ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Guide to the Competency Standards for Registration as a Professional Engineer			
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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.

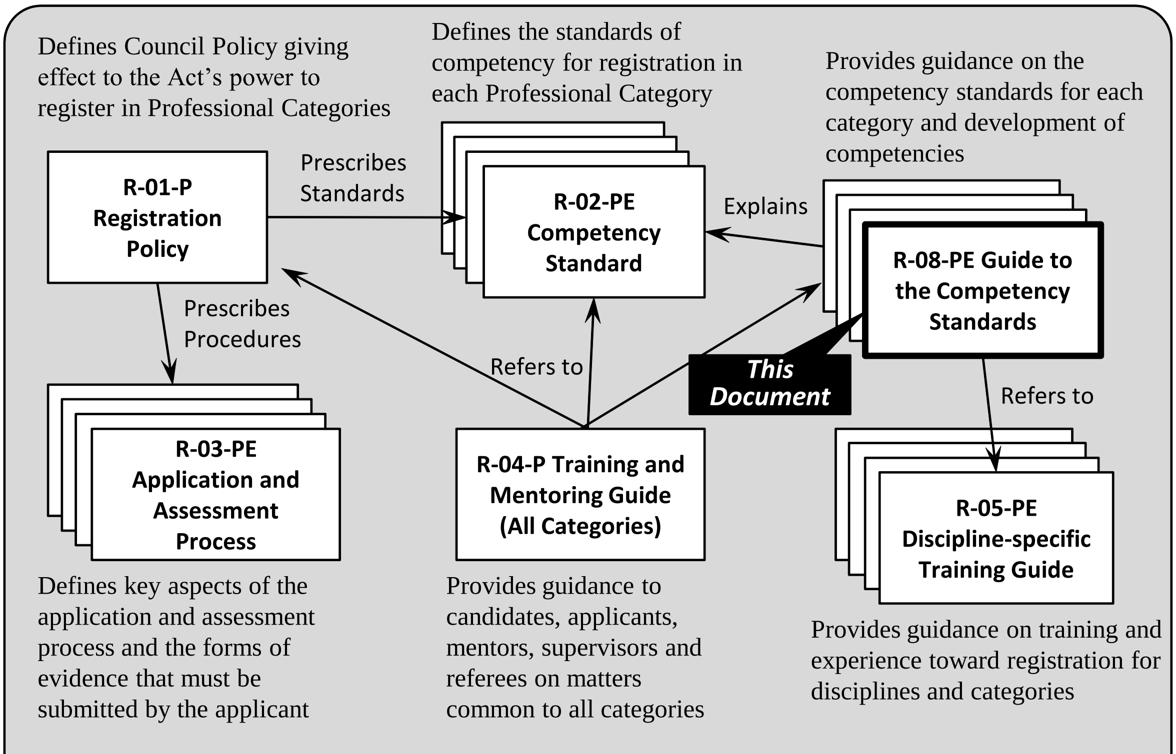

Figure 1: Documents defining the ECSA Registration System

1 Purpose of this document

This *guide* amplifies the general training and mentoring guide R-04-PE, concentrating on an understanding of the competency standards for Professional Engineers defined in document R-02-PE. This guide also 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 Discipline Specific Training Guidelines, if they exist for the trainee's discipline.

The intended audience of this guide includes candidates undergoing training toward professional registration, mentors, supervisors as well as assessors of applicants for registration.

2 Navigating the document

3 About competency, standards and performance

What is the competency of a Professional Engineer? In general *competence* is the possession of the *knowledge*, *skills* and *attitudes* necessary 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 subsequently acquired, which is likely to be specialised and related to the engineering work context. The skills and attitude component are defined by a set of assessable outcomes.

What is the standard of competence for registration as a Professional Engineer? ECSA document R-02-PE provides the formal definition of the competence that must be demonstrated. That document states the requirement for registration in its section 2.1 in the following terms:

Competence must be demonstrated:

- within *complex engineering activities,* **(**defined in R-02-PE section 2.1.2),
- by *integrated performance* of the outcomes (defined in R-02-PE sections 3-7), and
- at the *level defined* for each outcome (see R-02-PE sections 2.1.2 and 3.1.1).

The standard applies across 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 Guidelines.

