ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Discipline Specific Training Guide (DSTG) for Registration as a Professional Engineer in Mining Engineering

R-05-MIN-PE

REVISION 2: 30 JANUARY 2018

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ECSA

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1. BACKGROUND: ECSA REGISTRATION SYSTEM DOCUMENTS

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

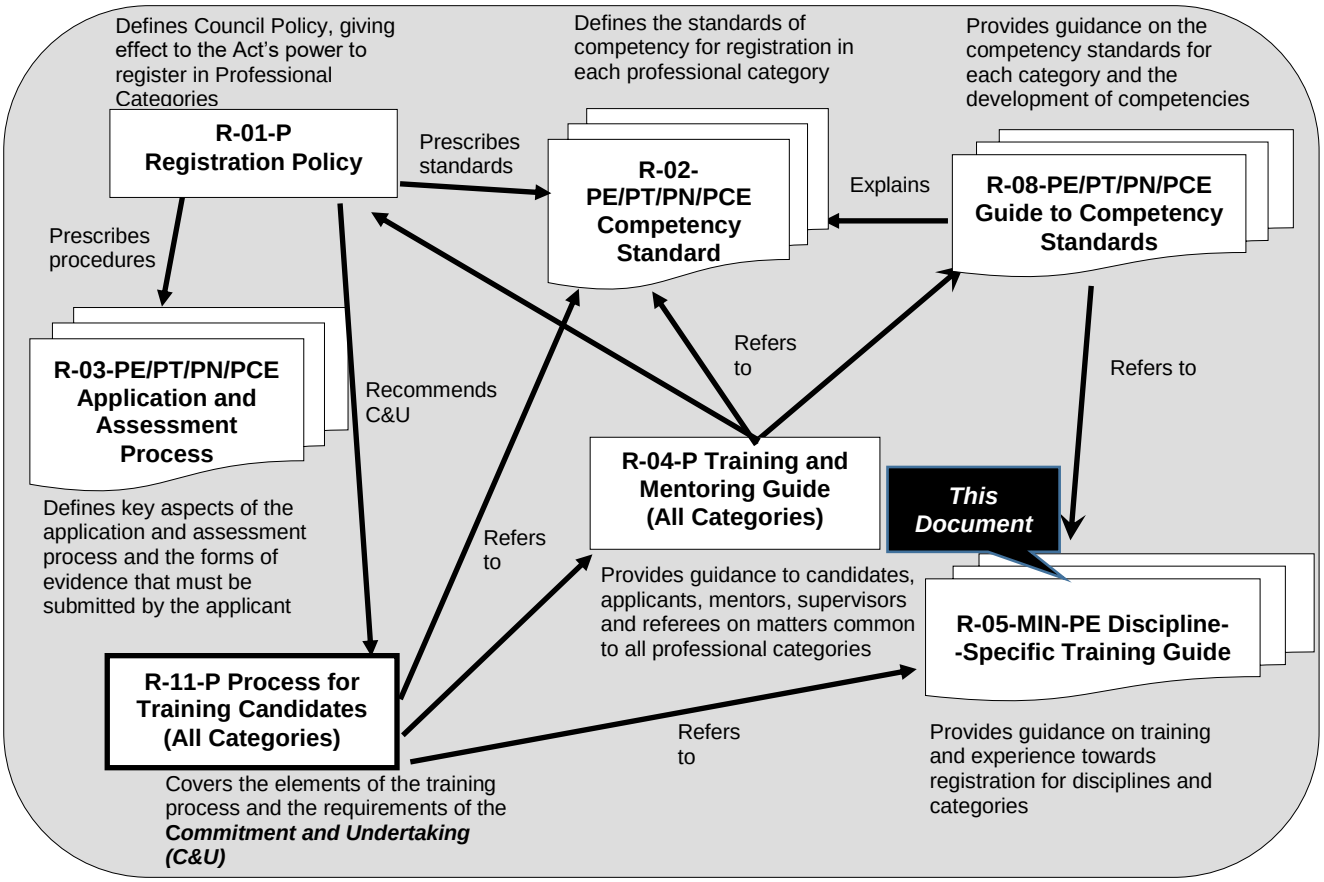

Figure 1: Documents defining the ECSA Registration System

2. PURPOSE

All persons applying for registration as Professional Engineers are expected to demonstrate the competencies specified in document R-02-PE through work performed at the prescribed level of responsibility, irrespective of the trainee's discipline.

