control and Administration, Integrated Environmental Management.
- Supervisory Experience: Miner/Rock breaker, Shift Supervisor, Mine Overseer or equivalent and preferably a Sub-ordinate Manager.

Rock Engineers/Strata Control:

- Production: Mineral Excavation Processes including Occupational Health and Safety and Environmental Management.
- Production Programming and Scheduling: To be recorded in an appropriate Mining Plan.
- Basic Mining processes and procedures: Mineral Excavation Processes including Occupational Health and Safety, Support Installation and Rock Stability, Stability of Mining Excavations.
- Rock Mechanics Design Criteria: Optimisation of broadly-defined mining layouts, Computer applications in Rock Mechanics, selection of occupationally safe Mining Methods, addressing OH&S-related Hazards and Risks and Stability of Mining Excavations.
- Supervision of Rock Mechanics: Installation in a supervisory capacity, e.g. Miner/Rock breaker, Shift Supervisor / Mine Overseer equivalent Monitoring and Maintenance of Support Installations.

Occupational Environmental Engineering and Hygiene:

- Basic Mining: Mineral excavation Processes including Occupational Health and Safety and Environment Management.
- Project Work/Research and Development: To be covered in a Project Report
- Mine Environment Design & Specification: Layouts, Refrigeration, Fan specifications, Airflow; Occupational Environment Control/Hygiene.
- Supervision of Ventilation: Controlling and Monitoring of Dust, Air Control, Fumes and Gases in a section of a mine, Installation of Fans, Air Conditioners, Hazardous Substances and Pollution, etc.
- Installation: Fans, Air Controls, Brattices, etc.

Mineral Asset Valuations (MAV);

- Basic Mining: Mineral Excavation Processes including Occupational Health and Safety and the Environment Management.
- Performing oversight on Tonnage / Grade Estimates: Sampling, Regression, Geostatistics, Kriging, Geology, and Sedimentology on Evaluation process.
- Mine Planning and Mine Development: Impact of Mine layouts on the Evaluation Process, Rock Mechanics, HIRA.

- Survey: Appreciation of survey techniques and interpretation of mine plans.
- Project Work /Research and Development: To be covered in a Project Report
- Economic Evaluation: Costs, Revenue, Pay Limits, Life of Mine calculations, Cash Flow Estimates, Return on investment, Pre-and Feasibility Studies, Bankable documents and Business Planning,
- Geology: Appreciation of geological analysis techniques and interpretation of well-defined geological models.

Mining Operation Optimisation;

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

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

Mine Planning and Mine Development;

- Broadly-defined mineral resource to mineral reserve conversion
- Broadly-defined mining value chain
- Broadly-defined mine design criteria
- Mining technical risk analysis
- Production forecasting
- Public reporting requirements, compliance to Codes
- Broadly-defined planning horizons and planning cycles
- Multi criteria decision process and trade off studies
- Planning integration
- Mining business optimisation
- Mineral resource management
- Value engineering

6. Training Implications of the Nature and Organisation of the Industry

Certificated Engineers may be employed in both the private and public sector.

Typically in the private sector they would be carrying legal appointments in mining operations, manufacturing, factories, shipping and related industries. They may also be appointed to carry legal responsibilities for contracting or project work in these types of industries. Engineering contractors are responsible for project implementation and activities include planning, construction, labour and resource management. Maintenance and safe operation of systems, processes, plant, equipment and machinery are key functions of Certificated Engineers. They have to ensure that work processes and activities are undertaken in accordance with the requirements of the regulations and in compliance to design specifications, standards and codes.

The public sector is responsible for service delivery and is usually the client, though in some departments design and construction are also carried out. Certificated Engineers are required at all levels of the public sector, including at national, provincial and local government level, state owned enterprises (SOEs), and public utilities. The public sector largely handles planning, specifying, overseeing implementation, operations and maintenance of infrastructure.

Certificated Engineers may be appointed as inspectors by the ministries of energy, public works, mineral resources and transport to ensure that compliance with the regulations is being maintained by affected industries.

Depending on where the candidate is employed, there may be situations where the opportunities in-house are not sufficiently diverse to develop all the competencies required in both Groups A and B noted in document R-02-PCE. For example the opportunity for developing problem solving competence (including design synthesis or developing solutions) and for managing engineering activities (including implementing or constructing solutions) may not both be available to the candidate. In such cases employers are encouraged to put a secondments system in place.

It has been fairly common practice that where an organisation is not able to provide training in certain areas that secondments are arranged with other organisations, so that the candidate is able develop all the competencies required for registration. These secondments are usually of a reciprocal nature so both employers and their respective employees get the mutual benefit from the other party. Secondments between consultants and contractors, and between the public and private sector should be possible.

Problem solving in various sectors of engineering is a logical thinking process that requires *Certificated Engineers* to apply their minds diligently in bringing solutions to technically broadly-defined problems. This process involves the analysis of systems or assembly of mechanical, electrical, marine or mining components, and integration of various elements in mechanical, electrical, marine or mining engineering through the application of fundamental knowledge in engineering sciences.

Owing to the diversity in application of Mining Engineering within the SA Mining Industry, Mining Certificated Engineers can follow a range of routes to registration across multiple minerals/commodities (e.g. precious metals, precious stones, ferrous metals, coal) in differing mining method environments (e.g. surface mining, narrow tabular underground mining, massive underground mining) and underground coal mining.

These routes to registration usually cover, from graduation as a Candidate *Certificated Engineer*, a period of operational experience which leads to specialisation in an application of mining engineering in a particular field or sector of the SA Mining Industry. Typically these fields are: mining operations, mine planning and design, rock engineering/strata control, occupational environment engineering (ventilation), refrigeration engineering, techno-economic evaluation, equipment selection, establishment and maintenance of Mining infrastructure, provision of Mining consulting services and education and training of certificated-engineers-in-training.

In the case of *Certificated Engineers* training as a Chief or Second Marine Engineer Officer on a vessel with a registered power of no less than 3000 kW, Candidate training will depend on the type and size of the vessel and the range of mechanical and electrical equipment available. To enhance training in the case of important equipment not being in use on a particular ship, secondment should be considered.

Location of training in overall engineering lifecycle and functions performed.

