ENSURING THE
EXPERTISE TO GROW
SOUTH AFRICA

Guide to the Competency Standards for Registration as a Professional Engineer

R-08-PE

REVISION 2: 22 May 2018

ENGINEERING COUNCIL OF SOUTH AFRICA
Tel: 011 6079500 | Fax: 011 6229295
Email: engineer@ecsa.co.za | Website: www.ecsa.co.za

TABLE OF CONTENTS

1. PURPOSE 2
2. INTRODUCTION TO COMPETENCY, STANDARDS AND PERFORMANCE 3
3. OUTCOMES FOR PROFESSIONAL REGISTRATION 4
4. OVERVIEW OF THE OUTCOMES 4
5. DEMONSTRATING THE ACHIEVEMENT OF OUTCOMES FOR PROFESSIONAL REGISTRATION 6
6. DEFINING ENGINEERING ACTIVITIES 6
   7.1. Outcome 1 7
   7.2. Outcome 2 9
   7.3 Outcome 3 12
8. GROUP A: KNOWLEDGE-BASED ENGINEERING PROBLEM-SOLVING 13
   8.1 Outcome 4 13
   8.2 Outcome 5 15
9. GROUP B: MANAGING ENGINEERING ACTIVITIES 16
   9.1 Outcome 6 16
   9.2 Outcome 7 17
10. CANDIDATES WHO HAVE COMPLETED ADVANCED DEGREES 18
   10.1 Outcome 8 18
   10.2 Outcome 9 19
   10.3 Outcome 10 20
11. GROUP D: EXERCISING JUDGEMENT AND TAKING RESPONSIBILITY 21
   11.1 Outcome 11 21
12. GROUP E: PROFESSIONAL DEVELOPMENT 23
REVISION HISTORY 24
APPENDIX A: GENERAL AND SPECIFIC ENGINEERING LEGISLATION 25

LIST OF TABLES

Table 1: Overview of outcomes 23
Table 2: Test for a complex engineering problem 8

LIST OF FIGURES

Figure 1: Documents defining the ECSA Registration System 23
Figure 2: Summary of the 11 outcomes 6

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 below. The grey text box indicates the current document.