This document supplements the generic *Training and Mentoring Guide* (document R-04-P) and

the *Guide to the Competency Standards for Professional Engineers* (document R-08-PE).

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

7.3.2 Duration of training and length of time 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 (document R-08-P) provides a high-level, outcome-by-outcome understanding of the competency standards that form an essential basis for this Discipline-Specific Training Guide (DSTG).

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

3. AUDIENCE

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

This guide applies to persons who have

- completed the tertiary educational requirements in Mining Engineering
  - by obtaining an accredited B.Eng.-type qualification from a recognised tertiary university in South Africa,
  - by obtaining a Washington Accord recognised qualification, or

- through evaluation/assessment;

- registered with the ECSA as a Candidate Engineer; and/or
- embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) programme under the supervision of an assigned mentor guiding the professional development process at each stage.

4. PERSONS NOT REGISTERED AS A CANDIDATE AND/OR NOT TRAINED UNDER COMMITMENT AND UNDERTAKING

Irrespective of the development path followed, all applicants for registration must present the same evidence of competence and be assessed against the same standards. Application for registration as a Professional Engineer is permitted without being registered as a Candidate Engineer and without training under C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration.

If the employer of the trainee does not offer C&U, the trainee should establish the level of mentorship and supervision that the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The Voluntary Association for the discipline may be consulted for assistance in locating an external mentor. A mentor should keep abreast of all stages of the development process.

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

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

5. ORGANISING FRAMEWORK FOR OCCUPATIONS

Mining Engineering (Organising Framework for Occupations (OFO) 214600)

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

5.1 Typical tasks performed by the Mining Engineer

Tasks performed by the Mining Engineer include one or more of the following:

- all levels of feasibility studies, life-of-mine extraction strategies, bankable studies and business plans based on best practice standards for mining ventures;
- design, planning and scheduling of mines for the extraction of metals and minerals, including technical and infrastructure support services, occupational health and safety requirements and environmental considerations;
- establishment and operation of mines with due regard to legislation, operation controls and standards, occupational health and safety, and site-specific and socio-political requirements;
- fundamental and operational research to identify new technologies, mining methods and systems and operating systems to improve safety and health, productivity, sustainability and social responsibility; and
- education and training of future Mining Engineers.

5.2 Typical practice areas for Mining Engineers

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

- Operation of mines
- Rock Engineering and Strata Control
- Occupational health and safety and Environmental Engineering

- Mine planning and design
- Mineral asset valuation
- Education and training of Mining Engineers
- Consultancy

5.2.1 *Mining Engineering: Mine operations*

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

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

5.2.2 *Rock Engineering*

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

- the basic mining process, including mine design, programming and scheduling and occupational health and safety;

- rock engineering designs and specifications applicable to mine layouts and mining methods, including stability of mine excavations, support design and installation;
- rock engineering hazards, risk identification and amelioration;
- support and training of subordinates and mine production personnel in the rock engineering aspects of safe mining;
- project design and execution principles; and
- research and development.