The areas where the *certificated engineer* works generally follow the conventional stages of the project (or product) life cycle in the following diagram:

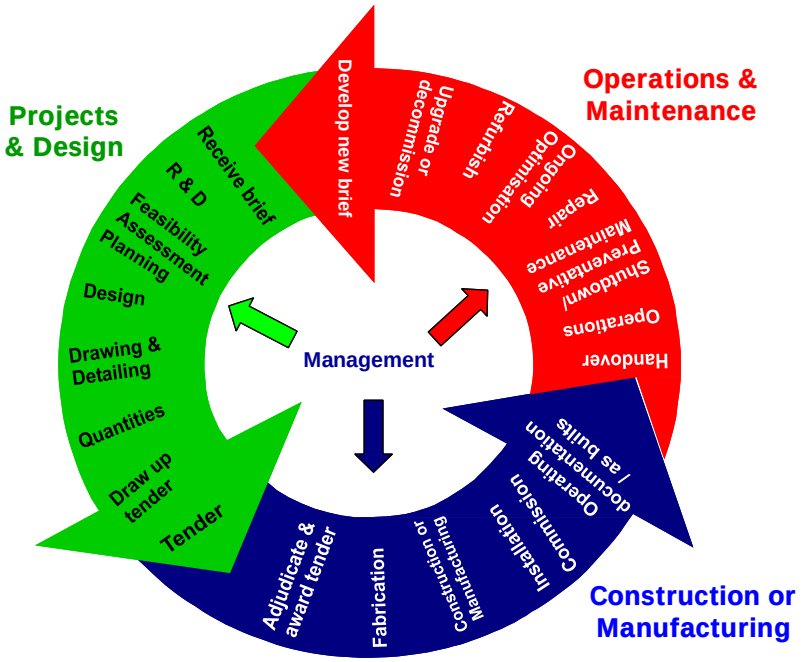
a) Analysis of broadly-defined problems and design or development of solutions to improve the performance of products or systems within the areas of their legal responsibilities.

b) Broadly-defined system or product design or development to solve a broadly-defined system or product problem, or to achieve a particular desired result, or to select equipment for a particular purpose.

c) Project engineering to install and test and commission the necessary equipment or system to ensure compliance with operational requirements and design specifications.

d) Safe operation and maintenance of the system or process in accordance to the legislative requirements.

e) Decommissioning and disposal of assets.



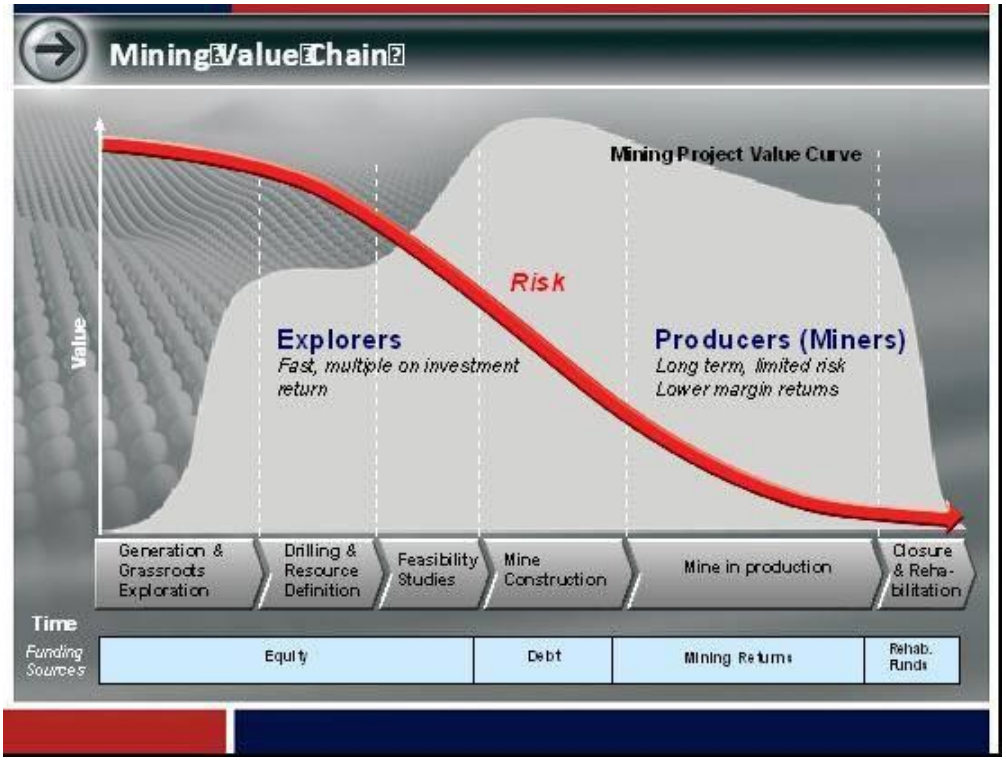
It is not expected that candidates will have to change their occupation in order to work in all the areas as listed above. Candidates however must ensure that in whatever area they are employed they undertake tasks that provide experience in all the 11 outcomes where competencies are being assessed.

In Appendix A, a generic schema is presented for the outcomes applicable to all disciplines that a candidate should become competent to do in the various phases of a project or task:

a) Solving problems based on broadly-defined engineering and contextual knowledge;
b) Managing engineering activities;
c) Impacts of the engineering activity;
d) Judgement, responsibility and ethical behaviour during an engineering activity; and
e) Further professional development since graduation.

Appendix A details the types of evidence of performance that would be appropriate.

In Mining Engineering it is preferred that *Certificated Engineers* should be able to demonstrate sufficient and appropriate exposure and experience across the elements of the typical Mining Value Chain with particular emphasis on mine construction and/or production:



Specific appropriate exposure and/or experience should be demonstrated across the following five phases of the typical mining project life cycle.

- Project data collection and investigations;
- Evaluation Planning and Design;
- Construction and Mine Establishment (Mandatory);
- Mining Operations (Mineral excavation/exploitation) (Mandatory);
- Mine Decommissioning and Closure.

In Mechanical Engineering *Certificated Engineers* should be competent in the operation of the following engineering systems:

- Broadly-defined fluid systems, which includes rotating or reciprocating machines.
- Broadly-defined machines/equipment or major parts thereof.
- Broadly-defined energy systems involving heat transfer.
- Broadly-defined pressure systems/HVAC systems.
- Broadly-defined structures.

The problem solving experience may be obtained in any of the above work categories.

Acceptable broadly-defined design reviews would include reviews of major machine systems such as turbines/compressors with their auxiliary systems, power station systems and their major components, broadly-defined refrigeration systems, petrochemical and other production and manufacturing plant systems and the like.