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

The competency standard defines eleven outcomes, conveniently grouped as follows and in nested form in Figure 2:

Group A: Knowledge-based Engineering Problem Solving (Outcomes 1, 2, 3)
Group B: Managing Engineering Activities (Outcomes 4, 5)
Group C: Risk and Impact Mitigation (Outcomes 6, 7)
Group D: Exercising Judgement and Taking Responsibility (Outcomes 8, 9, 10)
Group E: Developing Own Competency (Outcomes 11)

Essential Activities of Professional Engineers	**Using Enabling Knowledge**	**Taking Account of Consequences**	**Exercising Personal Attributes**	**Maintaining and Extending Competence**
1: Define, investigate and analyse *complex* engineering problems. **2:** Design or develop solutions to *complex* engineering problems. **4:** Manage part or all of one or more *complex* engineering activities. **5:** Communicate clearly with others in the course of his or her engineering activities.	**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.	**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 his or her *complex* engineering activities.	**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 *complex* engineering activities.	**11:** Undertake professional development activities sufficient to maintain and extend his or her competence.

Figure 2: Nesting of the outcomes specified for registration as a Professional Engineer

3.1 How does one Visualise the Outcomes?

The outcomes do not stand alone. Competent engineering work invariably requires the simultaneous performance of several of the actions embodied in the outcomes. Section 2.1 of the standard therefore calls for *integrated performance* of the outcomes. The outcomes can be thought of as nesting as shown in Figure 2.

The set of 11 outcomes have a logic that flows through them as suggested by the column headings in figure 2.

- Outcomes 1, 2, 4, and 5 capture the essential things that Professional Engineers do: analyse and solve problems, manage processes, projects and operations to deliver results, all supported by communication.

- To perform these four core functions, they rely on fundamental and specialised engineering knowledge as well as knowledge of the context in which the work takes place. Outcome 3 reflects the importance of engineering knowledge: this is what makes the work engineering!

- While solving problems and managing processes, the Professional Engineers must be able to identify and handle the impacts of the solutions and applicable regulatory requirements as reflected in the grouped outcomes 6 and 7.

- A number of attributes are essential at a personal level: the Professional Engineer must act ethically, exercise judgement and take responsibility as reflected in the grouped outcomes 8, 9 and 10.

- The single outcome 11, shown as an underpinning layer to all the other outcomes, brings out the need to be able to develop professionally, that is increase knowledge and the competencies required for effective performance of engineering work

An alternative visualisation of the set of 11 outcomes is given in Figure 3 of document R-04-P, where problem solving (analysis and synthesis) is seen in a central position with competencies represented by other outcomes are in a supporting role.

3.2 At what Level must Achievement of Outcomes be demonstrated?

All of the outcomes defined in R-02-PE and summarised in Figure 1 may arise from work of varying levels of demand. 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 defined to have specific meanings in the standard R-02-PE:

- Section 3.1.1 defines as set of level descriptors for a *complex engineering problem;* and
- Section 2.1.2 defines the level descriptors that allow engineering activity to be classified within *complex engineering activities.*

What are engineering activities? The standard takes a broad view of engineering activities, listing a number of possible functions: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; implementation, construction, manufacture, engineering operations; maintenance; project management; research, development and commercialisation. This list is not exhaustive. Discipline Specific Training Guidelines may elaborate on types of activities in which a person may or must demonstrate competence

In summary, evidence of competent performance has two essential requirements: first, a capability to *perform a number of defined actions* must be demonstrated, and second, the performance must be at or exceed a *specified level of demand*. The defined actions are the outcomes and the level is defined by a specification for the demands of the engineering activities and the nature of 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 assessment is holistic.

3.3 Introduction of Competency Standards

The Competency Standards in document R-02-PE are being introduced via the adoption of the set of documents shown in section 1. The intention is not to change the standard required for registration as a professional engineer, but to better express it to support focussed training, effective presentation of evidence and assessment. Section 3 of document R-03-PE identifies areas of change from the training-based requirements to output-based competency standards and the accompanying changes in preparation of applications and assessment of competency.

4 Group A: Knowledge-based Engineering Problem Solving

4.1 What is Engineering Problem Solving?

Problem solving is a process carried out by individuals or teams to bring about a change between a given state and a desired state by means of multi-step or multipath activities having barriers that must be overcome using knowledge and abilities and taking situational requirements into account. Engineering problem solving is distinguished by requiring engineering knowledge, that is, it 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 activities including design, planning, implementing and constructing, operating and closing engineering systems, infrastructure and plant. Competent problem solving has two phases: analysis and solution synthesis as captured in outcomes 1 and 2 of R-02-PE. Because engineering problem solving is knowledge-based, outcome 3 is grouped with 1 and 2. However, outcome 3 supports other outcomes as well, as depicted in Figure 2.

