ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Discipline-specific Training Guideline for Candidate Engineers in Metallurgical Engineering			
Status: Approved by Registration Committee for Professional Engineers			
Document : R-05-MET-PE	**Rev-1**	**12 March 2013**	

Background: ECSA Registration System Documents

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

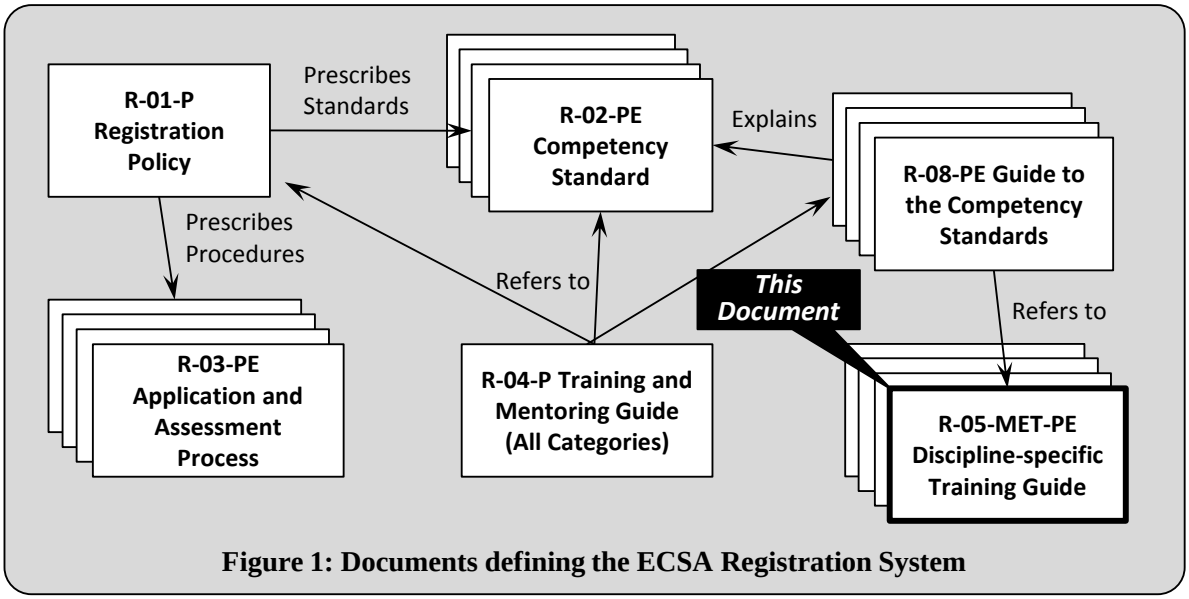

Figure 1: Documents defining the ECSA Registration System

1. Purpose

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

This document supplements the generic *Training and Mentoring Guide* 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 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-P provides both a high-level and outcome-by-outcome understanding of the competency standards as an essential basis for this discipline specific guide.

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

2. Audience

This Guide is directed to candidates and their supervisors and mentors in the discipline of Metallurgical Engineering. The Guide is intended to support a programme of training and experience incorporating good practice elements.

This guide applies to persons who have:

1. Completed the education requirements by obtaining an accredited BEng-type qualification, or a Washington-Accord Recognised qualification or through evaluation/assessment;
2. Registered as Candidate Engineers;
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, irrespective of the development path followed. Application for registration as a Professional Engineer is permitted without being registered as a Candidate 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 Voluntary Association for the discipline should be consulted for assistance in locating an external mentor. A mentor should be in pace at all stages of the development process.

This guide is written for the recent graduate who is training and gaining experience toward registration. Mature applicants for registration may apply the guide 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 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 (see section 7.3).

4. Metallurgical Engineering

Extractive Metallurgical Engineer (OFO 214603)

Extractive Metallurgical Engineering: perform research, plan, design, develop, and operate commercial-scale processes for the extraction of metals or intermediate compounds from ores by chemical or physical processes, including those at high temperatures.