Mechanical Engineering *Certificated Engineers* should be conversant with operations mostly dealing with investigating failure or underperformance of major equipment or systems and the synthesis of implemented and proven solutions to avoid recurrence of the problem. In addition this category of work will also involve the practical improvement recommended for optimising the operational efficiencies. The mechanical *Certificated Engineers* must, in performing the abovementioned work, apply professional engineering judgment to all work he or she does in the management of operations. This include, but would not be limited to, the ability to assess design work against the following criteria:

- Conformance to design specifications, health and safety regulations.
- Ease of installation and assembly.
- Constructability.
- Maintainability.
- Conformance to environmental requirements.
- Ergonomic considerations.
- Life cycle costs.
- Sustainability

7. Developing competency: Elaborating on sections in the Guide to the Competency Standards, document R-08-PT

Applicants are required to demonstrate the insight and ability to use and interface various engineering aspects through verifiable work carried out in providing engineered and innovative solutions to practical broadly-defined problems experienced in their operating work environment where they are legally appointed. In addition applicants must develop the skills required to demonstrate the use of fundamental or specialist engineering knowledge in optimizing the efficiency of operations or the constructability of projects.

Candidates must be able to demonstrate that they have been actively involved in a work environment participating in the execution of practical work such that they have learnt sufficient details on fundamental engineering knowledge to be able to exercise judgment in the workplace thereafter.

Applicants must show evidence of adequate training in this function through broadly-defined project work carried out in the analysis of problems and the synthesis of solutions. Evidence is required in the form of a separate comprehensive engineering report that should accompany the application. This report should describe a synthesized solution to sufficiently broadly-defined engineering problems to demonstrate that applicants have had an opportunity to apply their engineering knowledge and expertise gained through Government Certificate of Competence qualification education and practical work experience respectively. In applying engineering knowledge gained through academic training, the applicant must also demonstrate the financial and economic benefits of engineered solutions, synthesized from scientific and engineering principles at a sufficiently broadly-defined level.

What is a sufficiently broadly-defined engineering (Appendix A) problem?

We can summarise the definition of *broadly-defined* in *broadly-defined engineering problems* as follows:

> "Composed of ***inter-related conditions***; requiring ***underpinning engineering knowledge judgment*** to create a solution within a set of **original broadly-*defined circumstances*"**

Mechanical, electrical and mining engineering forms an integral part of broader engineering systems and infrastructure in technologically complex manufacturing, processing, mining, construction, maintenance, and marine environment. Applicants are required to undertake engineering projects that significantly enhance the operability and constructability of integrated engineering systems and infrastructure. Such project work must not be stand-alone type of assignment, but should be part of a solution to integrated engineering systems that requires a broader application of various theoretical aspects of engineering.

The engineering problem solving is a logical thinking process that requires *certificated engineers* to apply their minds carefully in bringing solutions to broadly-defined engineering problems. This process involves the analysis of systems or assembly of components, and integration of various elements in engineering through the application of fundamental and specialist knowledge in engineering sciences. Simple, straightforward calculation exercises and graphical representations from computer generated data are not considered as sufficiently broadly-defined engineering solutions. The reason is because anybody with qualifications in basic science and engineering science can be able to perform this kind of work, and professional registration requires an in-depth analysis and original application of engineering **knowledge** in broadly-defined engineering problems.

Candidate *Certificated Engineers* must obtain experience in solving a variety of problems in their work environment, and the solution to these problems should also involve the use of fundamental and advanced engineering knowledge obtained from Government Certificate of Competence qualification underpinned by engineering education from accredited academic engineering programmes where applicable. The problems that require scientific and engineering approach in solving them may be encountered in any engineering work environment that consists of integrated engineering systems, equipment, machinery and infrastructure. From their early training years, candidates must actively seek opportunities to obtain experience in the area of synthesizing solutions to real life engineering problems encountered at the workplace.

7.1 Contextual Knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The recognised Voluntary Association applicable and their functions and services to members, for example, provide a broad range of contextual knowledge for the Candidate *Certificated Engineer* through the full career path of the registered *Professional Certificated Engineer*. The practice area of *Professional Certificated Engineer* identifies specific contextual activities that are considered an essential component of the development of competence. These include awareness of basic workshop, manufacturing, fabrication, mining, and on site or on board activities and the competencies required of the *certificated engineer*.

Candidate Certificated Engineers in mining should demonstrate appropriate exposure and experience in:

- Mineral Excavation processes;
- Mine Planning and Development;
- Project execution;
- Incident and Accident Investigations
- Supervision and Management;
- Technical and Financial valuation;
- Mine Health and Safety and Environmental Management; and

This should be done in one or more of the following sub-sectors/contexts of the SA Mining Industry:

- U/G Narrow Tabular Hard Rock;
- U/G Massive Hard Rock;
- U/G Coal Mining; and
- Surface Mining inclusive of Open Pits, Open Cast and Quarrying operations.

7.2 Functions Performed

Special considerations in the *Certificated Engineer* group and each specific type of system or speciality must be given to the Degree of Responsibility as described in the scales in document R-04-P, Table 4 on the competencies specified in the following groups:

a) Knowledge based problem solving
b) Management and Communication
c) Identifying and mitigating the impacts of engineering activity
d) Judgement and responsibility
e) Independent learning

Discipline-specific Requirements (Refer to Clause 8.6 below and Form R-05-DSRR-PCE).

The progression of the candidate's competency can be measured as in clause 8.1 below.

Appendix A has been developed to align the progression with the Degree of Responsibility Scale. Activities should be selected to ensure that the candidate reaches the required level of competency and responsibility.

It is very useful to measure the progression of the candidate's competency by making use of the Degree of Responsibility, Problem Solving and Engineering Activity scales as specified in the relevant documentation

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

Degree of responsibility E means performing at the level required for registration. This corresponds to the range statement in outcome 10 in the Competency Standard R-02-PCE which requires the applicant to display responsibility "for the outcomes of significant parts of one or more broadly-defined engineering activities".

It should be noted that the Candidate *Certificated Engineer* working at Responsibility level E on the Degree of Responsibility Scale carries the responsibility for work thus performed appropriate to that of a registered person except that the Candidate *Certificated Engineer* supervisor is accountable for the Candidates recommendations and decisions.

7.3 Industry-related statutory and other requirements

Candidates are expected to have a working knowledge of the regulations, Acts and standards that are applicable to their working environment. The following list covers all the 7 sub-disciplines of the Certificated Engineers:

- ECSA – Engineering Profession Act, 2000, (Act No. 46 of 2000)' its Rules and the Code of Conduct
- OHS Act – Occupation Health and Safety Act, 1993 (Act No. 85 of 1993), as amended by Act No. 181 of 1993.
- Mine Health and Safety Act. 1996 (Act No. 29 of 1996).
- Environment Conservation Act, 1989 (Act No. 73 of 1989), as amended by Act No. 52 of 1994 and Act No. 50 of 2003.
- Merchant Shipping Act, 1951 (Act No. 57 of 1951)
- Machinery and Works Regulations
- Labour Relations Act
- Building Regulations – National Building Regulations and Building Standards Act, 1977 (Act No. 103 of 1977), as amended by Act No. 49 of 1995

- Water Services Act 1997 (Act No. 108 of 1997)
- National Water Act 1998 (Act No. 36 of 1998)
- Minerals Act and Regulations 1991 (Act 50/1991)
- Industry specific work instructions including manufacturer instructions applicable to specific lifting equipment types
- SANS and other international standards such as ISO, EN, DIN or US Federal Standards.

