ENSURING THE
EXPERTISE TO GROW
SOUTH AFRICA

Guide to the Competency Standards for Registration as a Professional Engineering Technologist

R-08-PT

REVISION 2: 22 May 2018

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ECSA

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Background: ECSA Registration System Documents

Figure 1 below defines the documents that comprise the Engineering Council of South Africa (ECSA) system for registration in professional categories. The illustration also locates the current document (in grey).

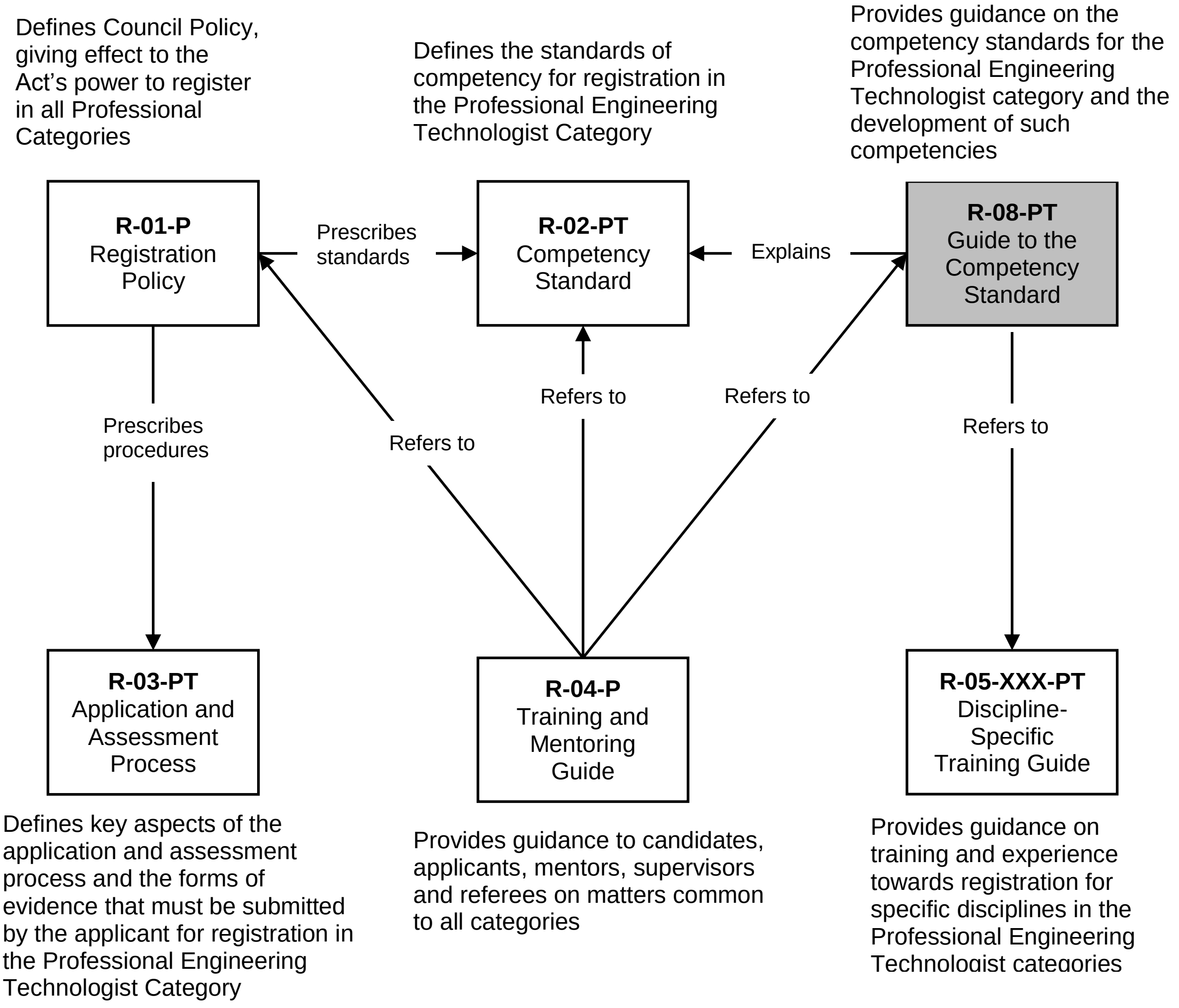

Figure 3: Documents defining the ECSA registration system

1. PURPOSE

This guide, document **R-08-PT**, amplifies the general Training and Mentoring Guide, document

R-04-P, and concentrates on the understanding of the Competency Standards for Professional Engineering Technologists defined in document **R-02-PT**. This guide can be used to determine whether an applicant is ready for professional registration or not. In addition, the guide 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 guidelines **R-05-XXX-PT**, if available for the applicant's discipline.