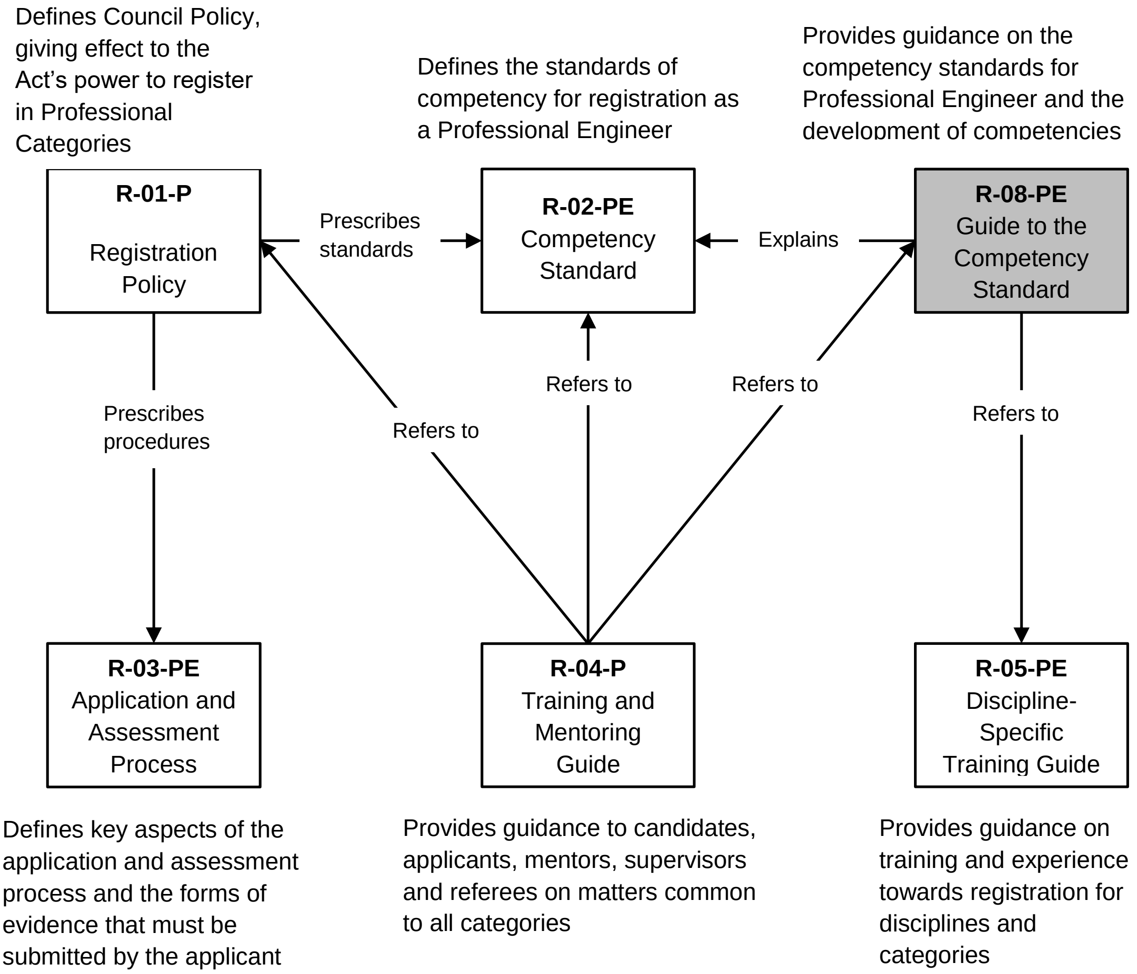

Figure 1: Documents defining the ECSA Registration System

1. PURPOSE

This guide amplifies the general training and mentoring guide (document **R-04-P**), concentrating on an understanding of the competency standards for Professional Engineers that are defined in document **R-02-PE**. This guide (document **R-08-PE**) can be used to determine if an applicant is ready for professional registration. In addition, the document indicates ways of developing the requisite competencies and how the competencies can be demonstrated through engineering work. This guide may, in turn, be supplemented by the Discipline-Specific Training Guide, document **R-05-PE**, if available for the applicant's discipline.

The intended audience of this guide includes applicants undergoing training towards professional registration and their mentors and supervisors. Document **R-08-PE** is also an important document for persons registered as Professional Engineers who serve as assessors, moderators and reviewers of applicants applying for registration.

2. INTRODUCTION TO COMPETENCY, STANDARDS AND PERFORMANCE

What is the competency of a Professional Engineer? In general, *competence* is defined as possession of the necessary *knowledge*, *skills* and *attitudes* to perform the activities within the professional category to the standards expected in independent employment or practice.

The knowledge component of competency consists of knowledge from the engineering education process and knowledge that is subsequently acquired during specialised engineering-related activities. The skills and attitude components are defined by a set of assessable outcomes.

The ECSA document **R-02-PE** provides the formal definition of the competence that must be demonstrated in order to be registered as a Professional Engineer. The standard applies to all engineering disciplines and specialities. Contexts and functions in which competency may be developed and the outcomes demonstrated may be described in the applicable Discipline-Specific Training Guide.

According to the Competency Standard, document **R-02-PE**, competence must be demonstrated

- **within** complex engineering activities;
- ***by*** the *integrated performance* of the outcomes; and
- ***at*** the *level defined* for each outcome.
-

This guide enlarges on the outcomes, the level of performance and the integrated performance required of an applicant for registration as a Professional Engineer.

3. OUTCOMES FOR PROFESSIONAL REGISTRATION

Eleven outcomes must be demonstrated by applicants in order to be considered for professional registration. The following section should be consulted by applicants and used as a rubric to determine if they are receiving the necessary exposure. Assessors, moderators and reviewers specifically use these outcomes to evaluate applicants' applications for professional registration.

4. OVERVIEW OF THE OUTCOMES

The outcomes required for professional registration as outlined in document **R-02-PE** are summarised in Table 1 below.

Table 1: Overview of outcomes

GROUP	OUTCOME	DESCRIPTION
Group A Knowledge-Based Engineering Problem-Solving	**1**	Define, investigate and analyse complex engineering problems
	2	Design or develop solutions to complex engineering problems
	3	Comprehend and apply advanced knowledge of the widely applied principles that underpin good engineering practice, specialist knowledge and knowledge specific to the jurisdiction and local conditions
Group B Managing Engineering Activities	**4**	Manage part or all of one or more complex engineering activities
	5	Communicate clearly with others in the course of the engineering activities
Group C Risk and Impact Mitigation	**6**	Recognise and address the reasonably foreseeable social, cultural and environmental effects of complex engineering activities
	7	Meet all legal and regulatory requirements and protect the health and safety of persons in the course of the complex engineering activities
Group D Exercising Judgement and Taking Responsibility	**8**	Conduct engineering activities ethically
	9	Exercise sound judgement in the course of complex engineering activities
	10	Be responsible for making decisions on part or all of the complex engineering activities

Group E Professional Development	**11**	Undertake Professional Development that is sufficient to maintain and extend competence

As described in document **R-02-PE**, the outcomes do not stand alone, and the performance of the outcomes must be integrated successfully. Competent engineering work invariably requires the simultaneous performance of several of the actions embodied in the outcomes.

Outcomes 1, 2, 4 and 5 capture the essential functions of Professional Engineers, which include analysing and solving problems and managing processes, projects and operations to deliver results, all of which are supported by communication. To perform these four core functions, engineers rely on fundamental and specialised engineering knowledge and knowledge of the context in which the work takes place.

Outcome 3 reflects the importance of engineering knowledge: This is the essence of engineering work.