5.2.3 *Occupational Environmental Engineering*

In the field of mine ventilation and occupational hygiene, the Mining Engineer must demonstrate competence in

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

5.2.4 *Mine planning and design*

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

- the engineering criteria of mine design, including criteria relating to rock, ventilation and occupational health and safety;
- design and planning of mines and mine layouts and the impacts on production levels in addition to rock and ventilation engineering requirements, logistics, ore clearance, mine services, equipment requirements and productivity;
- mineral resource management, including the conversion of mineral resources to mineral reserves;
- life of mine: long- and short-term production forecasting;
- mine business cycles, including the strategic and the tactical mine design and planning process;
- mining value chain, business optimisation and Value Engineering;
- design, planning and scheduling, risk identification and amelioration; and
- project design and execution principles.

5.2.5 *Mineral asset valuation*

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

- the basic mining process, including mine design, programming, scheduling and occupational health and safety;
- appreciation of geological evaluation techniques and models and interpretation of mine planning outcomes;
- determination and classification of mineral resources and reserves;
- mine economics in regard to commodity prices, capital and operating cost, cash flow, return on investment and business modelling;
- technical and financial risk assessment on project and operations; and
- project design and execution principles.

5.2.6 *Research and development*

In the field of research and development, the Mining Engineer must demonstrate competence in the use of mining engineering knowledge to

- improve mining safety and health performance;
- improve operational efficiency and productivity;
- solve complex mine design, rock engineering and mine ventilation problems;
- develop and/or apply new technologies for mining methods, layouts and machinery; and
- modernise and automate mines and mining methods.

5.2.7 *Education and training*

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

- training undergraduate and postgraduate Mining Engineers and Mining Technologists;
- performing the duties of a supervisor as set out in document R-04-P; and
- performing the duties of a mentor as set out in document R-04-P.

5.2.8 *Consulting*

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

6. NATURE AND ORGANISATION OF THE INDUSTRY

Mining Engineers may be employed in either the private or the public sector.

In the private sector, Mining Engineers would typically be involved in consulting and contracting in supply and manufacturing organisations. Mining engineering consultants are responsible for

planning, designing, documenting and overseeing the construction of projects on behalf of their clients. Mining engineering contractors are responsible for project implementation, and their activities include planning, construction and labour and resource management. Mining Engineers working in supply and manufacturing companies are involved in production, supply and quality control of equipment and machinery and could be involved in research and development. An extension of the public sector includes tertiary academic institutions and research organisations.

Depending on where the candidate is employed, there may be situations in which the in-house opportunities are not sufficiently diverse to develop all the required competencies that are noted in groups A and B in document R-02-PE. For example, the opportunities for developing problem-solving competence (including design and the development of solutions) and for managing engineering activities may not be available to the candidate through their direct employers. In such cases, employers are encouraged to implement a secondment system.

It is fairly common practice that for situations in which organisations are not able to provide training in certain areas, secondments are arranged with other organisations so that candidates are able to develop all the competencies required for registration. Such secondments are usually of a reciprocal nature so that both employers and their respective employees mutually benefit from the other party. Secondments between consultants and contractors and between the public and the private sector should be possible.

Problem-solving in the environments of design, operation, construction and research is the core competence of the Mining Engineer. It is a logical thinking process that requires engineers to apply their minds diligently in bringing solutions to technically complex problems. This process involves the analysis of systems and the integration of various elements of Mining Engineering through the application of basic and engineering sciences.

6.1 Diversity of mining

Owing to the diversity in the application of Mining Engineering within the South African mining industry, Mining Engineers can follow various routes to registration across multiple minerals/commodities (e.g. precious metals, precious stones, ferrous metals and coal) in differing

mining-method environments (e.g. surface mining, narrow tabular ore body underground mining, massive ore body underground mining and underground coal mining).

After graduation as a Candidate Mining Engineer, these routes to registration usually cover a period of operational experience that leads to specialisation in a particular field or sector of the South African mining industry. Typically, these fields include mining operations, mine planning and design, Rock Engineering/Strata Control, Ventilation and Occupational Environmental Engineering, Refrigeration Engineering, techno-economic evaluation, equipment selection, establishment and maintenance of mining infrastructure, provision of mining consulting services, and education and training of engineers-in-training.