The intended audience of this guide includes the candidates/applicants undergoing training towards professional registration, mentors, supervisors, assessors, moderators, and reviewers.

2. INTRODUCTION TO COMPETENCY, STANDARDS AND PERFORMANCE

What is a competent Professional Engineering Technologist? In general, competence is defined as the possession of the knowledge, skills and attitudes that are 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 gained in the engineering education process and knowledge subsequently acquired during specialised engineering-related activities both in the work environment and from Continuing Professional Development (CPD). The skills and attitude component are defined by a set of assessable outcomes.

The ECSA Competency Standard, document **R-02-PT,** provides the formal definition of the competence that must be demonstrated in order to register as a Professional Engineering Technologist. The standard applies to all engineering disciplines and specialities. Contexts and functions in which competency may be developed and the outcomes demonstrated are described in the applicable Discipline-Specific Training guideline **R-05-XXX-PT**.

The following competencies must be demonstrated:

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

This guide, document R-08-PT, enlarges on the outcomes, level of performance and integrated performance required of an applicant for registration as a Professional Engineering Technologist.

3. OUTCOMES FOR PROFESSIONAL REGISTRATION

There are 11 outcomes that must be demonstrated by candidates/applicants in order to be considered for professional registration. The following section should be consulted by candidates/applicants and used as a rubric to determine if they are receiving the necessary exposure or not. Assessors, moderators and reviewers specifically use these outcomes to evaluate candidates/applicants for professional registration.

3.1. Overview of the outcomes

The outcomes required for professional registration as outlined in the Competency Standard, document **R-02-PT,** are summarised in Table 1 below in a nested Group A–E configuration.

Table 2: Overview of outcomes

GROUP	OUTCOME	DESCRIPTION
Group A Knowledge-based Engineering Problem-Solving	1	Define, investigate and analyse broadly defined engineering problems
	2	Design or develop solutions to broadly defined engineering problems
	3	Comprehend and apply knowledge embodied in widely accepted engineering principles, practices, procedures, processes, systems or methodologies specific to the jurisdiction in which the candidate practises
Group B Managing Engineering Activities	4	Manage part or all of one or more broadly defined engineering activities
	5	Communicate clearly with others in the course of the candidate's engineering activities

GROUP	OUTCOME	DESCRIPTION
Group C Risk and Impact Mitigation	6	Recognise and address the reasonably foreseeable social, cultural and environmental effects of *broadly defined engineering activities*
	7	Meet all legal and regulatory requirements and protect the health and safety of persons in the course of the candidate's *broadly defined engineering activities*
Group D Exercising Judgement, Taking Responsibility and Acting Ethically	8	Conduct engineering activities ethically
	9	Exercise sound judgement in the course of *broadly defined engineering activities*
	10	Be responsible for making decisions regarding part or all of the *broadly defined engineering activities*
Group E Initial Professional Development (IPD)	11	Undertake professional development that is sufficient to maintain and extend the candidate's competence

As described in the Competency Standard, document **R-02-PT**, and depicted in Table 1 above, the outcomes do not stand alone, and the performance of these 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 Engineering Technologists, which are all supported by communication and involve analysing and solving problems and managing processes, projects and operations to deliver results. To perform these four core functions, Professional Engineering Technologists rely on fundamental and specialised engineering knowledge together with knowledge of the context in which the work takes place.

Outcome 3 reflects the importance of the engineering knowledge that is embodied in outcomes 1, 2 and 4. This is the essence of engineering work!

While solving problems and managing processes, the Professional Engineering Technologist must be able to identify and address the impacts of the solutions and the applicable regulatory requirements as reflected in Group C (i.e. outcomes 6 and 7).

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

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

An alternative visualisation of the set of 11 outcomes is depicted in Figure 2 below, in which problem-solving (analysis and synthesis) is seen in the central position and competencies represented by other outcomes are shown as supporting roles.