While solving problems and managing processes, the Professional Engineer must be able to identify and deal with the impacts of the solutions and the applicable regulatory requirements as reflected in Group C (outcomes 6 and 7).

There are a number of attributes that are not necessarily taught or necessarily part of the education component but are essential at a personal level. The Professional Engineer must act ethically, exercise judgement and take responsibility as reflected in Group D (outcomes 8, 9, 10).

Outcome 11, shown as an underpinning layer to all the other outcomes, emphasises the need to develop professionally, that is, to increase knowledge and to gain the required competencies for the effective performance of engineering work.

An alternative visualisation of the set of 11 outcomes is given in Figure 2 below. Problem-solving (analysis and synthesis) is seen in the central position, with competencies being represented by other outcomes as supporting roles.

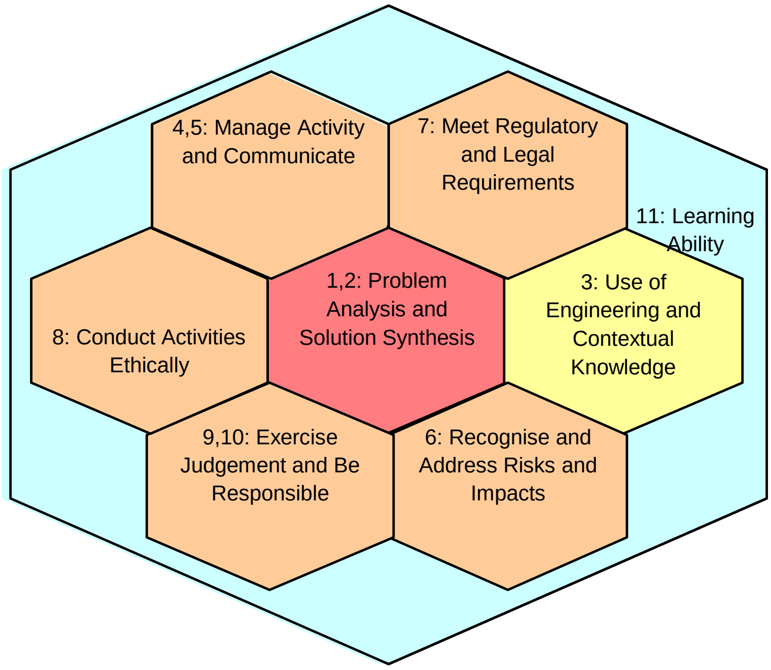

Figure 2: Summary of the 11 outcomes

5. DEMONSTRATING THE ACHIEVEMENT OF OUTCOMES FOR PROFESSIONAL REGISTRATION

All the outcomes defined in document **R-02-PE** and summarised in Table 1 of this document may arise from work demonstrating varying levels of demand and responsibility. At what level must a person demonstrate the defined outcomes to be judged competent to register as a Professional Engineer? Two level-defining phrases are presented as having specific meanings in the Competency Standard document **R-02-PE**:

- defines a set of level descriptors for a complex engineering problem; and
- defines the level descriptors that allow an engineering activity to be classified within complex engineering activities.

6. DEFINING ENGINEERING ACTIVITIES

The Competency Standard, document **R-02-PE**, takes a broad view of defining engineering activities, listing several possible functions such as design; planning; investigation and problem resolution; improvement of materials, components, systems and processes; implementation, construction, manufacture and engineering operations; maintenance; project management; research; development; and commercialisation.

The Discipline-Specific Training Guideline **R-05-PE** should be consulted for the types of activities that a candidate needs to perform to demonstrate competence.

In summary, evidence of competent performance has two essential requirements:

- Capability to *perform a number of defined actions* must be demonstrated.
- Performance must be at or exceed a *specified level of demand*.

The defined actions are the outcomes, and the level of performance is defined by the specification for the demands of the engineering activities and the nature of the problem-solving. In a professional field, evidence of competent performance is obtained from the competent performance of substantial engineering tasks by the person being assessed. Typical tasks provide evidence of several outcomes, and the assessment of activities/knowledge is holistic.

Document **R-03-PE** identifies areas of change from the training-based requirements to output-based competency standards and the accompanying changes in the preparation of applications and assessments of competency.

7.1. Outcome 1

Problem-solving is a process carried out by individuals or teams to bring about a change from a given state to a desired state by means of multistep or multipath activities with barriers that must be overcome through using knowledge and abilities and taking situational requirements into account. Engineering problem-solving relies on the fundamental engineering sciences and specialised engineering knowledge. Proficiency in solving engineering problems at the level described as *complex* is a characteristic of the competency of a Professional Engineer.

Problem-solving is the common thread that runs through engineering activities and is required in many engineering fields including design, planning, implementing and constructing, operating engineering systems, infrastructure and plants. Competency in problem-solving has two phases, analysis and solution synthesis, as captured in outcomes 1 and 2 of document **R-02-PE**. Because engineering problem-solving is knowledge-based, Outcome 3 is grouped with outcomes 1 and 2. However, Outcome 3 also supports other outcomes in line with the notion of integrated performance as described in document **R-02-PE**.