Each field has been covered above, but all the supplementary elements may not have been mentioned after each heading. The objective is that the Mining Engineer becomes a well-rounded Engineer.

7. DEVELOPING COMPETENCY: ELABORATING ON SECTIONS IN THE GUIDE REGARDING COMPETENCY STANDARDS (DOCUMENT R-08-PE)

7.1 Contextual knowledge

Applicants are expected to be aware of the requirements of the engineering profession, the Voluntary Associations that are applicable to the Mining Engineer and the functions and services that these associations render to members.

7.2 Functions performed

Special consideration in the discipline, sub-discipline or specialty must be given to the competencies specified in the following groups:

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

- Judgement and responsibility
- Independent learning

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

Appendix 1 presented below has been developed against the Degree of Responsibility Scale. Activities should be selected to ensure that the candidate reaches the required level of competency and responsibility.

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

7.3 Statutory and regulatory requirements

Candidates are expected to have a working knowledge of the regulations and Acts and how the legislation affects their working environment:

- Engineering Profession Act, No. 46 of 2000, its rules and the Code of Conduct
- Occupation Health and Safety Act as amended by Occupation Health and Safety Act, No. 181 of 1993 (OHSA) – latest revision used
- Labour Relations Act, No. 66 of 1995
- National Environmental Act, No. 107 of 1988
- Environment Conservation Act, No. 73 of 1989 as amended by Environment Conservation Act, No. 52 of 1994 and Environment Conservation Amendment Act, No. 50 of 2003
- Water Services Act, No. 108 of 1997
- National Water Act, No. 36 of 1988
- Mine Health and Safety Act, No. 29 of 1996
- Minerals Act, No. 50 of 1991 and regulations

- Minerals and Petroleum Resources Development Act, No. 28 of 2002
- Mining Charter
- Mandatory Codes of Practice
- SANS applicable specifications and other related mining standards
- Chief Inspector of Mines: Directives/Instructions
- Chief Inspector of Mines: Guidelines.

Other Acts not listed here may also be pertinent to a candidate's work environment. Candidates are expected to have a basic knowledge of the relevant Acts and to investigate whether any Acts are applicable to their particular work environment.

7.4 Desirable formal learning

The following includes useful courses for formal learning:

- Formally registered Continuing Professional Development (CPD) courses
- Project Management (basic)
- Value Engineering
- Negotiation Skills
- Engineering Finance
- Hazard Identification and Risk Assessment (HIRA, HAZOP)
- Quality Systems
- Environmental Impacts
- Management
- Report Writing
- Planning Methodology and Technique
- Systems Engineering
- Public Speaking

8. PROGRAMME STRUCTURE AND SEQUENCING

8.1 Best practices

There is no ideal training programme structure or unique sequencing that constitutes best practice. The training programme for each candidate depends on the available work opportunities at the time that are assigned to the candidate by the employer.

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

The training programme should be such that the candidate progresses through the levels of work capability described in section 7.3.4 of document R-04-P so that by the end of the training period, the candidate exhibits a Level E Degree of Responsibility and is able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

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

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

Examples are as follows:

- Technology selection
- Process simplification
- Classes of facility quality
- Waste minimisation
- Energy optimisation

- Process reliability modelling
- Customisation of standards and specifications
- Predictive maintenance
- Design to capacity
- Value Engineering
- Constructability

8.2 Realities

The minimum period for the Candidacy Phase is stated by the ECSA as three years. The likelihood, however, is that the period of training will be longer. This time frame is determined by the availability of opportunities and the exposure to various functions in the actual work environment.

Irrespective of the route followed, the overriding consideration is that the applicant must provide evidence of competence against the standard and provide objective evidence of meeting the 11 specified outcomes.

8.3 Generalists, specialists, researchers and academics

Section 10 of document R-08-PE adequately describes what is expected of persons whose formative development has not followed a conventional path, for example, academics, researchers and specialists.