Many other Acts not listed here may also be pertinent to a Candidate Certificated Engineers work environment. Candidate Certificated Engineers will be expected to have a basic knowledge of the applicable Acts and to investigate whether any Acts are applicable to a particular work environment.

7.4 Recommended Formal Learning Activities

The following list of formal learning is a sample of some useful course types:

- Conditions of Contract\Value Engineering – NEC, JBCE etc.
  Standard Specifications
- Preparation of Specifications
- Engineering Finance
- Energy Efficiency
- Electrical Tariffs
- Management
- System Engineering
  Industrial Relations
  Public Speaking
- Project Management
- Negotiation Skills
- Risk Analysis
- Quality Systems
- Occupation Health and Safety
- Maintenance Engineering
- Environmental Impacts
- Value Engineering
- Report writing and communication
- Planning methods
- CPD courses on specific disciplines and equipment types

8. Programme Structure and Sequencing

8.1 Best Practice

There is no ideal training programme structure or a unique sequencing that constitutes best practice.

The training programme for each Candidate *Certificated Engineer* will depend on the work opportunities available at the time for the employer to assign to the candidate

It is suggested that the Candidate *Certificated Engineer* works with their mentors to determine appropriate projects to gain exposure to elements of the asset cycle, to ensure that their designs are constructible, operable, and are designed considering life cycle coating and long-term sustainability.

The training programme should be such that Candidate *Certificated Engineer* progresses through levels of work capability, which is described in 7.3.4 of document R-04-P, such that by the end of the training period, the Candidate *Certificated Engineer* must perform individually and as a team member meeting the engineering outcomes as well as the discipline-specific requirements at the level required for registration and exhibit degree of responsibility E.

The nature of work and degrees of responsibility defined in document R-04-P, Table 4, are used here (and in **Appendix A** below)**:**

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

The Mentor and the Candidate *Certificated Engineer* must identify at which level of responsibility an activity provides the compliance with and demonstration of the various Outcomes. The evidence of the candidate's activities will be recorded on the appropriate system such that it meets the requirements of the Training Elements, **Appendix A**. (This will be in the form of an Engineering Report).

Mining Candidate *Certificated Engineers, d*epending on the nature and extent of the engineering-related work undertaken by an Employer, should be able to develop candidate-specific development programs which will provide opportunities to undertake the necessary exposure/experience in a **phased approach**, described in **APPENDIX 1**. This guidance should be read in conjunction with sections herein first.

8.2 Orientation requirements

- Introduction to Company
- Company Safety Regulations
- Company Code of Conduct
- Company Staff Code and Regulations
- Company records and record keeping
- Typical functions and activities

8.3 Realities

Generally, irrespective of the type of Certificate, it is unlikely that the period of training will be three years, the minimum time required by ECSA. Typically, it will be longer and would be determined amongst others by the availability of functions in the actual work situation.

Each candidate will effectively undertake a unique programme where the various activities carried out at the discipline-specific level are then linked to the generic competency requirements of R-08-PT and the **Compulsory Discipline-specific Requirements to be met during the Candidacy**.

Mining Candidate *Certificated Engineers* would most probably only accommodate exposure to experience in one of the following sub-sectors/specialisation practice areas:

- U/G Thin Tabular Hard rock operations;
- U/G Massive Hard Rock operations;
- U/G Coal mining; and
- Surface Mining.

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

8.4 Considerations for generalists, specialists, researchers and academics

Section 10 of document R-08-PT adequately describes what would be expected of persons whose formative development has not followed a conventional path, for example academics, researchers, specialists and those who have not followed a candidate training programme.

This unconventional path is not normally applicable to Certificated Engineering candidates.

The overriding consideration is that, irrespective of the route followed, the applicant must provide evidence of competence against the **Standard** and the **Discipline-specific Requirements**.

8.5 Moving into or Changing Candidacy Programmes

This Guide assumes that the Candidate *Certificated Engineers* enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the Candidate *Certificated Engineer* is supervised and mentored by persons who meet the requirements in document R-04-P section 7.2. 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 be completed:

- The Candidate *Certificated Engineer* must complete the Training and Experience Summary (TES) and Training and Experience Reports (TER) for the previous programme or unstructured experience. In the latter case it is important to reconstruct the experience as accurately as possible. The TERs must be signed off.
- On entering the new programme, the Mentor and Supervisor should review the Candidate *Certificated Engineer's* development in the light of the past experience and opportunities and requirements of the new programme and plan at least the next phase of the candidate's programme.
- The Candidate *Certificated Engineer* must complete the Discipline-specific Requirements Report (DSRR) on elements already covered during the first part of the candidacy.

8.6 Compulsory Discipline-specific Requirements to be met during the Candidacy

Evidence on *broadly-defined* Engineering Competency, eventually at level E, is presented in the Engineering Report Form **D2.3 ER** and associated Training and Experience Reports of the Application for Registration as a Professional Certificated Engineer form.

The applicable legislation and regulations require specific responsibilities to be designated to *Competent Persons.* Specific training during the candidacy period must be aimed at developing the Candidate to achieve the competency required to accept this responsibility. In addition to assessing candidates for engineering responsibility at level E, Discipline-specific Requirements are assessed as well to confirm legal responsibility, also at level E.

While the emphasis in the training of Candidate *Certificated Engineer*s is on developing Engineering Competency to address *broadly-defined* engineering problems and perform *broadly-defined* engineering activities, the emphasis in meeting the Discipline-specific Requirements must be development towards accepting legal responsibility.

The Candidate assisted by Mentors and Supervisors must during candidacy ensure that he or she is conversant with the legal knowledge set out in the form below, and submit evidence as such as part of the Application for Registration form. Although the focus in this form is not on *broadly-defined* problems and activities as such, the integration between the legal appointment and application of engineering principles is important.

Applications for *Professional Certificated Engineer*s must submit the Discipline-specific Requirements Report (DSRR) form **R-05-DSRR-PCE.**

Discipline-Specific Requirements Report. **Form R-05-DSRR-PCE** (2017-08-21)

Surname and Initials:

Use this form to report in about 100 words per Requirement applicable, on the applicant's personal knowledge. Attach to this report the actual applicable policies, procedures, standard forms, schedules, etcetera for the Certificate selected, done by the applicant under the supervision of an ECSA registered Professional Certificated Engineer.