The test for a complex engineering problem stated in section 3.1.1 of R-02-PE is based on the four logical steps, illustrated in Table 1:

Step 1: Item (a) establishes whether a problem is, in fact, an engineering problem by virtue of requiring engineering knowledge. For example, a person performing only project management functions with no role in the engineering aspects of a project would not be solving an engineering problem.

Step 2: Items (b), (c) and (d) establish the factors describing complexity of the initial state and the desired end state of the problematic situation; how many factors are known or specified, what is unknown, are there multiple goals?

Step 3: Factors (e) to (h) test the complexity of the solution path or process from initial state to the goal state.

Step 4: Factors (i) and (j) test the level of decision making needed in the process and the possible consequences for which responsibility must be taken.

Table 1: Illustrating the test for a *complex engineering problem*

Is the problem an engineering problem? Does it:	(a) require in-depth fundamental and specialized engineering knowledge;
What is the nature of the problem? Does it have one of characteristics b, c or d?	(b) is ill-posed, under- or overspecified, requiring identification and refinement; (c) is a high-level problem including component parts or sub-problems; (d) is unfamiliar or involves infrequently encountered issues;
What is encountered in the solution process? Do solutions have one of characteristics e, f, g or h? Solutions:	(e) are not obvious, require originality or analysis based on fundamentals; (f) are outside the scope of standards and codes; (g) require information from variety of sources that is complex, abstract or incomplete; (h) involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties;
What is involved in decision making while solving the problem and in evaluating the solution? Does it have one of characteristics i or j? Do decisions:	(i) require judgement in decision making in uncertain contexts; (j) have significant consequences in a range of contexts.

If there is one or more affirmative answer at each step, the problem is classified as a *complex engineering problem.*

4.2 How will I know when I am performing adequately at problem solving?

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

Systematic analysis would follow a schema such as the following. The applicant:

1. Identifies and formulates problem, leading to an agreed definition of the problem to be addressed;
2. Collects, organises, and evaluates information;
3. Uses conceptualisation, abstraction, modelling;
4. Identifies and justifies assumptions, limitations, constraints, premises;
5. Uses of analytical methods both mathematical and non-mathematical;
6. Evaluates result of analysis, using judgement;
7. Expresses understanding emerging from analysis.

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

1. Analyses the design/ planning /solution requirement and draws up a detailed requirements specification;
2. Synthesises a range of potential solutions to the problem or approaches to developing a solution, consistent with assumptions, premises, limitations and constraints;

3. Evaluates the potential approaches against requirements, including cost, and impacts outside requirements;
4. Presents reasoned arguments and proposal for preferred option;
5. Fully develops the design of selected option;
6. Evaluates resulting solution;
7. Produces design documentation for implementation.

What kind of problem could be offered to demonstrate problem solving ability? Many types of problem 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 to a problematic situation.

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

4.3 Developing knowledge-based Engineering Problem Solving

Problem solving is the core activity of engineering. A wide range of engineering functions are either specific manifestations of problem solving or 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 a transformation from an initial requirement to produce the documented instructions on how to realise the end product. On the way to 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: It frequently happens that an existing piece of infrastructure, plant or process is in need of improvement. A proper process is to analyse the exiting state and define the desired final state. A process for moving from the initial to final state must be worked out. Again the investigation is a problem-solving activity as is the solution synthesis phase.

Other engineering activities have problem solving based on engineering knowledge are at their centre: 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

At the end-point of training the candidate must demonstrate these three competencies through his or her work. The starting point of training is the level of problem-solving ability of the new graduate. The graduate is expected to produce the same level of problem solving but in an academic rather that work environment. The candidate must develop problem solving abilities in an environment where the consequences of engineering decisions and actions are significant.

At graduation, the knowledge of the candidate centres around the scientific basis of engineering, engineering technologies, some contextual knowledge and some specialist knowledge. During candidacy, knowledge must develop in the candidate’s practice area and about the context in which the candidate practices.