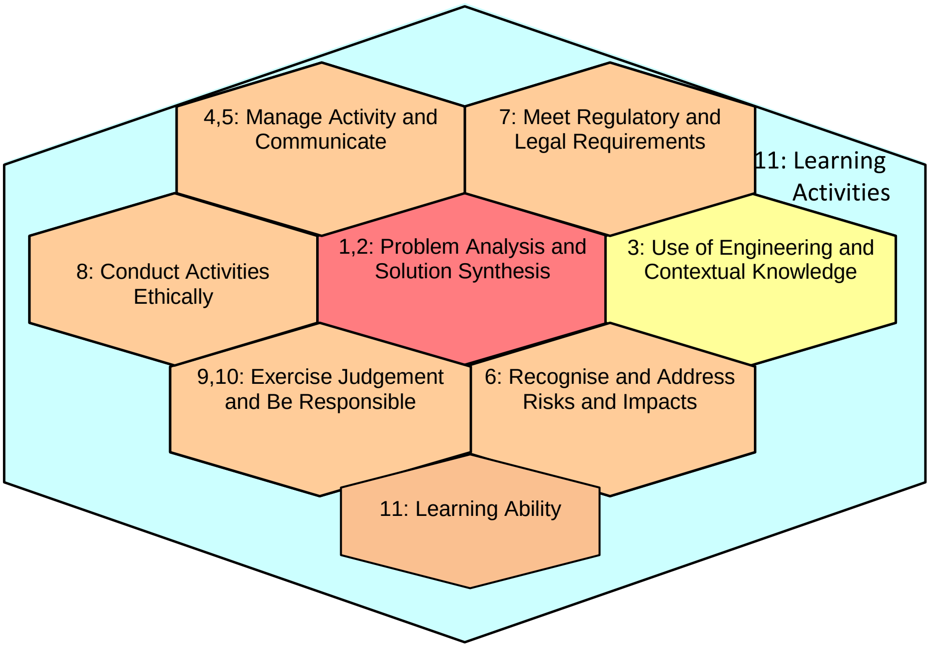

Figure 4: Summary of all 11 outcomes

3.2. Demonstrating the achievement of outcomes for professional registration

All the outcomes defined in the Competency Standard, document **R-02-PT,** and summarised in Table 1 of this document may arise from work of varying levels of demand and degrees of responsibility. Thus, at which level must an applicant demonstrate the defined outcomes to be judged competent to register as a Professional Engineering Technologist? Two level-defining phrases that have specific meanings appear in the Competency Standard, document **R-02-PT**:

- a set of level descriptors for a *broadly defined engineering problem*; and
- the level descriptors that allow engineering activity to be classified within *broadly defined engineering activities*.

The degrees of responsibility (i.e. Levels A–E) as defined in the Training and Mentoring Guide, document **R-04-P**, are used to measure the progression of the applicant's competency and are illustrated in Table 2 below. The applicant's competency for registration as a Professional Engineering Technologist is expected to be at Level E for Degree of Responsibility in regard to solving *broadly defined engineering problems* and carrying out the activities for each outcome.

Table 3: The nature of work and degrees of responsibility defined in document R-04-P

A: Being Exposed	B: Assisting	C: Participating	D: Contributing	E: Performing
Undergoes induction, observes processes and work of competent practitioners	Performs specific processes under close supervision	Performs specific processes as directed with limited supervision	Performs specific work with detailed approval of work outputs	Works in team without supervision, recommends work outputs, responsible but not accountable
No responsibility	Limited responsibility for work output	Full responsibility for supervised work	Full responsibility to supervisor for immediate quality of work	Level of responsibility to supervisor is appropriate to that of a registered person, supervisor is accountable for applicant's decisions

Mentor explains challenges and forms of solution	Supervisor/mentor coaches, offers feedback	Supervisor progressively reduces support but monitors outputs	Articulates own reasoning and compares it with that of supervisor	Assumes problem-solving without support, very limited guidance

3.3. Defining engineering activities

The Competency Standard, document **R-02-PT,** takes a broad view of defining engineering activities, listing several possible functions that include the following: 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.

The Discipline-Specific Training guideline **R-05-XXX-PT** should be consulted on the types of activities that a candidate needs to perform to demonstrate competence.

In summary, the following are essential in demonstrating evidence of competent performance:

1. The capability to perform a number of defined actions must be demonstrated.
2. 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 the assessment of activities/knowledge is holistic.

The Application and Assessment Process Guide, document **R-03-PT**, identifies areas of change from the training-based requirements to output-based competency standards and the accompanying changes in preparation for application and assessment of competency.

4. 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 *broadly defined engineering problems*.
- **Outcome 2 –** Design or develop solutions to *broadly defined engineering problems*.
- **Outcome 3** – Comprehend and apply advanced knowledge of the widely applied principles underpinning good engineering practice, specialist knowledge and knowledge that is specific to the jurisdiction and local conditions.

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 that have barriers that must be overcome 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 *broadly defined* is a characteristic of the competency of a Professional Engineering Technologist.

Problem-solving is the common feature that runs through engineering activities and is required in many engineering activities, including the design, development, research, investigation, planning, implementation, construction and operation of engineering systems and maintenance of plant infrastructure. Competency in problem-solving involves two phases: analysis and solution synthesis as captured in outcomes 1 and 2 of document **R-02-PT**. 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-PT**.