Complex engineering problem-solving is perhaps the best starting point for an applicant to determine the level at which they are working. Complex engineering problem-solving must be demonstrated for an applicant to be considered for professional registration. Applicants who are unsuccessful in their application are often either not performing at the required level of complexity of problem-solving or have not conveyed it appropriately in the reports and in the review process.

An applicant should refer to the suggested test for a complex engineering problem that is recorded in the document **R-02-PE**. The test is based on the four logical steps illustrated in Table 2. If there is one or more affirmative answers at each step, the problem is classified as a complex engineering problem.

Table 2: Test for a complex engineering problem

STEP	MAIN QUESTION	CRITERIA
Step 1 Identify the engineering problem	Is the problem an engineering problem?	a) Does solving the problem require in-depth fundamental and specialised engineering knowledge?
Step 2 Establish the level of complexity of the initial problem state	What is the nature of the problem? Does it have ***one or more*** of the characteristics **b**, **c** and **d**?	b) The problem is ill-posed, under- or over specified and requires identification and refinement.
		c) The problem is a high-level problem and includes component parts or sub-problems.
		d) The problem is unfamiliar or involves infrequently encountered issues.
Step 3 Determine the complexity of the solution path from the initial state	What is encountered in the solution process? Do the solutions have ***one or more*** of the characteristics **e**, **f**, **g** and **h**?	e) The solutions are not obvious and require originality or analysis based on fundamentals.
		f) The solutions are outside the scope of standards and codes.
		g) The solutions require information from a variety of sources that are complex, abstract or incomplete.

STEP	MAIN QUESTION	CRITERIA
		h) The solutions involve wide-ranging or conflicting issues such as technical and engineering issues and interested or affected parties.
Step 4 Determine the level of decision-making required and potential consequences	What is involved in the decision-making while solving the problem and evaluating the solution? Does it have ***one or more*** of the characteristics **i** and **j**?	i) Decisions require judgement in decision-making in uncertain contexts. j) Decisions have significant consequences in a range of contexts.

7.2. Outcome 2

At the end-point of training, applicants must demonstrate these three competencies through their work. The starting point for training is the level of problem-solving ability of the new graduate. The applicant is expected to produce the same level of problem-solving but in a work environment rather than within academia. The applicant must develop problem-solving abilities in an environment in which the consequences of engineering decisions and actions are significant.

At graduation, the knowledge of the candidate centres on the scientific basis of engineering, engineering technologies, some contextual knowledge and some specialist knowledge. During preparation for registration, knowledge must develop in the applicant's practice area and be relevant to the context in which the applicant practices.

Mentors, supervisors and applicants must plan the progression of tasks and responsibility to ensure the development of these competencies. They are advised to use suitable planning, recording and assessment tools and feedback sessions. The applicant's progress should be evaluated against each outcome using the responsibility scale in document **R-04-P**. It should be noted that the same body of work may enable development of competencies in other groups.

The strategy for developing problem-solving competence to the level required in the workplace and the degree of responsibility suggested in document **R-04-P** is useful:

- being exposed;
- assisting;

- participating;
- contributing; and
- Performing.

Initially, the applicant assists experienced engineering personnel in their problem-analysis and solution activities and receives detailed guidance while being monitored. The applicant then progresses to contribute individually and as a team member to the solution of engineering problems. Finally, the applicant must progress to performing at Level E both individually and as a team member to solve problems. In this last phase, the applicant must perform over the entire problem lifecycle.

The applicant should be given the opportunity to experience complex problem-solving in contexts such as design, investigation, planning, and process and product improvement. The applicant should be encouraged to apply first principles to complex problems in order to develop and apply specialist and contextual knowledge.

Considering the problem of assessing a person's performance against learning outcomes 1 and 2, we must determine if the person performs a creative, systematic analysis of problems at the required level and if the person works systematically to synthesise a solution to the problems.

An example of a schema for the systematic analysis is presented below. The candidate:

- identifies and formulates the problem, which leads to an agreed definition of the problem to be addressed;
- collects, organises and evaluates information;
- uses conceptualisation, abstraction and modelling;
- identifies and justifies assumptions, limitations, constraints and premises;
- uses both mathematical and non-mathematical analytical methods;
- evaluates the results of the analysis, using judgement; and
- expresses understanding of the results emerging from the analysis.

A similar schema would apply to the synthesis phase. The applicant:

- analyses the requirements for the design / planning / solution and draws up a detailed requirements specification;

- synthesises a range of potential solutions to the problem or a range of approaches to developing a solution that is consistent with assumptions, premises, limitations and constraints;
- evaluates the potential approaches against the requirements and includes cost and impacts outside the requirements;
- presents reasoned arguments and a proposal for the preferred option;
- fully develops the design of the selected option;
- evaluates the resulting solution; and
- produces design documentation for implementation.