Mentors, supervisors and candidates 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. The candidate's progress should be evaluated against each outcome using the scale in Table 4 of document R-04-P. It should be noted that the same body of work may serve to develop competencies in other groups.

The strategy for developing problem solving competence to the level required in the workplace and degree of responsibility suggested in Table 4 of document R-04-P is useful: *being exposed, assisting, participating, contributing and performing*. Initially, the candidate assists experienced engineering personnel in their problem-analysis and solution activities, receiving detailed guidance and being monitored. The candidate then progresses to contributing individually and as a team member to the solution of engineering problems. Finally, the candidate must develop to the level of performing individually and team member to solve problems at the required level. In this last phase, the candidate must perform over the entire problem life cycle.

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

5 Outcome 3: Using Engineering and Contextual Knowledge

All engineering activity and problem solving in particular relies on a body of knowledge. The statement of outcome 3 recognises three components of the knowledge of a Professional Engineer. First, knowledge is rooted in principles, that is the general laws of the natural and engineering sciences and the principles of good engineering practice. Second, 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. Third, knowledge which is specific to the environment in which the person practises is essential. This 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 of knowledge for every discipline, sub-discipline or practice area. Rather, it is recognised that each engineering practitioner develops a practice area. This may be a commonly understood area such as structural engineering or power distribution or may be a particular blend coming out of the individual's experience. Knowledge requirements in section 3.3.1 of R-02-PE are therefore stated in generic terms.

For the Professional Engineer, the engineering fundamentals acquired in the undergraduate programme are 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 from other engineering disciplines, other engineering role-players, other professions, contractors and other parties. It is therefore essential to have a working knowledge of the discipline and other areas with which interaction is necessary.

Engineering work does not occur in isolation and knowledge of the regulatory requirements, health and safety, environmental, contractual, quality and risk is essential.

5.1 How would I display my application of knowledge?

This outcome is normally demonstrated in the course of design, investigation or operations. The candidate typically:

1. Displays mastery of understanding of engineering principles, practice and technologies in the practice area;
2. Applies general and underpinning engineering knowledge to support analysis and provide insight;
3. Uses a fundamentals-based, first principles analytical, approach building models as required;
4. Displays working knowledge of areas that interact with the practice area; and
5. Applies related knowledge: financial, statutory, safety, management.

6 Group B: Manage Engineering Activities

Groups B, C and D reflect competencies that are both linked to problem solving and are essential to engineering activities at the professional level. For example, taking impacts into account is an important stage in the solution of a problem. Similarly, an engineering operation also has impacts that must be assessed and managed.

6.1 What are Engineering Management Competencies?

Competent engineering practitioners must not only perform technical functions but must manage engineering activities. Two statements of management competency are in group B in 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, applied together with engineering knowledge in contexts including the management of projects, construction, operations, maintenance, quality, risk, change and business. The level of engineering management that a person is involved in or is sufficiently experienced to do is of necessity limited at the stage of applying for registration as a professional engineer.

Engineering management is more than project management. Project management is in most cases supportive of technical engineering activity. Work that is predominantly project management with minor technical engineering content is not acceptable as a demonstration of performance at degree of responsibility E.

6.2 What level of Activities Must I be Able to Manage?

Section 2.1 of the competency standard (R-02-PE) provides a test of whether a given engineering activity is classed as a complex engineering activity. The tests are applied to the activity itself to test 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 also render the problem complex.

The definition of the required level of activity in R-02-PE does not imply that practitioners in every category work at that level all the time. Rather, the practitioner in each category must demonstrate ability to practice at the required level. Similarly, a candidate, at the culmination of training, must demonstrate that he/she is capable of performing the required actions at the required level by having actually done so in the work situation.

6.3 Developing Competency to Manage Engineering Activities

The progression of levels of engineering work and degrees of responsibility defined in Table 4 of R-04-P, namely, *Be exposed – Assisting – Participating - Contributing* and *Performing*, also applies to the management outcomes. It is feasible for a candidate to demonstrate the communication outcome 5 at the stage of applying for a professional engineer.

Various candidate phase activities assist in developing the ability to plan, organize, lead and control. The candidate must be able to perform these functions, alone and in a team. Conducting engineering work on one's own or in a team requires planning and organizing 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

Technical communication at a level that supports analysis, synthesis and implementation of solutions is an inherent part of engineering work. The candidate needs the opportunity to communicate orally and in writing about technical matters but also financial social, cultural, environmental or political aspects of engineering activity

6.4 How do I Know when I am Managing and Communicating at the Required Level?

The candidate is expected to display personal and work process management abilities:

1. Manage self;
2. Work effectively in a team environment;
3. Manage people, work priorities, work processes and resources;
4. Establish and maintain professional and business relationships.