Typical Tasks that an *Extractive Metallurgical Engineer* may undertake include:

- Conducting research, developing methods of extracting metals from their ores and advising on their application
- Design, development and implementation of process projects
- Operation and optimisation of process plants

Practising *Extractive Metallurgical Engineers* generally concentrate in one or more of the following fields:

Lecturer / Researcher
Technical
Projects / Commercial
Operations

and sub-disciplines:

Mineral Processing
Pyrometallurgy
Hydrometallurgy

Metallurgical and Materials Engineer (OFO 214605/214907)

Metallurgical and Materials Engineers perform research, analysis, design, production, characterisation, failure analysis and application of materials, including metals, for engineering applications based on an understanding of the properties of matter and engineering requirements.

Typical Tasks that a *Metallurgical and Materials Engineer* may undertake include:

- Develop, control and advise on processes used for casting, alloying, heat treating or welding of metals, alloys and other materials to produce commercial metal products or develop new alloys, materials and processes, evaluate and specify materials for engineering applications, and do quality control and failure analyses.
- Investigate properties of metals and alloys, develop new alloys and advise on and supervise technical aspects of metal and alloy manufacture, processing, use and manufacturing.
- Do residual life evaluations and predictions, failure analyses, and prescribe remedial actions to avoid material failures.

Practising *Metallurgical and Materials Engineers* generally concentrate in one or more of the following areas:

- Physical Metallurgist
- Materials Engineer
- Welding Engineer
- Corrosion Engineer
- Quality Assurance Engineer

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

Since the metallurgical engineering industry encompasses a wide field of activity, ranging from extractive metallurgy to physical metallurgy, it is not realistic to expect that all training programmes

should cover the same field. However, it is recognised that a metallurgical engineer is usually employed in an organisation operating in one or more of the following fields:

1. Metallurgical Plant Operation / Optimisation
2. Specification, Design, and Commissioning of Metallurgical Plants / Components
3. Research, Development, Technology transfer and Consulting

The CE should have sound training in at least one of these fields and insight in preferably all three fields. Ideally the CE should start in field 1. Field 1 generally allows some exposure to fields 2 and 3. Experience in field 1 allows improved progress in fields 2 and 3.

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

6.1 Contextual Knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The Voluntary Associations applicable to the Metallurgical Engineer and their functions and services to members, for example, provide a broad range of contextual knowledge for the Candidate Engineer through the full career path of the registered Engineer.

The profession identifies specific contextual activities that are considered essential to the development of competence of the Mechanical Engineers. These include awareness of basic analytical, process and fabrication activities, as applicable, and the competencies required of the technologist, technician and artisan. Exposure to practice in these areas will be identified in each programme within the employer environment.

The Professional Advisory Committee (Metallurgical) of ECSA carries out the review of the Candidate's portfolio of evidence at the completion of the training period.

6.2 Functions Performed

6.2.1 Metallurgical Plant Operation / Optimisation

It should be mentioned that one of the most useful ways in which the CE can gain experience is to be a member of a team responsible for the commissioning of a new or modified plant. Routine operation of existing plants will be considered as sufficient training, provided that as many of the following facets as possible are covered, with emphasis being placed on those that are particularly relevant to the operation:

1.1 Measurement and analysis of performance data;
1.2 Material and energy balances;
1.3 Process plant operation, especially with direct and increasing responsibility for certain sections of the plant;
1.4 Quality control in respect of measurement and specifications;
1.5 Plant records and operating costs;
1.6 The selection and application of instrumentation;
1.7 Optimization and control of the process to improve performance;
1.8 The principles of industrial engineering practice, including the critical study of work methods and the development of more effective techniques for recognizing real and significant problems and how to solve them;

1.9 Safety, and the acceptance of the principle that an engineer may not endanger the life and limb of people through negligence;

1.10 Inter-relationships between engineering personnel and management, and between the members of the engineering team; especially between production and maintenance

1.11 The impact that the operation may have on the environment;

1.12 Involvement in sound financial business concepts ranging from budgeting to feasibility studies;

6.2.2 Specification, Design, Erection and Commissioning of Plants and Components

Training in this field should contain elements of each of the following three sub-sections:

2.1 Process Plant Development - laboratory, pilot, or full-scale plant work primarily aimed at obtaining engineering data for the specification and design of new metallurgical plants or the improvement of existing plants;

2.2 Plant Design - preparation of flow sheets and material and energy balances, appreciation of the operation of a drawing office and an engineering purchasing office, checking of working drawings for suitability with respect to the particular metallurgical operation, specification, design and selection of equipment, and service requirements, consideration of the design with regard to materials used,

economics, instrumentation, quality control, logistics, safety, acceptable operation conditions, spillage management and the effect on the environment;

2.3 2.4 Commissioning - measurement and analysis of actual performance data versus design parameters, responsibility for performance of the plant, optimization of plant performance, review of all safety standards, operability of the plant, sound labour relations and practices and managerial aspects.