What type of problem could be offered to demonstrate problem-solving ability? Many types of problems would suffice; 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 solution may be the design of a component, system or process or a recommendation of the remedy for the problematic situation.

The level of the problem analysed must be gauged by the test described above to determine its suitability for presentation as evidence of competence.

Problem-solving is the core activity of engineering. A wide range of engineering functions are either specific manifestations of problem-solving or are functions that rely on problem-solving at different levels. Some examples follow:

- Design is the systematic process of conceiving and developing materials, components, systems and processes to serve useful purposes. Design involves the transformation of an initial requirement to produce documented instructions on how to realise the end product. In determining a solution, barriers must be overcome. A design assignment, therefore, is an engineering problem and involves sub-problems that must be addressed.

- Product or process improvement also involves problem-solving. Frequently, an existing piece of infrastructure, plant or process is in need of improvement. The proper process is to analyse the exiting state and define the desired final state, and this process must be developed. Again, the investigation is a problem-solving activity, as is the solution synthesis phase.

Problem-solving based on engineering knowledge is at the centre of other engineering activities such as planning, research, development and technology transfer, quality assurance, risk analysis, domain-specific project management, managing engineering processes, safe work practices, environmental protection, sustainability analysis and systems engineering.

7.3 Outcome 3

All engineering activities, particularly problem-solving, relies on a body of knowledge. The statement of Outcome 3 recognises the three components that comprise the knowledge of a Professional Engineer:

1. Knowledge is rooted in principles (generally first principles) of general laws of the natural and engineering sciences and the principles of good engineering practice.
2. It is recognised that individual Professional Engineers develop specialised knowledge that may be in a generally recognised area or may be a particular combination of topics.
3. Knowledge that is specific to the environment in which the person practises is essential. It includes knowledge about the society, economy, regulatory system and physical environment in which the person practises engineering.

Engineering knowledge is too diverse to allow a detailed specification for every discipline, sub-discipline or practice area. Rather, it is recognised that each engineering practitioner develops a practice area. The Discipline-Specific Training Guideline, document **R-05-PE**, may be consulted on this topic. For example, the practice area may be a commonly understood area such as structural engineering or power distribution or it may be a particular blend emanating from the individual's experience. The engineering knowledge requirements in document **R-02-PE** are, therefore, stated in generic terms.

For the Professional Engineer, the engineering fundamentals that are acquired in an accredited undergraduate programme form the base for specialist knowledge, and the Professional Engineer must be capable of first-principles analysis. Fundamental knowledge may be used explicitly or tacitly.

Professional Engineers invariably work in teams with specialists, engineering role-players, contractors and other parties from other engineering disciplines and professions. It is, therefore, essential to have a working knowledge of the discipline and the areas in which interaction is required. The applicant needs to be aware that certain engineering disciplines may require more diverse cross-discipline interaction and knowledge. However, this depends on the environment and the level at which the engineer is performing the work.

Engineering work does not occur in isolation, and knowledge of the health and safety, environmental, contractual, quality and risk regulatory requirements is essential. The application of engineering knowledge as an outcome is normally demonstrated during design, investigation or operations. The applicant typically

- displays mastery in the understanding of engineering principles, practices and technologies in the practice area;
- applies general and underpinning engineering knowledge to support analysis and to provide insight;
- uses an analytical approach based on fundamentals and first principles in building models as required;
- displays working knowledge of areas that interact with the practice area; and
- applies related financial, statutory, safety and management knowledge.

8. GROUP A: KNOWLEDGE-BASED ENGINEERING PROBLEM-SOLVING

As described in Table 1 of this document, Group A consists of three outcomes:

- *Outcome 1* – Define, investigate and analyse complex engineering problems
- *Outcome 2* – Design or develop solutions to complex engineering problems
- *Outcome 3* – Comprehend and apply advanced knowledge of the widely applied principles underpinning good engineering practice, specialist knowledge and knowledge specific to the jurisdiction and local conditions

8.1 Outcome 4

Competent Professional Engineers must not only perform technical functions but must also manage engineering activities. Two statements of management competency are presented in Group B in document **R-02-PE**. Competency to manage *complex engineering activities* must be demonstrated. Linked with management is the ability to communicate with those involved in the engineering activities.

Engineering management can be defined as the application of the generic management functions of planning, organising, leading and controlling together with engineering knowledge in contexts that include the management of projects, construction, operations, maintenance, quality, risk, change and business. The level of experience in engineering management is of necessity limited at the stage of applying for registration as a Professional Engineer. However, the applicant must take on the requisite responsibility to demonstrate competency under the guidance of suitably competent persons, as described in document **R-04-P**.

Engineering management is more than project management. In most cases, project management is in itself supportive of technical engineering activity and does not demonstrate the acceptable level of performance at the required degree of responsibility.

Demonstration of the Competency Standard in document **R-02-PE** provides a test of whether a given engineering activity is classed as a complex engineering activity or not. The test for complex engineering activity is summarised in this document in Table 2. The test is applied to the activity itself to determine the complexity of its scope and operating environment, resource intensiveness, severity of constraints, risks and consequences. This test is not independent of the test for complex problem-solving; most of the factors are those that give rise to barriers in the problem-solving process and render the problem complex.