Effective communication could be demonstrated by:

1. Write clear, concise, effective, technically, legally and editorially correct reports using a structure and style which meets communication objectives and user/audience requirements.
2. Read and evaluate technical and legal matter relevant to the function of the Professional Engineer.
3. Receive instructions, ensuring correct interpretation.
4. Issue clear instructions to subordinates using appropriate language and communication aids, ensuring that language and other communication barriers are overcome.
5. Make oral presentations using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose

7 Group C: Risk and Impact Mitigation

7.1 What are the Group C Outcomes?

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 the use and control of complex information. The actions inherent in engineering activity have accompanying risks. These risks must be mitigated to a level 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, may occur for the first time with the application of new technology and may not in consequence be regulated. Risks may have objective technical measures while others are subject to the judgement of individuals and communities. Some may be ethical (outcome 8 in Group D). The ability to assess and deal with all prevailing risks is integral to the competency of an engineering practitioner. The Professional Engineer is expected to be able to identify and deal with wide-ranging risks associated with engineering work.

The two outcomes in Group C, outcomes 6 and 7 defined in R-02-PE, deal respectively with the impacts of engineering activity that are not subject to regulation but rely on the professionalism of the practitioner and those which are subject to regulation, both specific and general.

Outcome 7 is concerned with explicitly regulated aspects of engineering practice and more general legislation that may apply. Each candidate should ascertain the legislation that applies in his or her work environment. Appendix A provides a list of Acts that apply generally and in specific areas. Candidates are reminded that this list is provided for information, is not exhaustive and the onus rests on each candidate to identify applicable legislation.

Of particular importance is occupational health and safety legislation. There are two principal Acts: the Occupational Health and Safety Act (Act No 85 of 1993), its various Regulations and the Mine Heath and Safety Act (Act No 29 of 1996) as amended. While Certificated Engineers have specific responsibility under these Acts, all engineering professionals must be cognisant with and act in accordance with the Acts.

7.2 Developing the Competency to Analyse and Manage the Impacts, Benefits, and Consequences of Engineering Activity

Outcomes 6 and 7 in the competency standard are relevant to this cluster of competencies:

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

- Social/cultural impacts
- Community/political considerations
- Environmental impact
- Sustainability analysis
- Regulatory conditions
- Potential ethical dilemmas

7.3 How do I know when I am Performing at the Right Level?

To show that you are competent in impact analysis and mitigation you would do the following

1. Identifies interested and affected parties and their expectations;
2. Identifies interactions between technical considerations and social cultural and environmental factors;
3. Identifies environmental impacts of the engineering activity;
4. Identifies sustainability issues;
5. Proposes and evaluates measures to mitigate negative effects of engineering activity;
6. Communicate with stakeholders.

To show that you are competent in regulatory aspects you would typically:

1. Identify applicable legal, regulatory and health and safety requirements for the engineering activity;
2. Identify risk and apply defined, widely accepted risk management strategies;
3. Select safe and sustainable materials, components, processes and systems.

7.4 Developing Group C Competencies

Outcomes 6 (impacts of engineering), 7 (legal and regulatory aspects) and 8 (ethical behaviour in Group D) reflect the professional behaviour and attitudes expected of a Professional Engineer. These are supported by knowledge of the context in which the individual practises (aspect of outcome 3). It is recognized that, during candidacy, the exposure to these issues may not be as intensive as for an experienced registered engineer. Candidates are therefore expected to supplement experience by reading and reflecting on these issues before applying for registration. Appendix A and the Discipline Specific Guidelines lists material that should be consulted, including the relevant legislation. Candidates should also make use of suitable CPD courses in these areas. As part of the competency assessment, each applicant for registration as a Professional Engineer is required to write essays on topics related to outcomes 6, 7 and 8 which draw on contextual knowledge.

8 Group D: Exercising judgement and taking responsibility

Engineering practitioners must make technical and managerial decisions related to risks arising from their activity. Three outcomes in Group D are concerned with competencies exercised at a personal level.

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 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.