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

8.4 Orientation requirements

For the Candidate Engineer starting a career with an employer, the basic introduction to the company's functions is usually performed during the first months of employment. The induction

process usually includes the following aspects:

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

8.5 Moving into or changing candidacy training programmes

This guide assumes that the candidate enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the candidate is supervised and mentored by persons who meet the requirements stated in section 7.2 of document R-04-P. In the case of a person changing from one candidacy programme to another or moving into a candidacy programme from a less structured environment, it is essential that the following steps are completed:

- The candidate must complete the Training and Experience Summary (TES) and the Training and Experience Reports (TERs) for the previous programme or unstructured experience. In the latter case, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant supervisor or mentor.
- On entering the new programme, the mentor and supervisor should review the candidate's development while being mindful of the past experience and opportunities and the requirements of the new programme. At minimum, the mentor and supervisor should plan the next phase of the candidate's programme.

REVISION HISTORY

Revision Number	Revision Date	Revision Details	Approved By
Rev 0: Concept A	01 Nov 2011	Drafting of point 3	Dr Gordon Smith
Rev 0: Concept B	02 Jul 2012	New draft of template	HH
Rev 0: Concept C	18 Sep 2012	New draft of template	PAC (Mining)
Rev 0: Concept D	29 Oct 2012	Standard section 1–3 inserted, formatted	PAC (Mining)
Rev 0: Concept E	22 Feb 2013	Total review/editing of document	PAC (Mining)
Rev 1	12 Mar 2013		Registration Committee for Professional Engineers
Rev 2	11 Jan 2018	As per approved DSTG Framework	Mike Rogers
Rev 2	30 Jan 2018	Approval	PDSGC

The Discipline-Specific Training Guide (DSTG) for:
Registration as a Professional Engineer in Mining Engineering

Revision 2 dated 30 January 2018 and consisting of 21 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Policy Development and Standards Generation (PDSG).