The definition of the required level of activity in document **R-02-PE** does not imply that applicants in every category must work at the stated level all the time. Rather, applicants in each category must demonstrate the ability to practise at the required level. Similarly, at the culmination of training, applicants must be able to demonstrate that they are capable of performing the required actions at the required levels through physically carrying out the actions in the work situation.

The progression of levels of engineering work and the degrees of responsibility defined in Table 4 of document **R-04-P** are presented below.

Level A	Exposure
Level B	Assisting
Level C	Participating
Level D	Contributing

Level E	Performing

The applicant's various phase activities assist in developing the ability to plan, organise, lead and control. The applicant must be able to perform these functions alone and in a team. Conducting engineering work alone or in a team requires planning and organising to attain the required technical outcomes. Team participation and contribution as a team member and as a leader give the opportunity to demonstrate leadership and the ability to control on a limited scale.

8.2 Outcome 5

Technical communication at a level that supports analysis, synthesis and implementation of solutions is an inherent part of engineering work. The applicant needs the opportunity to communicate orally and in writing not only technical matters but also financial, social, cultural, environmental or political aspects of engineering activity.

In fulfilling Outcome 5, the applicant is expected to display personal and work process management abilities:

- manage self;
- work effectively in a team environment;
- manage people, work priorities, work processes and resources; and
- establish and maintain professional and business relationships.

Effective communication can be demonstrated by:

- writing clear, concise, effective reports that are technically, legally and editorially correct using a structure and style that meet communication objectives and user/audience requirements;
- reading and evaluating technical and legal matter relevant to the function of the Professional Engineer;
- receiving instructions and ensuring correct interpretation;
- issuing clear instructions to subordinates using appropriate language and communication

aids, ensuring that language and other communication barriers are overcome; and

- making oral presentations using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.

This outcome will be evaluated at the following two stages:

- The applicant's written application for registration
- The review process in which the applicant is required to make a presentation and answer questions during the professional review

9. GROUP B: MANAGING ENGINEERING ACTIVITIES

Groups B, C and D reflect the competencies that are linked to problem-solving (Group A) and are essential to engineering activities at the professional level. For example, considering impacts is an important stage in the solution of a problem. Similarly, engineering operations also have impacts that must be assessed and managed.

As described in Table 1 of this document, Group B consists of two outcomes:

- *Outcome 4* – Manage part or all of one or more complex engineering activities
- *Outcome 5* – Communicate clearly with others in the course of Professional Engineer's engineering activities

9.1 Outcome 6

Engineering activities deliver benefits to society and the economy in the form of infrastructure, services and goods. Engineering involves harnessing or controlling natural forces or using and controlling complex information. The actions inherent in engineering activity have accompanying risks. These risks must be mitigated to a level that is acceptable to the affected parties. The management of risk accompanying engineering activity is the very rationale for the regulation of the profession. Some risks are well known and understood, and the means of addressing them may be embodied in regulation, for example, pressure vessel design. Other situations may not occur frequently or may occur for the first time with the application of new technology and in consequence, may not be regulated. Certain risks may have objective technical measures while others are subject to the judgement of individuals and communities. Some risks may be ethical (Outcome 8 in Group D). The ability to assess and deal with all prevailing risks is integral to the competency of a Professional Engineer: The Professional Engineer is expected to be able to identify and deal with the wide-ranging risks associated with engineering work.

The applicant should be given the opportunity to study, analyse and recommend measures for

- social/cultural impacts;
- community/political considerations;
- environmental impact;
- sustainability analysis;
- regulatory conditions; and
- potential ethical dilemmas.

To demonstrate competency in *impact analysis and mitigation*, the following must be accomplished:

- identify interested and affected parties and their expectations;
- identify interactions between technical considerations and sociocultural and environmental factors;
- identify environmental impacts of the engineering activity;
- identify sustainability issues;
- propose and evaluate measures to mitigate negative effects of engineering activity; and
- communicate with stakeholders.

9.2 Outcome 7

Outcome 7 is concerned with explicitly regulated aspects of engineering practice and more general legislation that may apply. Each applicant should ascertain the legislation that is applicable in one's work environment. Appendix A of this document and the Discipline-Specific Guideline, document **R-05-PE**, lists recommended (but not exhaustive) material that should be consulted, including the relevant legislation.

Of particular importance is occupational health and safety legislation. There are two principal Acts that are applicable in the South African context:

- Occupational Health and Safety Act, No. 85 of 1993 as amended, and associated regulations
- Mine Heath and Safety Act, No. 29 of 1996 as amended

All certificated engineers have a specific responsibility under these Acts. All Professional Engineers must be cognisant of the Acts and comply with their provisions.