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

Engineers are accorded professional status in society by virtue of their competence, the fact that the profession self-regulates and that professionals are accountable for their actions. The person registering as a Professional Engineer must therefore understand the obligation to be responsible and have experience of making decisions which, if wrong, could have adverse consequences. Subject to the limitations on taking responsibility as a candidate or unregistered person discussed in section 8.4 of R-04-P the applicant for registration as a professional engineer must have demonstrated the capacity to make recommendations that display responsible behaviour.,

8.1 Developing Competency to Make Ethical Decisions

Outcome 8 has the simple statement: Conduct engineering activities ethically. The baseline for ethical behaviour is the ECSA Code of Conduct[1]. The Code of conduct covers the need to practise competently and with one's competency, to work with integrity, to respect the public interest and the environment, and uphold the dignity of the profession, including one's relationship with fellow professionals. There is also a section on administrative matters that relate to ethical practice. The candidate must study the Code of Conduct and be aware of its implications in situations that arise in engineering work.

8.2 Developing Competency to Exercise Judgement and take Responsibility

The candidate should be given the opportunity and be challenged to:

- Make decisions when full information is not available.
- Take due care that the outputs and impacts of an assignment are handled.
- Self-assess their competence from time to time.

8.3 How do I Know when I am Performing at the Right Level?

To show that you are sensitive to and capable of handling ethical issues you would adopt a systematic approach to resolving these issues typified by:

1. Identify the central ethical problem;
2. Identify affected parties and their interests;
3. Search for possible solutions for the dilemma;
4. Evaluate each solution using the interests of those involved, accorded suitable priority;
5. Select and justify solution that is best resolves the dilemma.

An indication that a person exhibits judgement is typically by:

1. Considers several factors, some of which may not be well defined or unknown;
2. Considers the interdependence, interactions, and relative importance of factors;
3. Foresees consequences of actions;
4. Evaluates a situation in the absence of full evidence;
5. Draw on experience and knowledge.

Being responsible would be evidenced by:

1. Demonstrates a professional approach at all times;
2. Has due regard to technical social, environmental and sustainable development considerations;
3. Seeks advice from a responsible authority on any matter considered to be outside area of competence;
4. Makes decisions on and takes responsibility for work output.

9 Group E: Developing Own Competency

Continuing Professional Development (CPD) is the systematic maintenance, improvement and broadening of knowledge and skills, and the development of personal qualities necessary for the execution of professional and technical duties throughout an engineer's career. A registered

[1] Published as *Rules of Conduct for Registered Persons*, Government Gazette No. 28605, 17 March 2006 and available on the ECSA website.

Professional Engineer is required to maintain and extend competence and must complete at least the required level of CPD to maintain registration.

Candidates training toward registration do not have to satisfy a formal CPD requirement. However, at the time of applying for registration as a professional, candidates will be assessed as to their ability to manage and complete CPD-type activities. This is an integral part of professional competence required to practice safely and effectively in engineering. CPD-type activity carried out before registration is often termed initial professional development (IPD).

The ability to develop and maintain competency is an essential and demonstrable competency and is embodied in outcome eleven, namely the ability to undertake professional development activities sufficient to maintain and extend his or her competence. This is more than completing courses or other activities. The emphasis falls on the individual's ability to self-develop. This capability has several dimensions: taking responsibility for one's own development, reflect on strengths and weaknesses, recognise needs, plan and execute development activities and overcome obstacles.

The range of methods of prosecuting IPD open to the candidate is substantial: reading, researching, in-house training, accredited CPD courses, credit-bearing courses in higher education institutions or even higher degree studies that complement the individuals training and work experience. The essential test is: is the activity appropriate to the specific developmental needs of the individual? Also, the role of the candidate in planning learning activities is important, rather than just leaving it to the employer.

The ability to continually develop one's skills is seen as sufficiently important in an engineering professional to be enshrined as an outcome that must be demonstrated in order to attain registration.

9.1 At what level must I manage my development

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

9.2 Managing Own Development

Any of the activities listed below or combinations constitute CPD (and hence IPD):

- Attending courses, seminars, congresses and technical meetings organized by Engineering Institutions/Institutes, universities, other professional bodies and course providers.
- Actively participating in conferences, serving on technical or professional committees and working groups.
- Undertaking structured self-study (i.e. using textbooks with examples).
- Studying technical literature (e.g. journals, magazines)
- Taking correspondence courses and studying other supervised study packages.
- Taking in-house courses provided by employers.
- Enrolling for formal post-graduate studies (limited credits).
- Writing technical papers or presenting papers or lectures at an organized event.