Broadly defined engineering problem-solving is perhaps the best starting point for applicants to determine the level at which they are working. *Broadly defined engineering problem-solving* must be demonstrated for an applicant to be considered for professional registration. Candidates/applicants who are unsuccessful in their application are often either not performing at the level of complexity of problem-solving required or did not convey it appropriately in the reports and the review process.

4.1. Outcome 1

4.1.1. What is engineering problem-solving?

An applicant should refer to the suggested test for a *broadly defined engineering problem* that is presented in the Competency Standard, document **R-02-PT**. The test is based on the four logical steps illustrated in Table 3. If there is one or more affirmative answers at each step, the problem is classified as a *broadly defined engineering problem*.

Table 4: Test for a *broadly defined engineering problem*

STEP	MAIN QUESTION	CRITERIA
Step 1 Identification of the engineering problem	Is the problem an engineering problem?	a) Does solving the problem require coherent and detailed engineering knowledge underpinning the applicable technology area?
Step 2 Establishment of 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, is under or over specified and requires identification and refinement into the technology area.
		c) The problem encompasses systems within complex engineering systems.
		d) The problem is classified as falling within typical engineering requirements and is solved in well accepted and innovative ways.
Step 3 Complexity of the problem path from the	What is encountered in the problem investigation and analysis process?	e) The problem can be solved by structural analysis techniques / tools / methodologies.

STEP	MAIN QUESTION	CRITERIA
initial state	Does it have **one or more** of the characteristics **e**, **f**, **g** and **h**?	f) Standards, codes and procedures must be applied to solve the problem, and justification to operate outside these standards and codes must be provided.
		g) The solutions require information from a variety of sources that are complex, abstract or incomplete. h) Involve set of interested and affected parties with defined needs to be taken into account, including needs for sustainability.
Step 4 Level of decision-making required and potential consequences	What is involved in the decision-making while analysing the problem? Does it have **either or both** characteristics **i** and **j**?	i) Practical solutions to the problem require knowledge and judgement in decision-making in the practice area and require consideration of the interface with other areas.
		j) Decisions have significant consequences that are important in the practice area but may extend more widely.

4.2. Outcome 2

4.2.1. How will I know when I am performing adequately at problem-solving?

At completion of the training period, candidates must demonstrate competence in outcomes 1, 2 and 3 through their work. The starting point of training is the level of problem-solving ability of the new graduate. The candidate/applicant is expected to produce the same level of problem-solving in the work environment as that previously produced in the academic environment. The candidate/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 candidate’s practice area and centre on the context in which the applicant practises.

Mentors, supervisors and applicants/candidates must plan the progression of tasks and responsibility to ensure the development of these competencies. They are advised to use suitable planning and recording assessment tools and feedback sessions. The progress of the applicant/candidate should be evaluated against each outcome using the Degree of Responsibility scale in the Training and Mentoring Guide, 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 the degree of responsibility defined in the Training and Mentoring Guide, document **R-04-P**, is illustrated in Table 2 of section 4.2 of this document.

Initially, the candidate/applicant assists experienced engineering personnel in their problem-analysis and solution activities, receiving detailed guidance and continuous monitoring. The candidate/applicant then progresses to contribute individually and as a team member in the solution of engineering problems. Finally, the candidate/applicant must achieve Level E of responsibility, performing individually and as a team member to solve problems. In this last phase, the candidate/applicant must perform over the entire problem lifecycle.

The candidate/applicant should be given the opportunity to experience *broadly defined engineering problem-solving* in contexts such as design, development, research, investigation, planning, implementation, construction and operation of engineering systems and maintenance of plant infrastructure. The candidate should be encouraged to apply first principles to *broadly defined engineering problems* and to develop and apply specialist and contextual knowledge.

Considering the problem of assessing the performance of an applicant/candidate against learning outcomes 1 and 2, the ECSA requires the applicant/candidate to perform a creative, systematic analysis of problems at the required level and to work systematically to synthesise solutions to the problems.

Outcome 1: Systematic analysis follows a schema as presented below. The applicant

- interprets and clarifies requirements, leading to an agreed definition of the problem to be addressed;
- identifies interested and affected parties and their expectations;
- gathers, structures and evaluates adequate information relating to the problem;
- performs a structured analysis;
- evaluates the result of the analysis and revises or refines as required; and
- documents, reports and conveys outcome to the requesting party.

Outcome 2: A similar schema applies to the synthesis phase. The applicant:

- proposes potential approaches to the solution;
- conducts a preliminary synthesis following selected approaches;
- evaluates potential solutions against requirements and wider impacts;
- presents reasoned, economical and contextual engineering arguments for the selected option;
- fully develops the chosen option;
- evaluates the resulting solution; and
- documents the solution for approval and implementation.