To demonstrate competency *in regulatory aspects*, the applicant must

- identify applicable legal, regulatory and health and safety requirements for the engineering activity;
- identify risk and apply defined and widely accepted risk-management strategies; and
- select safe and sustainable materials, components, processes and systems.

10. CANDIDATES WHO HAVE COMPLETED ADVANCED DEGREES

Candidates who have completed higher education programmes beyond the BEng or the equivalent educational level required for registration as a Professional Engineer should identify opportunities to present evidence at the required level against the outcomes defined in the competency standards. The registration policy allows such candidates to offer appropriate aspects of the advanced programme as part of the evidence of competence against particular outcomes.

10.1 Outcome 8

Outcome 8 simply states: Conduct engineering activities ethically. The baseline for ethical behaviour is the ECSA Code of Conduct. The ECSA Code of Conduct covers the need to practise ethically and within one’s area of competency, to work with integrity, to respect the public’s interest and the environment and to uphold the dignity of the profession, including one’s relationship with fellow professionals. The ECSA Code of Conduct also contains a section on administrative matters that relate to ethical practice. The applicant must study the ECSA Code of Conduct and be aware of its implications in situations that arise in engineering work.

As in other professions and business situations, ethical problems arise in engineering activity. These may relate to business practices, inducements or an unregulated impact, for example, the use of a rare and unsustainable material for a solution that will be required well into the future. The Professional Engineer must be capable of detecting, analysing and handling ethical dilemmas and problems that arise in the course of engineering activity. This is a non-negotiable aspect of the Code of Conduct, and the Professional Engineer must handle any ethical problems that arise.

An applicant who is capable of handling ethical issues adopts a systematic approach to resolve ethical issues, which is typified by

- the identification of the central ethical problem;
- the identification of affected parties and their interests;
- the search for possible solutions to the dilemma;
- the evaluation of each solution using the interests of those involved and according suitable priority; and
- the selection and justification of the solution that most appropriately resolves the dilemma.

10.2 Outcome 9

The Professional Engineer is expected to make decisions in situations where the information to underpin the decision may be highly complex; that is, it has many parts with a myriad of interactions or it may be incomplete. Such decision-making requires due care by the Professional Engineer and may be informed by experience. The Professional Engineer, therefore, must have the ability to think of many matters at once and address their interdependence, their relative importance and their consequences. This process is known as exercising *judgement* within *complex engineering activities* or exercising equal judgement in the solution of *complex engineering problems.*

Firstly, applicants considering the training and mentoring guide, document **R-04-P**, should be given the opportunity and be challenged to

- make decisions when full information is not available;

- use engineering judgement;
- take due care that the outputs and impacts of an assignment are addressed; and
- self-assess their competence from time to time.

All the above should be done under the supervision and guidance of a suitably qualified person as described in document **R-04-P**.

Secondly, the indication that an applicant exhibits engineering judgement is typically demonstrated by the following:

- considering several factors, some of which may be ill-defined or unknown;
- considering the interdependence, interactions and relative importance of factors;
- foreseeing consequences of actions;
- evaluating a situation in the absence of full evidence; and
- drawing on experience and knowledge.

10.3 Outcome 10

Engineers are accorded professional status in society by virtue of their competence, the fact that the profession self-regulates and because professionals are accountable for their actions. The person registering as a Professional Engineer, therefore, must understand the obligation to be responsible and to have experience in making decisions, which if wrong, could have adverse consequences. Subject to the limitations of taking responsibility as a candidate (discussed in document **R-04-P**), the applicant for registration as a Professional Engineer must demonstrate the capacity to make recommendations that display responsible behaviour in accordance with the ECSA Code of Conduct.

According to document **R-05-PE**, demonstrating responsibility at the required level (Level D and Level E) is evidenced by:

- demonstrating a professional approach at all times;
- indicating due regard to technical, social, environmental and sustainable development considerations;
- seeking advice from a responsible authority on any matter considered to be outside the area

of competence; and

- making decisions and taking responsibility in regard to work output.

11. GROUP D: EXERCISING JUDGEMENT AND TAKING RESPONSIBILITY

As described in Table 1 of this document, Group D consists of three outcomes:

- *Outcome 8* – Conduct engineering activities ethically
- *Outcome 9* – Exercise sound judgement in the course of complex engineering activities
- *Outcome 10* – Be responsible for making decisions on part or all of complex engineering activities

Professional Engineers must make technical and managerial decisions regarding the risks that arise from their activity. Three outcomes in Group D are concerned with competencies exercised at a personal level.

11.1 Outcome 11

Outcome 11 concerns Professional Development (PD). Professional Development is defined as the activities that a registered professional is required to perform, and these activities must be completed at the required level to maintain registration. Professional Development is the systematic maintenance, improvement and broadening of knowledge and skills and the development of the personal qualities that are necessary for the execution of professional and technical duties throughout an engineer's career.

A registered Professional Engineer is required to maintain and extend competence and at minimum, must complete Continuing Professional Development (CPD) at the required level to maintain registration.