6.2.3 Research, Development, Technology Transfer and Consulting

Research, Development, Technology Transfer and Consulting would include any of the following sub-disciplines:

- Mineral Processing
- Hydrometallurgy
- Pyrometallurgy
- Materials engineering and other physical metallurgy sub-disciplines

Graduate metallurgical engineers employed in research, development, technology transfer and consulting should gain experience in as many of the following facets as possible:

3.1 Develop a clear understanding of the problem/opportunity to be investigated by conducting a critical analysis of the literature and other relevant information, and assembling of the documentation on the subject in an organised manner;

3.2 Motivation, planning and design of the research project and its associated equipment and/or plant;

3.3 Theoretical or paper investigations;

3.4 Laboratory-scale investigation;

3.5 Investigations on a pilot plant and/or industrial plant scale;

3.6 Interpretation of results, and ensuring that results are meaningful and have been correctly obtained in accordance with scientific principles;

3.7 Data processing and analysis;

3.8 Studies of technical and economic feasibility;

3.9 Compilation of the results into a written report and presentation of verbal reports;
3.10 Safety aspects with respect to the handling of hazardous materials, and selection of instrumentation and equipment;
3.11 Spillage management and the effect on the environment;
3.12 Operational staff training and acceptable operating conditions;
3.13 Technology transfer to ensure that the maximum benefit is obtained from the research and development effort.
Consulting will generally bring together the majority of the aspects listed under 5.2.1, 5.2.2 and 5.2.3.

6.3 Industry-related statutory requirements

The Candidate Engineer should be aware of the requirements for safety appointments in terms of the occupational Health and Safety Act for plant managers.

6.4 Recommended Formal Learning Activities

Attendance of relevant technical courses and conferences is recommended. Formal safety training should be mandatory.

7. Programme Structure and Sequencing

7.1 Realities

There is no ideal training programme structure or a unique sequencing that constitutes best practice.
The training programme for each candidate will depend on the work opportunities available at the time for the employer to assign to the candidate. What is expected for ECSA registration is that in whatever area they are employed, applicants ensure that they undertake tasks that provide experience in the 3 generic engineering competence elements: problem investigation and analysis; problem solution; execution/ implementation. It should be possible, by judicious selection of work task opportunities with the same employer, to gain experience in all three elements. Candidate Engineers are advised that although 3 years is the minimum period of experience following graduation, in practice it is found that very seldom do metallurgical engineers meet the experience requirements in three years, and then only if they have followed a structured training program. Applicants are advised to gain at least 5 years of experience before applying.

7.2 Considerations for generalists, specialists, researchers and academics

To be able to become a professional engineer the lecturer / researcher must become involved in the application of engineering knowledge by way of applied research and consulting work under the supervision of a professional engineer.

For generalists and specialists, provided that the applicant's specialist knowledge is at least at the level of a master’s degree and provided that the applicant has demonstrated the ability, at a professional level, to identify engineering problems, and to produce solutions which can be satisfactorily implemented, a degree of trade-off may be acceptable in assessing the experience. Where an applicant's experience is judged to be in a narrow specialist field, a minimum of five years' experience after obtaining the bachelor degree in engineering will be required, but each application will be considered on merit.

7.3 Moving into or Changing Candidacy 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 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 structure environment, it is essential that the following steps be completed:

- The candidate 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'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.

Revision History

Version	Date	Revised/Approved by	Nature of Revision
Rev 0: Concept A	2 Jul 2012		Inital draft in new template
Rev 0: Concept B	1 Nov 2012		Standard sections 1-3 inserted. Formatted.
Rev 1	12 Mar 2013	Registration Committee for Professional Engineers	