Many types of problems can be offered to demonstrate problem-solving ability. 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. Developing solutions to *broadly defined engineering problems* does not only involve the actual design. The applicant/candidate is expected to indicate competence in the choice of the systematic approach to provide the solution, to demonstrate how alternative options are considered and how the preferred option/solution is selected by developing detailed design specification requirements and other engineering design documentation.

The level of the analysed problem 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 rely on problem-solving at different levels.

Some examples follow:

- Design: This 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. 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: It frequently happens that an existing piece of infrastructure, plant, equipment or process is in need of improvement. The proper process is to analyse the existing state and define the desired final state. A process for moving from the initial to the final state must be developed. Again, the investigation is a problem-solving activity as is the solution synthesis phase.

- Developing the solution for engineering problems: This is the part of the design process that is iterative because of the related steps that are used until the appropriate solution is found and a decision is made. This decision is based on a number of alternatives/options that are considered against engineering standards or codes of practice in the technology area to meet set parameters or criteria.

Other engineering activities have problem-solving based on engineering knowledge at their centre. These include: 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.

4.3. Outcome 3

4.3.1. How will I display my application of engineering and contextual knowledge?

All engineering activities, and problem-solving in particular, rely on the applicant comprehending and applying the relevant ECSA benchmarked qualification theory and knowledge that is embodied in widely accepted and applied engineering procedures, processes, systems, tools and methodologies that are specific to the practice area.

The statement of Outcome 3 recognises three components comprising the knowledge that must be comprehended by the Professional Engineering Technologist:

1. Knowledge is rooted in principles (generally first principles) of general laws of the natural and engineering sciences, technologies, methodologies and the applied principles of good engineering practice.

2. It is recognised that individual Professional Engineering Technologists develop specialised knowledge regarding either a generally recognised area or a particular combination of topics. This includes understanding *broadly defined* procedures, codes and techniques that are mathematically, scientifically and engineering based and that underpin teamwork.

3. Knowledge that is specific to the practice area in which the Professional Engineering Technologist practises is essential. This includes knowledge of the society, economy, regulatory system and physical environment in which the Professional Engineering Technologist 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. The Discipline Specific Training guides **R-5-XXX-PT** may be consulted on this topic. The practice area, for example, may be a commonly understood area such as Structural Engineering or power distribution or may be a particular blend as a result of the individual's experience. Therefore, the engineering knowledge requirements from the Competency Standard, document **R-02-PT**, are stated in generic terms.

For the Professional Engineering Technologist, the engineering knowledge acquired in an accredited engineering programme is the basis for practice area knowledge. The Professional Engineering Technologist must be capable of engineering analysis. Engineering knowledge may be used explicitly or tacitly.

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

Engineering work does not occur in isolation, and knowledge of the regulatory requirements in regard to health and safety, the environment, the contract and quality and risk are essential. The application of engineering knowledge as an outcome is normally demonstrated during the design, investigation or operation. The applicant typically

- displays mastery of understanding current and emerging technologies in the practice area;
- applies general and underpinning engineering knowledge to support analysis and provide insight into technologist activities;
- uses an analytical approach as required;
- displays working knowledge of areas that interact with the practice area; and
- applies related financial, statutory, safety and management knowledge.

5. GROUP B: MANAGING ENGINEERING ACTIVITIES

Groups B, C and D reflect competencies that are all linked to problem-solving (Group A) 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.

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

- **Outcome 4 –** Manage part or all of one or more *broadly defined engineering activities*
- **Outcome 5 –** Communicate clearly with others in the course of their *broadly defined engineering activities*

5.1. Outcome 4

5.1.1. What are engineering managing competencies?

Competent Professional Engineering Technologists must not only perform engineering functions but must also manage engineering activities. Two statements of management competency in Group B described in the Competency Standard, document **R-02-PT**, are as follows:

1. Competency to manage *broadly defined engineering activities* must be demonstrated.
2. 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 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 Engineering Technologist. However, the applicant must take on the responsibility necessary to demonstrate competency under the guidance of suitable competent persons, as described in the Training and Mentoring Guide, document **R-04-P.**

Engineering management is more than project management. Project management in itself is in most cases supportive of engineering activity and does not represent the level of demonstration of performance at the degree of responsibility required.

5.1.2. What level of activities must I be able to manage?

The Competency Standard, document **R-02-PT,** provides a test of whether a given engineering activity is classed as a *broadly defined engineering activity* or not. The test for *broadly defined* *engineering activity* has been summarised in Table 1, section 4.1 of this document. The test is applied to the activity itself to determine the complexity of its scope and operating environment, its resource intensiveness, the severity of constraints and the risks and consequences. This test is not independent of the test for *broadly defined problem-solving*; most of the factors are those that give rise to barriers in the problem-solving process and also render the problem *broadly defined*.