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Business Unit Manager

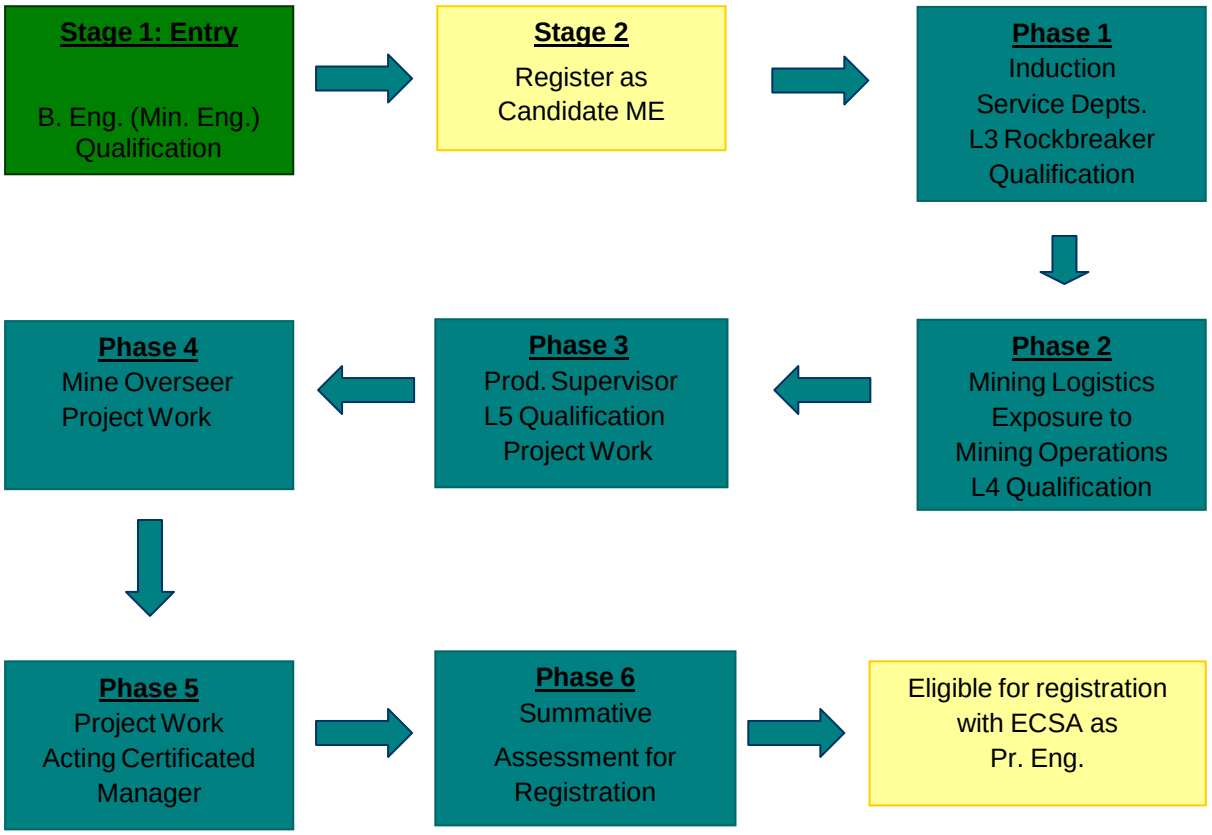
30/05/2018
Date

.....
Executive: **PDSG**

30/5/2018
Date

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

APPENDIX 1: PHASED APPROACH FOR PDPs



APPENDIX 2: TRAINING ELEMENTS

	Occupational		Work Experience	Scope of Work Experience
	Tasks	Contexts		
1	Solving problems based on engineering and contextual knowledge			
1.1		Conceptualisation of complex engineering problems		
1.1.1			Receive brief	
1.1.2			Investigate/evaluate requirements	
1.1.3			Develop preliminary solutions	
1.1.4			Justify the preliminary design	
1.2		Design or development processes for complex engineering problems		
1.2.1			Detailed design or development processes	
1.2.2			Documentation development for implementing complex engineering solutions	
2	Implementing or operating engineering projects, systems, products and processes			
2.1		Planning processes for implementation or operations		
2.1.1			Develop business and stakeholder relationships	
2.1.2			Scope and plan	
2.2		Organising processes for implementation or operations		
2.2.1			Manage resources	
2.2.2			Optimise resources and processes	
2.3		Controlling processes for implementation or operations		
2.3.1			Monitor progress and delivery	
2.3.2			Monitor quality	
2.4		Close-out processes for implementation or operations		
2.4.1			Commissioning processes	
2.4.2			Development of operational documentation	
2.4.3			Hand-over processes	
2.5		Maintenance and repair processes		
2.5.1			Maintenance planning and scheduling	
2.5.2			Monitoring quality	
2.5.3			Overseeing repairs and/or implementing remedial processes	
3	Risk and impact mitigation			
3.1		Impact and risk assessments		
3.1.1			Impact assessments	
3.1.2			Risk assessments	
3.2		Regulatory compliance processes		
3.2.1			Health and safety	
3.2.2			Legal and regulatory	
4	Managing engineering activities			
4.1		Self-management processes		
4.1.1			Manages own activities	
4.1.2			Communicates effectively	
4.2		Team environment		
4.2.1			Participates in and contributes to team planning activities	
4.2.2			Manages people	
4.3		Professional communication and relationships		
4.3.1			Establishes and maintains professional and business relationships	
4.3.2			Communicates effectively	
4.4		Exercising judgement and taking responsibility		

4.4.1			Ethical practices
4.4.2			Exercises sound judgement in the course of complex engineering activities
4.4.3			Is responsible for decision-making in some or all complex engineering activities
4.5		Competency development	
4.5.1			Plans own development strategy
4.5.2			Constructs initial professional development record

NOTE: The phases of the PDP and the Training Elements are works in progress.