Professional Development activities carried out between graduation and applying for professional registration is termed Initial Professional Development (IPD). This is an integral part of the professional competence that is required to practise safely and effectively in engineering.

The ability to develop and maintain competency is embodied in Outcome 11, namely the ability to undertake sufficient PD activities to maintain and extend competence. This involves more than completing courses or other activities. The emphasis is on the individual's ability to self-develop. This capability has several dimensions:

- taking responsibility for one's own development;
- reflecting on strengths and weaknesses, recognising needs, planning; and
- executing development activities and overcoming obstacles.

An applicant's training towards registration does not have to satisfy formal PD requirements. However, at the time of applying for registration as a professional, the applicant will be assessed on the ability to manage and complete PD-type activities. Pre-registration IPD is not subject to the requirement of annual points. Initial Professional Development involves the initiation of learning activities by the applicant that are distinct from the structured learning activities required by the employer.

The essential test is the activity that is appropriate to the specific developmental needs of the individual. Also, involvement of the applicant in the planning of the learning activities is important, rather than simply entrusting this to the employer. The ability to develop one's skills continually is regarded as sufficiently important in an engineering professional to be enshrined as an outcome that must be demonstrated in order to attain registration.

For a Professional Engineer, it should be noted that boundaries of practice areas change over time, new engineering principles are formulated, new procedures, standards and codes are developed and engineering practice is advanced. Initial Professional Development should be planned with these factors in mind.

Each of the activities listed below or combinations thereof constitute PD and hence, IPD:

- attending courses, seminars, congresses and technical meetings organised by Engineering Institutions/Institutes, universities, other professional bodies and course providers;
- actively participating in conferences, serving on technical or professional committees and engaging in working groups;
- undertaking structured self-study (i.e. using textbooks with examples);
- taking correspondence courses and studying other supervised study packages;
- enrolling for formal postgraduate studies (limited credits);
- writing technical papers or presenting papers or lectures at an organised event;

- reading of technical papers such as white papers or peer-reviewed articles;
- conducting research and literature reviews that are part of the engineering design and synthesis process;
- taking in-house training courses offered by companies;
- undertaking accredited CPD activities; and
- taking credit-bearing courses in higher education institutions that directly complement the individual's engineering-related knowledge.

Applicants typically demonstrate PD by

- planning their own PD strategy;
- selecting appropriate PD activities;
- keeping thorough records of PD strategy and activities;
- demonstrating independent learning ability; and
- completing PD activities.

12. GROUP E: PROFESSIONAL DEVELOPMENT

As indicated in Table 1 of this document, Group E consists of only one outcome:

Outcome 11 – Undertake sufficient professional development activities to maintain and extend competence.

REVISION HISTORY

Revision Number	Revision Date	Revision Details	Approved By
Rev. 0: Concept E	4 March 2011	Adapted from working document Concept D	JIC Working Document
Rev. 0: Concept F	11 April 2011	Edited; Appendix A material moved out of the text	JIC Working Document
Rev. 0: Concept G	16 May 2011	Cross references corrected; Section 8.1 added; Section 10 added	JIC Working Document
Rev. 0: Concept H	7 June 2011	Appendix A moved to R-03-PE; Editorial changes and additions	JIC Working Document
Rev. 0: Concept I	27 June 2011	Editorial changes	JIC Working Document
Rev. 0: Draft 1	31 Oct 2011	No changes relative to Concept I	JIC submitted for Council Approval
Rev. 1.0	12 Jan 2012		Approved by Council
Rev. 2	22 May 2018	Routine review and alignment to R-01-P	Approved by PDSGC

The Guideline for:

Guide to the Competency Standards for Registration as a Professional Engineer

Revision 2 dated 22 May 2018 and consisting of 25 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Policy Development and Standards Generation (**PDSG**).

....
Business Unit Manager

24/07/2018
Date

....
Executive: **PDSG**

25/07/18
Date

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

APPENDIX A: GENERAL AND SPECIFIC ENGINEERING LEGISLATION

1. Engineering Profession Act, No. 46 of 2000
2. Occupational Health and Safety Act, No. 85 of 1993
   - 2.1. General Machinery Regulations
   - 2.2. Construction Regulations
   - 2.3. Driven Machinery Regulations
   - 2.4. Pressurised Equipment Regulations
3. Mine Health and Safety Act, No. 29 of 1996
   - 3.1. Design of underground dam walls, plugs and barricades; Regulations on use of water for mining
4. Environment Conservation Act, No. 73 of 1989
5. National Building Regulations and Building Standards Act, No. 103 of 1977
   - 5.1. Certification of a structural system of a building or home
   - 5.2. Certification of a fire protection system
   - 5.3. Certification of an artificial ventilation system
   - 5.4. Geotechnical site investigations; Stability of excavations; Geotechnical investigations on sites underlain by dolomites
6. National Water Act, No. 36 of 1998
   - 6.1. Various measures relating to pollution of a water resource
7. Water Act, No. 54 of 1956
   - 7.1. Determination of persons permitted to design dams