The definition of the required level of activity as described in the Competency Standard, document **R-02-PT**, does not imply that applicants in every category work at that level all the time. Rather, candidates 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 level by having in effect done so in the work situation.

The strategy for developing problem-solving competence to the level required in the workplace and to the degree of responsibility is defined in the Training and Mentoring Guide, document **R-04-P**, and illustrated in Table 2, section 4.2 of this document.

The various phase activities of an applicant assist in developing the ability to plan, organise, lead and control. The applicant must be able to perform these functions both alone and in a team. Conducting engineering work on one's own or in a team requires planning and organising to attain the required engineering 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.

5.2. Outcome 5

5.2.1. How do I know when I am managing and communicating at the required level?

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 about not only engineering matters but also the financial, social, cultural, environmental and political aspects of engineering activity.

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

- Manage self
- Work effectively in a team environment
- Manage people, work priorities, work processes and resources
- Establish and maintain professional and business relationships

Effective communication can be demonstrated by the ability to

- write clear, concise and effective reports that are technically, legally and editorially correct using a structure and style that meets communication objectives and user/audience requirements;
- read and evaluate engineering and legal matter relevant to the function of the Professional Engineering Technologist;
- receive instructions and ensure correct interpretation;
- issue clear instructions to subordinates using appropriate language and communication aids and ensure that language and other communication barriers are overcome; and
- undertake oral presentations using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.

This outcome will be evaluated at two stages:

1. Applicant's written application for registration
2. During the professional review process in which the applicant is required to answer engineering questions.

6. GROUP C: RISK AND IMPACT MITIGATION

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

- **Outcome 6** – Recognise and address the reasonably foreseeable social, cultural and environmental effects of *broadly defined engineering activities*
- **Outcome 7 –** Meet all legal and regulatory requirements and protect the health and safety of

persons in the course of the *broadly defined engineering activities*

These outcomes deal respectively with the impacts of engineering activity that are not subject to regulation but rely on the professionalism of the applicant and the impacts that are subject to regulation, both specific and general.

Outcome 6 (impacts of engineering), Outcome 7 (legal and regulatory aspects) and Outcome 8 (ethical behaviour in Group D) reflect the professional behaviour and attitudes expected of a Professional Engineering Technologist. These are supported by knowledge of the context in which the individual practises (an aspect of Outcome 3). It is recognised that during candidacy, exposure to these issues is not as intensive as for an experienced Professional Engineering Technologist. Candidates are, therefore, expected to supplement experience by reading and reflecting on these issues before applying for registration.

Appendix A of this document and the Discipline-Specific Training guideline **R-05-XXX-PT** list materials that should be consulted and include relevant legislation. Both candidates and applicants should also make use of suitable IPD courses in these areas.

6.1. Outcome 6

6.1.1. How do I know when I am able to analyse and manage the impacts, benefits and consequences of engineering activities?

Engineering activities deliver benefits to society and the economy in the form of infrastructure, services and goods. Engineering involves the harnessing and control of 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 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 as a 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 Engineering Technologist: The Professional Engineering Technologist is expected to be able to identify and to deal with 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
- Potential ethical dilemmas

To show competency in ***impact analysis and mitigation***, the following should be done:

- Identify interested and affected parties and their expectations.
- Identify interactions between engineering considerations and social-cultural and environmental factors.
- Identify environmental impacts of the engineering activity.
- Identify sustainability issues.
- Propose and evaluate measures to mitigate the negative effects of engineering activity.
- Communicate with stakeholders.
- Adopt measures to mitigate the negative effects of engineering activities.

6.2. Outcome 7

6.2.1. How do I know when I have met all the legal and regulatory requirements in the course of my engineering activities?

Outcome 7 is concerned with explicitly regulated aspects of engineering practice and the more general legislation that may apply. Applicants should ascertain the legislation that applies in their work environment. Appendix A of this document and the Discipline-Specific Training guideline **R-05-XXX-PT** list certain recommended material that should be consulted, including the relevant legislation.

Of particular importance is Occupational Health and Safety legislation. The following are the principal Acts that are applicable in the South African context as depicted in Appendix A of this document:

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

All Professional Engineering Technologists who are registered or practise as certificated and specified category engineers must be cognisant with and comply with the provisions of the Acts.

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

- identify the applicable legal, regulatory and health and safety requirements for the engineering activity;
- identify the risk and apply defined widely accepted risk management strategies;
- select safe and sustainable materials, components, processes and systems; and
- communicate with parties involved in the legal and regulatory aspects of the work.

7. 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 *broadly defined engineering activities*
- **Outcome 10 –** Be responsible for making decisions on part or all of *broadly defined engineering activities*

Professional Engineering Technologists must make engineering and managerial decisions that are related to risks arising from their activities. Three outcomes in Group D are concerned with competencies exercised at a personal level.