Tick off (✓) the specific certificate applicable to your registration application:			
1. Electrical Engineer's Certificate of Competency issued in terms of the Mines Health and Safety Act, 1996		5. Manager's Certificate of Competency (Metalliferous) issued in terms of the Mines Health and Safety Act, 1996	
2. Mechanical Engineer's Certificate of Competency issued in terms of the Mines Health and Safety Act, 1996		6. Manager's Certificate of Competency (Coal) issued in terms of Mines Health and Safety Act, 1996	
3. Electrical Engineer's Certificate of Competency issued in terms of the Occupational Health and Safety Act, 1993		7. Chief Engineer Officer – Foreign Going Certificate of Competency issued in terms of the Merchant Shipping Act, 1951	
4. Mechanical Engineer's Certificate of Competency issued in terms of the Occupational Health and Safety Act, 1993			

REPORT:		
Item	Requirements	Report
1.	Briefly set out your area of responsibility as stipulated in your letter of appointment as the responsible person.	
2.	Explain the rationale behind your appointment.	
3.	List the Acts and Regulations applicable to your specific responsibility	
4.	List your duties as a responsible engineer appointed under the regulations.	
5.	Explain the action plans that you have taken to deliver on the duties listed above.	
6.	What are the standard operating procedures applicable to your areas of responsibility, which standards/ procedures did you review and what were the recommendations?	
7.	Briefly explain the relevance of your engineering knowledge in carrying out your appointed mandate.	

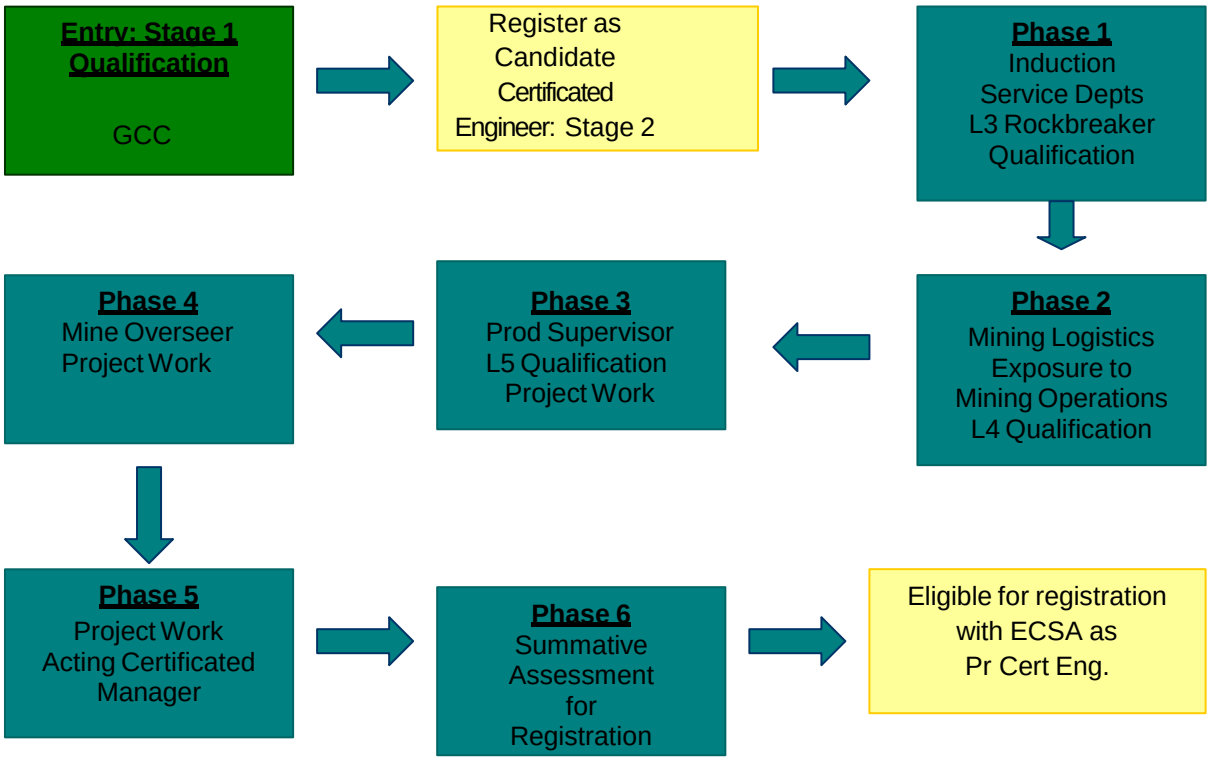
8.	Describe the steps you have taken to train and develop people within your jurisdiction to adhere to the requirements of the Acts and Regulations, and what measures you took to declare people competent to perform work.	
9.	How do you deal with contraventions of the applicable Act and Regulations?	
10.	Elaborate on incident reporting and corrective measures taken to address the non-conformance.	
11.	Describe the measures you took to ensure that you did undertake your responsibility ethically and diligently according to your letter of appointment and the corresponding Acts and Regulations.	
12.	Explain how the engineering equipment under your control and responsibility is evaluated and handled in terms of the particular Act and Regulations.	

Signature of Applicant: _____Date:

Signature of Mentor / Supervisor: _____

Name of Mentor/Supervisor printed: **Tel. No.:**

Appendix 1: Phased approach for Mining Candidates



Training Elements

Synopsis: A candidate certificated engineers should achieve specific competencies at the prescribed level during his/her development towards professional registration, at the same time accepting more and more responsibility as experience is gained. The outcomes achieved and established during the candidacy phase should form the template to all engineering work performed after professional registration regardless of the level of responsibility at any particular stage of an engineering career:

1. **Confirm 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 are not available;**
10. **Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain and evaluating shortcomings; and**
11. **Become conversant with your employer's training and development program and develop your own lifelong development program within this framework.**

Broadly-defined engineering work is usually characterised by the application of novel technology deviating from standard procedures, codes and systems, the deviation verified by research, modelling and/or substantiated design calculations.