Pre-registration IPD is not subject to an annual points requirement. IPD involves learning activities that are initiated by the candidate as distinct from structured learning activities required by the employer.

9.3 How do I know when I am performing at the right level?

A person typically demonstrates that he or she manages his or her own professional development by:

- Plans own professional development strategy;
- Selects appropriate professional development activities;
- Keeps record of professional development strategy and activities;
- Displays independent learning ability;
- Completes professional development activities.

10 Notes on Special Cases

10.1 Candidates who are in Academic and Research Positions

This guide is written for candidates who are training and working in the engineering industry. It is recognised that applicants for registration have in particular cases, worked in teaching and research positions during their development toward registration. While teaching and research do not conform to the normal industry employment situation, they do nevertheless offer opportunity to develop toward meeting the competency standards.

Candidates proceeding via this route are also likely to have completed higher education programmes beyond the BEng educational level required for registration as a Professional Engineer. The registration policy allows such applicants to offer appropriate aspects of the advanced programme as part of the evidence of competence against particular outcomes.

Candidates employed in teaching and research positions should be alert to opportunities in their work experience that demonstrate competence against the outcomes. For example, the planning, execution and commissioning of a new substantial laboratory may provide evidence against a number of outcomes. Candidates should seek opportunities to assist senior colleagues, who are themselves registered with ECSA, with consulting work. This engagement, while never full time, should be sustained over a long period. The senior colleague, who should fulfil a Mentorship role, should allow the candidate to take on increasing responsibility, moving up to level E on the responsibility scale.

It is likely that the time required for the lecturer of researcher to obtain the necessary experience at the required level may be longer that in a conventional industrial situation.

10.2 Candidates who have completed advanced degrees

Candidates who have completed higher education programmes beyond the BEng or 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 applicants to offer appropriate aspects of the advanced programme as part of the evidence of competence against particular outcomes.

Appendix A: Legislation Applicable Generally and in Particular Areas of Engineering[2]

	Disciplines								
Legislation	Aero	Chem	Civil	Elec	Indus	Mech	Met	Mining	
Engineering Profession Act (Act No 46 of 2000									
Occupational Health and Safety Act (Act No 85 of 1993) General Machinery Regulations									
Occupational Health and Safety Act (Act No 85 of 1993) Construction Regulations									
Occupational Health and Safety Act (Act No 85 of 1993) Driven Machinery Regulations									
Occupational Health and Safety Act (Act No 85 of 1993) Pressurised Equipment Regulations									
Mine Health and Safety Act (act No 29 of 1996) Design of underground dam walls, plugs and barricades Regulations on use of water for mining									
Environmental Conservation Act									
National Building Regulations and Building Standards Act 103 of 1977: Certify structural system of a building or home									
National Building Regulations and Building Standards Act 103 of 1977: Certification of fire protection system									
National Building Regulations and Building Standards Act 103 of 1977: Certification of artificial ventilation systems									
National Building Regulations and Building Standards Act 103 of 1977: Geotechnical site investigations, Stability of excavations, Geotechnical investigations on sites underlain by dolomites									
National Water Act 36 of 1998:Various measures relating to pollution of a water resource; Waterworks process controller									
Water Act 54 of 1956 Determination of persons permitted to design dams									
Health Professions Act 56 of 1974 (Check?)									
Municipal Management Act??									

[2] **This table is a selection that is to be developed further.**

Revision History

Version	Date	Status/Authorised by	Nature of Revision
Rev 0: Concept E	4 March 2011	JIC Working Document	Adapted from working document Concept D
Rev 0: Concept F	11 April 2011	JIC Working Document	Edited, Appendix A material moved out of the text
Rev 0:Concept G	16 May 2011	JIC Working Document	Cross references corrected, Section 8.1 added, Section 10 added
Rev0: Concept H	7 June 2011	JIC Working Document	Appendix A removed to R-03-PE. Editorial changes and additions.
Rev0: concept I	27 June 2011	JIC Working Document	Editorial changes
Rev 0: Draft 1	31 October 2011	JIC submitted for Council Approval	No changes relative to Concept I.
Rev 1.0	12 Jan 2012	Approved by Council	