7.1. Outcome 8

7.1.1. How do I know when I have developed the competency to conduct engineering activities ethically?

Outcome 8 has the simple statement: 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 interest and the environment, and to uphold the dignity of the profession and one's relationship with fellow professionals. Included is 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 Engineering Technologist 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 Engineering Technologist must deal with any ethical problems that arise.

An applicant who is capable of dealing with ethical issues adopts a systematic approach to resolve ethical issues that 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 a solution that most appropriately resolves the dilemma.

7.2. Outcome 9

7.2.1. How do I know when I have exercised sound judgement in the course of broadly defined activities?

The Professional Engineering Technologist is expected to make decisions in situations where the information to underpin the decision may be complex (i.e. the information has more than one part with interactions between parts or the information is incomplete). Such decision-making requires due care by the Professional Engineering Technologist and may be informed by experience. The Professional Engineering Technologist must, therefore, have the ability to think of many matters at once and consider their interdependence, their relative importance and their consequences. This process is known as exercising judgement within *broadly defined engineering activities* or in the solution of *broadly defined engineering problems*.

According to the Training and Mentoring Guide, document **R-04-P**, applicants should be challenged and given the opportunity

- to make decisions when full information is not available;
- to use engineering judgement;
- to take due care that the outputs and the impacts of an assignment are addressed; and
- to 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**.

Additionally, the indication that an applicant exhibits engineering judgement is typically demonstrated by

- considering several factors, some of which may not be well defined or may be unknown;
- considering the interdependence, interactions and relative importance of factors;
- foreseeing consequences of actions;
- evaluating a situation in the absence of full evidence;

- drawing on experience and knowledge; and
- justifying judgements in regard to risks associated with decisions.

7.3 Outcome 10

7.3.1. How do I know when I have taken responsibility for broadly defined engineering activities?

Professional Engineering Technologists are accorded professional status in society by their competence and the facts that the profession self-regulates and that professionals are accountable for their actions. The person registering as a Professional Engineering Technologist must, therefore, understand the obligation to be responsible and to have experience in making decisions since wrong decisions can have adverse consequences. Subject to the limitations regarding taking responsibility as an applicant as discussed in document **R-04-P**, the applicant for registration as a Professional Engineering Technologist must demonstrate the capacity to make recommendations that display responsible behaviour in accordance with the ECSA Code of Conduct.

According to document **R-05-PT**, being responsible at the required degree of responsibility (Levels D–E) is evidenced by:

- demonstrating a professional approach at all times;
- exhibiting due regard to engineering, social, environmental and sustainable development considerations;
- seeking advice from a responsible authority (or other professional) on any matter considered to be outside the area of competence; and
- making decisions and taking responsibility for work output.

8. GROUP E: PROFESSIONAL DEVELOPMENT

As described in Table 1 of this document, Group E consists of only **Outcome 11:** Undertake professional development activities sufficient to maintain and extend competence.

8.1 Outcome 11

8.1.1. How do I know when I have developed and managed my competence?

Outcome 11 concerns IPD that consists of activities identified to meet the CPD requirements before registration. Professional Development activities carried out between graduation and applying for professional registration is termed IPD This is an integral part of the professional competence that is required to practise engineering safely and effectively.

Continuing Professional Development is defined as the activities that a registered professional is required to maintain and complete at the required level to maintain registration. Continuing Professional Development is the systematic maintenance, improvement and broadening of knowledge and skills and the development of personal qualities necessary for the execution of professional and engineering duties throughout the career of a Professional Engneering Technologist.

A registered Professional Engineering Technologist is required to maintain and extend competence and must complete the required level of CPD at least to maintain registration.

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

This capability has several dimensions:

- Take responsibility for one's own development
- Reflect on strengths and weaknesses and recognise needs and plans
- Execute development activities and overcome obstacles.

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

The essential test is the activity that is appropriate for the specific developmental needs of the individual. In addition, rather than leaving the planning of learning activities to the employer, the role of the applicant regarding this is important. The ability to develop one's skills continually is seen 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 Engineering Technologist, 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 CPD and hence IPD:

- attending courses, seminars, congresses and technical/engineering meetings organised by engineering institutions / institutes, universities, other professional bodies and course providers;
- actively participating in conferences, serving on engineering committees, professional committees and in working groups;
- undertaking structured self-study (i.e. using textbooks with examples);
- taking correspondence courses and studying other supervised study packages, including e-Learning (i.e. online courses);
- enrolling for formal postgraduate studies (limited credits);
- writing technical/engineering papers and presenting papers or lectures at organised events;
- reading technical/engineering papers such as white papers or peer-reviewed articles;
- studying engineering literature (i.e. journals and magazines);
- conducting research and literature reviews that are part of the engineering design and synthesis process;
- attending in-house training courses offered by companies;
- participating in accredited CPD training activities; and
- taking credit-bearing courses in higher education institutions that directly complement the

individual's engineering-related knowledge.