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

Competency Standards for Registration as a Professional Certificated Engineer	Explanation and Responsibility Level
1. Purpose This standard defines the competence required for registration as a Professional Certificated Engineer. Definitions of terms having particular meaning within this standard is given in text in Appendix D.	Discipline Specific Training Guides (DSTG) gives context to the purpose of the Competency Standards. Professional Certificate Engineers operate within the nine disciplines recognised by ECSA. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given in Clause 5 of the specific Discipline Specific Training Guideline. DSTG's are used to facilitate experiential development towards ECSA registration and assist in compiling the required portfolio of evidence (Specifically the Engineering Report and Requirements Report in the application form). NOTE: The training period must be utilised to develop the competence of the trainee towards achieving the standards below at a responsibility level E, i.e. Performing. (Refer to 8.1 in the specific DSTG)
2. Demonstration of Competence Competence must be demonstrated within ***broadly-defined engineering activities,*** defined below, by integrated performance of the outcomes defined in section 3 at the level defined for each outcome. Required contexts and functions may be specified in the applicable Discipline Specific Training Guidelines.	Engineering activities can be divided into (approximately): a) 5% Complex (Professional Engineers) b) 5% Broadly Defined (Professional Engineering Technologists and Professional Certificated Engineers) c) 10% Well-defined (Professional Engineering Technicians) d) 15% Narrowly Well-defined (Registered Specified Categories) e) 20% Skilled Workman (Engineering Artisan) f) 55% Unskilled Workman (Artisan Assistants) The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.
Level Descriptor: *Broadly-defined engineering activities (BDEA)* have several of the following characteristics: a) *Scope* of practice area is linked to technologies used and changes by adoption of new technology into current practice; b) Practice area is located within a wider, complex *context,* requires teamwork, has interfaces with other parties and disciplines; c) Involve the use of a variety *resources,* including people, money, equipment, materials, technologies; d) Require resolution of occasional problems arising from *interactions* between wide-ranging or conflicting technical, engineering or other issues; e) Are *constrained* by available technology, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws; f) Have significant *risks* and *consequences* in the practice area and in related areas.	**Level Descriptor: B*DEA*** in the various disciplines are characterised by several or all of: a) *Scope* of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation; b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on complex activities and problems. *Broadly defined activities* in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team; c) The bulk of the work involves familiar, defined range of *resources,* including people, money, equipment, materials, but new technologies are investigated and implemented; d) Most of the impacts in the sub discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of *broadly-defined* non-standard engineering principles; e) The work packages and associated parameters are *constrained* by operational context with variations limited to different locations only. (Cannot be covered by standards and codes). f) Even locally important minor risks can have far reaching consequences.
Activities include but are not limited to: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; 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 Certificated Engineers, research, development and commercialisation happen more frequently in some disciplines and are seldom encountered in others.

3. Outcomes to be satisfied:	Explanation and Responsibility Level
Group A: Engineering Problem Solving.	
Outcome 1: Define, investigate and analyse *broadly-defined* engineering problems	**Responsibility level E** Analysis of an engineering problem means the "separation into parts possibly with comment and judgement". *Broadly* means "not minute or detailed" and "not kept within narrow limits".
Broadly-defined engineering problems *have the following characteristics:* (a) require coherent and detailed engineering knowledge, underpinning the technology area; *and one or more of:* (b) are ill-posed, under- or over specified, require identification and interpretation into the technology area; (c) encompass systems within complex engineering systems; (d) belong to families of problems which are solved in well-accepted but innovative ways; *and one or more of:* (e) can be solved by structured analysis techniques; (f) may be partially outside standards and codes; must provide justification to operate outside; (g) require information from practice area and sources interfacing with practice area that is complex and incomplete; (h) involves a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties; *and one or both of:* (i) requires judgement in decision making in practice area, considering interfaces to other areas; (j) have significant consequences which are important in practice area, but may extend more widely.	(a) coherent and detailed engineering knowledge for Certificated Engineers means the problem encountered cannot be solved without the combination of all the relevant detail including engineering principles applicable to the situation; (b) the nature of the problem is not immediately obvious, and further investigation to identify and interpret the real nature of the problem is necessary; (c) the problem is not easily recognised as part of the larger engineering task, project or operation and may be obscured by the complexity of the larger system; (d) recognised that the problem can be classified as a falling within a typical solution requiring innovative adaptation to meet the specific situation ; (e) solving the problem needs a step by step approach adhering to proven logic; (f) the standards, codes and documented procedures must be analysed to determine to what extent they are applicable to solve the problem and justification must be given to operate outside these; (g) the responsibility lies with the Certificated Engineer to verify that some information received as part of the problem encountered may remain incomplete and solutions to problems may need justified assumptions; (h) the problem handled by an Certificated Engineer may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, not maintainable, not sustainable, etc. The Certificated Engineer will have to justify his / her recommendation; (i) practical solutions to problems includes knowledge and judgement of the roles displayed by the multi-disciplinary team and impact of own work in the interactive environment; (j) Certificated Engineers must realise that their actions might seem to be of local importance only, but may develop into significant consequences extending beyond their own ability and practice area.
Assessment Criteria: A structured analysis of broadly-defined problems typified by the following performances is expected:. 1.1 Performed or contributed in defining engineering problems leading to an agreed definition of the problems to be solved. 1.2 Performed or contributed in investigating engineering problems including collecting, organising and evaluating information. 1.3 Performed or contributed in analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results	To perform an engineering task a certificated engineer will typically receive an instruction from a senior person (customer) to do a specific task, and must: 1.1 Make very sure that the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation. 1.2 The engineering problem and related information must be segregated from the bulk of the information, investigated and evaluated. 1.3 Ensure that the instruction and information to do the work is fully understood and complete, including engineering theory needed to understand the task and acceptance criteria, and to carry out and/or check calculations. If needed supplementary information must be gathered, studied and understood. Concepts and assumptions must be justified by engineering theory and calculations, if applicable.
Range Statement: The problem may be a design requirement, an applied Research and Development requirement or a problematic situation in an existing component, system or process. The problem is one amenable to solution by technologies known to the candidate. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.	**Please refer to clause 5 of the specific Discipline Specific Training Guideline.**

Outcome 2: Design or develop solutions to broadly-defined engineering problems	**Responsibility level C and D** Design means "drawing or outline from which something can be made". Develop means "come or bring into a state in which it is active or visible".
Assessment Criteria: This outcome is normally demonstrated after a problem analysis as defined in outcome 1. Working systematically to synthesise a solution to a broadly-defined problem, typified by the following performances is expected: 2.1 Designed or developed solutions to broadly-defined engineering problems. 2.2 Systematically synthesised solutions and alternative solutions or approaches to the problem by analysing designs against requirements, including costs and impacts on outside parameters. (Requirements). 2.3 Drawing up of detailed specification requirements and design documentation for implementation to the satisfaction of the client.	After the task received is fully understood and interpreted a solution to the problem posed can be developed (designed). To synthesise a solution means "the combination of separate parts, elements, substances, etc. into a whole or into a system" by: 2.1 The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an attachment. 2.2 The Certificated Engineer will in some cases not be able to support proposals with the complete theoretical calculation to substantiate every aspect, and must in these cases refer his / her alternatives to an Engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified. 2.3 The best complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc., for the execution of work to meet customer requirements.
Range Statement: Solutions are those enabled by the technologies in the candidate's practice area.	Applying theory to do *broadly-defined engineering* work is mostly done in a way that's been used before, probably developed by engineers in the past, and documented in written procedures, specifications, drawings, models, examples, etc. Certificated Engineers must seek approval of any deviation from these established methods, but also initiate and/or participate in the development and revision of these norms.