An applicant typically demonstrates professional development by

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

9. NOTES ON SPECIAL CASES

9.1. Applicants in academic and research positions

In certain cases, applicants are employed in engineering academia as lecturers, in the research and development industry or in highly specialised fields during their development towards registration. While these applicants do not conform to the normal industry employment situation, they nevertheless gain the opportunity for development towards meeting the Competency Standards.

Examples of these special cases are

- Teaching/lecturing/facilitation
- Research or further studying
- Laboratory experimental activities
- Conferences/symposia/seminars
- Consulting

Applicants proceeding via this route are likely to have completed higher education programmes beyond the relevant education qualification level benchmarked by the ECSA for registration as a Professional Engineering Technologist. The registration policy allows such applicants to offer appropriate aspects of the advanced programme as part of the evidence of competence against particular outcomes. It should be noted that applicants who have a number of years of industry experience with an educational level below the relevant ECSA benchmarked qualification can apply via this alternative route.

Applicants 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 and substantial laboratory may provide evidence against a number of outcomes. Applicants should seek opportunities to assist senior colleagues who are registered with the ECSA with consulting work. This engagement, while never full time, should be sustained over a long period. The senior colleague should fulfil a mentorship role and allow the candidate to take on increasing responsibility, moving up to Level E on the responsibility scale. It is likely that the time needed for the lecturer or researcher to obtain the necessary experience at the required level may be longer than in a conventional industrial situation.

9.2. Applicants who have completed advanced qualifications

Applicants who have completed advanced educational studies beyond the BTech or equivalent educational level (e.g. research degree) required for registration as a Professional Engineering Technologist should identify opportunities to present evidence at the required level against the outcomes defined in the Competency Standards. The Training and Mentoring Guide, document **R-04-P**, indicates the advanced studies that contribute towards training. In addition, the registration policy allows such applicants to present appropriate aspects (i.e. experimental and investigation) of their advanced studies as part of the evidence of competence against particular outcomes.

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 document 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 with document R-01-P	Approved by PDSGC

The Guideline for:

Guide to the Competency Standards for Registration as a Professional Engineering Technologist

Revision 2 dated 22 May 2018 and consisting of 34 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Policy Development and Standards Generation (**PDSG**).

.... 21/08/2018

Business Unit Manager — Date

.... 29/08/2018

Executive: **PDSG** — Date

This definitive version of this policy is available on our website

APPENDICES

Appendix A: Examples of legislation applicable generally and in particular areas of engineering

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
   4.1. National Environmental Management Act, No. 107 of 1998
   4.2. National Environmental Management Waste Act, No. 59 of 2008
   4.3. National Radioactive Waste Disposal Institute Act, No. 53 of 2008
   4.4. National Nuclear Regulator (NNR) Act, No. 47 of 1999
   4.5. Mine Health and Safety Act, No. 29 of 1996
   4.6. South African National Standard (SANS) 10248, 1023: Waste Classification and Management Regulations from the Constitution of the Republic of South Africa, (Act No. 108 of 1996) and the Hazardous Substances Act, No. 15 of 1973
5. National Building Regulations and Building Standards Act, No.103 of 1977

5.1. Certification of structural system of a building or home

5.2. Certification of fire protection system

5.3. Certification of artificial ventilation system

5.4. Geotechnical site investigations, stability of excavations, geotechnical investigations on sites underlain by dolomites

5.5. Fire Protection Standard SANS Code 10139: 2012 for fire detection and alarm systems for buildings – system design, installation and servicing

6. National Water Act, No. 36 of 1998

6.1. Various measures relating to pollution of a water resource

6.2. South Africa Bureau of Standards (SABS): Standards Act, No. 24 of 1945; Act No. 29 of 2008

6.3. List of SABS/TC 147 STANDARDS, listing SANS codes for chemical use for treatment of water intended for human consumption and other purposes (e.g. SANS 241: 2015 Drinking Water Standard)

6.4. SANS codes for food and beverages (e.g. SANS 10133, etc. from www.sans.co.za)

7. Water Act, No. 54 of 1956

7.1. Determination of persons permitted to design dams

8. ISO 9001: 2015

9. South Africa Bureau of Standards (SABS): Standards Act, No. 24 of 1945; Act No. 29 of 2008

10. Nuclear Energy Act, No. 46 of 1999

10.1 Minerals and Energy Acts (e.g. Mineral and Petroleum Resources Development Act, No. 28 of 2002)

11. SANS Codes from www.sabs.co.za