Outcome 3: Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems or methodologies and those specific to the jurisdiction in which he/she practices.	**Responsibility level E** Comprehend means "to understand fully". The jurisdiction in which an Certificated Engineer practices is given in **Clause 5 of the specific Discipline Specific Training Guideline.**
Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations. 3.1 Applied engineering principles, practices, technologies, including the application of BTech theory in the practice area. 3.2 Indicated working knowledge of areas of practice that interact with practice area to underpin team work. 3.3 Applied related knowledge of finance, statutory, safety and management.	Design work for Certificated Engineers is based on BTech theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel technology. Certificated Engineers develop and apply codes and procedures in their design work. Investigation would be on broadly-defined be incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations. 3.1 Calculations at BTech theoretical level confirming the correct application and utilisation of equipment, materials and systems listed in Clause 5 of the specific Discipline Specific Training Guideline must be done on *broadly-defined* activities. 3.2 The understanding of broadly-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team. 3.3 The ability to manage the resources within legal and financial constraints must be evident.
Range Statement: Applicable knowledge includes: (a) Technological knowledge that is well-established and applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others. (b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork. (c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practice area, a selection of: law of contract, health and safety, environmental, intellectual property, contract administration, quality management, risk management, maintenance management, regulation, project and construction management.	(a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of systems, materials, components and projected customer requirements and expectations. New ideas, materials, components and systems must be investigated, evaluated and applied accompanied by complex theoretical motivation. (b) In spite of having a working knowledge of interacting disciplines, Certificated Engineers 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 Certificated Engineers must be aware of and decide on the relevant requirements applicable to the each specific project that he/she is responsible for. They are usually appointed as the "responsible person" for specific projects in terms of the OHS Act.

Group B: Managing Engineering Activities.	Explanation and Responsibility Level
Outcome 4: Manage part or all of one or more *broadly-defined* engineering activities.	**Responsibility level D** Manage means "control".
Assessment Criteria: The candidate is expected to display personal and work process management abilities: 4.1 Managed self, people, work priorities, processes and resources in broadly-defined engineering work. 4.2 Role in planning, organising, leading and controlling broadly-defined engineering activities evident. 4.3 Knowledge of conditions and operation of contractors and the ability to establish and maintain professional and business relationships evident.	In engineering operations Certificated Engineers will typically be given the responsibility to carry out projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 The basic elements of managements must be applied to broadly-defined engineering work. 4.3 Depending on the project, Certificated Engineers can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
Outcome 5: Communicate clearly with others in the course of his or her broadly-defined engineering activities	**Responsibility level C**
Assessment Criteria: Demonstrates effective communication by: 5.1 Ability to write clear, concise, effective technical, legal and editorially correct reports shown. 5.2 Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident. 5.3 Oral presentations made using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.	5.1 Refer to Range Statement for Outcome 4 and 5 below. 5.2 Refer to Range Statement for Outcome 4 and 5 below. 5.3 Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
Range Statement for Outcomes 4 and 5: Management and communication in *well-defined engineering* involves: (a) Planning *broadly-defined* activities; (b) Organising *broadly-defined* activities; (c) Leading *broadly-defined* activities and (d) Controlling *broadly-defined* activities.	(a) Planning means "the arrangement for doing or using something, considered in advance". (b) Organising means "put into working order; arrange in a system; make preparations for". (c) Leading means to "guide the actions and opinions of; influence; persuade". (d) Controlling means the "means of regulating, restraining, keeping in order; check". Certificated Engineer write specifications for the purchase of materials and/or work to be done, recommendations on tenders received, place orders and variation orders, write work instructions, report back on work done, draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write work procedures, write inspection and audit reports, write commissioning reports, prepare and present motivations for new projects, compile budget reports, report on studies done and calculations carried out, report on customer requirements, report on safety incidents and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report back on cost control, etc.

Group C: Impacts of Engineering Activity.	Explanation and Responsibility Level
Outcome 6: Recognise the foreseeable social, cultural and environmental effects of *broadly-defined* engineering activities generally	**Responsibility level B** Social means “people living in communities; of relations between persons and communities”. Cultural means ”all the arts, beliefs, social institutions, etc. characteristic of a community”. Environmental means “surroundings, circumstances, influences”.
Assessment Criteria: This outcome is normally displayed in the course of analysis and solution of problems. The candidate typically: 6.1 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown. 6.2 Measures taken to mitigate the negative effects of engineering activities evident.	6.1 Engineering impacts heavily on the environment e.g. servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wild life, dangerous rotating and other machines, demolishing of structures, etc. 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases, compensation paid, etc.

Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his or her broadly-defined engineering activities.	**Responsibility level E**
Assessment Criteria: 7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity. 7.2 Circumstances stated where applicant assisted in, or demonstrated awareness of the selection of save and sustainable materials, components and systems and have identified risk and applied risk management strategies.	7.1 The OHS Act is supplemented by a variety of parliamentary acts, regulations, local authority by-laws, standards and codes of practice. Places of work might have standard procedures, instructions, drawings and operation and maintenance manuals available. These documents, depending on the situation (emergency, breakdown, etc.) are consulted before work is commenced and during the activity; 7.2 It is essential to attend a Risk Management (Assessment) course, and to investigate and study the materials, components and systems used in the workplace. The Certificated Engineer seeks advice from knowledgeable and experienced specialists if the slightest doubt exist that safety and sustainability cannot be guaranteed.
Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include: (a) Requirements include both explicit regulated factors and those that arise in the course of particular work; (b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied; (c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used; (d) Safe and sustainable materials, components and systems; (e) Regulatory requirements are explicit for the context in general.	(a) The impacts will vary substantially with the location of the task, e.g. the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex, and is identified and studied by the Certificated Engineer before starting the work. (b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirm or check that the instructions are in line with regulations. The Certificated Engineer is responsible to see to it that this is done, and if not, establishes which regulations apply, and ensure that they are adhered to. Usually the people working on site are strictly controlled w.r.t. health and safety, but the Certificated Engineer checks that this is done, but may authorise unavoidable deviation after setting condition for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained. (c) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The Certificated Engineer 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 Certificated Engineer or other professional specialists must be consulted. It is the responsibility of the Certificated Engineer 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 Certificated Engineer.

Group D: Exercise judgment, take responsibility, and act ethically.	Explanation and Responsibility Level
Outcome 8: Conduct engineering activities ethically.	**Responsibility level E** Ethically means “science of morals; moral soundness”. Moral means “moral habits; standards of behaviour; principles of right and wrong”.
Assessment Criteria: Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: 8.1 Conversance and operation in compliance with ECSA’s Rules of Conduct for registered persons confirmed 8.2 How ethical problems and affected parties were identified, and the best solution to resolve the problem selected.	Systematic means “methodical; based on a system”. 8.1 ECSA’s Code of Conduct, as per ECSA’s website, is known and adhered to. 8.2 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.

Outcome 9: Exercise sound judgement in the course of *broadly-defined* engineering activities	**Responsibility level E** Judgement means “good sense: ability to judge”.
Assessment Criteria: Judgement is displayed by the following performance 9.1 Judgement exercised in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies. 9.2 Factors taken into consideration given, bearing in mind, risk, consequences in technology application and affected parties.	9.1 The extent of a project given to a junior Certificated Engineer is characterised by the several *broadly-defined* and a few *well-defined* factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded. 9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Evaluation includes engineering calculations to substantiate decisions taken, and assumptions made.
Range Statement for Outcomes 8 and 9*:* *Judgement* in decision making involves: (a) taking several risk factors into account; **or** (b) significant consequences in technology application and related contexts; **or** (c) ranges of interested and affected parties with widely varying needs.	In Engineering about 5% of engineering activities can be classified as *broadly-defined* where the Certificated Engineer uses standard procedures, codes of practice, specifications, etc., but develops variations and completely unique standards when needed. Judgement must be displayed to identify any activity falling inside the *broadly-defined* range, as defined above by: (a) Getting the work done in spite of numerous risk factors needs good judgement and substantiated decision making. (b) Consequences are part of the project e.g. extra cost due to unforeseen conditions, incompetent contractors, long term environmental damage, etc. (c) Interested and affected parties with defined needs that may be in conflict e.g. need for a service irrespective of environmental damage, local traditions and preferences, etc. needs sound management and judgement.

Outcome 10: Be responsible for making decisions on part or all of all of one or more *broadly-defined* engineering activities	**Responsibility level E** Responsible means "legally or morally liable for carrying out a duty; for the care of something or somebody in a position where one may be blamed for loss, failure, etc.".
Assessment criteria: Responsibility is displayed by the following performance: 10.1 Engineering, social, environment and sustainable development taken into consideration in discharging responsibilities for significant parts of one or more activities. 10.2 Advice sought from a responsible authority on matters outside your area of competence. 10.3 Academic knowledge of at least BTech level combined with past experience used in formulating decisions[1].	10.1 All interrelated factors taken into consideration are indicative of professional responsibility accepted working on broadly-defined activities. 10.2 The Certificated Engineer does not operate on tasks at a higher level than *broadly-defined* and consult professionals at engineer level if elements of the project to be done are beyond his/her education and experience, e.g. power system stability. 10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction, and corrective action if necessary, forms an important element. The calculations, for example fault levels, load calculations, losses, etc. are done to ensure that the correct material and components are utilized.
Range Statement: Responsibility must be discharged for significant parts of one or more *broadly-defined* engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Demonstrating responsibility would be under supervision of a competent engineering practitioner but is expected to perform as if he/she is in a responsible position.	

Group E: Initial Professional Development (IPD)	**Explanation and Responsibility Level**
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his or her competence	**Responsibility level D**
Assessment Criteria: Self-development managed typically: 11.1 Strategy independently adopted to enhance professional development evident. 11.2 Awareness of philosophy of employer in regard to professional development evident.	11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a program drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and be in charge of experiential development towards Professional Certificated Engineer level.
Range Statement: Professional development involves: (a) Planning own professional development strategy; (b) Selecting appropriate professional development activities; and (c) Recording professional development strategy and activities; while displaying independent learning ability.	(a) In most places of work training is seldom organised by some training department. It is up to the Certificated Engineer to manage his/her own experiential development. Certificated Engineers frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely. (b) Preference must be given to engineering development rather than developing soft skills. (c) Developing a learning culture in the workplace environment of the Certificated Engineer is vital to his / her success. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.

Appendix D: Definitions

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

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

'Ill-posed problem" means problems whose requirements are not fully defined or may be defined erroneously by the requesting party.

"Integrated performance" means that an overall satisfactory outcome of an activity requires several outcomes to be satisfactorily attained, for example a design will require analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.

"Level descriptor" means a measure of performance demands at which outcomes must be demonstrated.

Management of engineering works or activities" means the coordinated activities required to:

(i) direct and control everything that is constructed or results from construction or manufacturing operations;
(ii) operate engineering works safely and in the manner intended;
(iii) return engineering works, plant and equipment to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts;
(iv) direct and control engineering processes, systems, commissioning, operation and decommissioning of equipment;
(v) maintaining engineering works or equipment in a state in which it can perform its required function.

"Over-determined problem" means a problem whose requirements are defined in excessive detail, making the required solution impossible to attain in all of its aspects.

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

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

"Range statement" means the required extent of or limitations on expected performance stated in terms of situations and circumstances in which outcomes are to be demonstrated.

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

Revision History

Version	Date	Revised/Approved by	Nature of Revision
Rev A	10 April 2017	For Approval by the PDSGC	Initial attempt at PCE DSTG based on R-05-ELE/MEC/MIN-PT and R-05-FPSS-SC. Needs editing from Professional Certificated Engineers.
Rev B	12 April 2017	Revised by the Working Group	Revisions to the Discipline-Specific Requirements Report (Form R-05-DSRR-PCE) initiated by Mr Botsane and other minor editing
Rev C	30 April 2017	Revised by the Working Group	Revisions to the entire document initiated by Mr Botsane.
Rev C	5 May 2017	Revised by the Working Group	Revisions proposed by Mr Klopper and Dr Stidworthy incorporated. Emphasis on the Outcomes, Competency Indicators, Range Statements in line with the Broadly-defined definitions confirmed. Option 2 will introduce a unique approach applicable to Professional Certificated Engineers only.
Rev C	3 July 2017	For approval by PDSGC	Approved
Rev c	17 August 2017	For approval by Council	Approved

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