


<b>ENGINEERING COUNCIL OF SOUTH AFRICA</b> <i>Standards and Procedures System</i>			 <b>E C S A</b>
<b>Competency Standard for Registration as a Professional Engineer</b>			
<b>Approved by Council: Under Review Joint Implementation Committee</b>			
<b>Document : R-02-PE</b>	<b>Rev-0 Draft-6.1</b>	<b>30 January 2007</b>	

## 1 Purpose

This document defines the competency required for registration with the Engineering Council of South Africa as a Professional Engineer. Section 2 defines the set of outcomes to be satisfied, together with typifying assessment criteria and range statements. Section 3 defines the general range of problem solving, engineering activities and required knowledge.

## 2 Outcomes that Demonstrate Competency

The candidate evidences the required competency by demonstrating in an integrated manner, in a workplace context, the following outcomes within *complex engineering activities* and solving *complex engineering problems* defined in the General Range Statement.

### Learning Outcome 1:

Define, investigate and analyse complex engineering problems.

**Assessment Criteria:** The candidate is expected to perform a creative, systematic analysis of problems typified by the following performances:

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, modeling;
4. Makes and justifies assumptions;
5. Uses of analytical methods both mathematical and non-mathematical;
6. Evaluates result of analysis, using judgement;
7. Expresses understanding emerging from analysis.

**Range Statement:** The problem may be a design requirement, an applied research and development requirement or a problematic situation in an existing component, system or process. This outcome is concerned with the understanding and judgement of a problem: Outcome 2 is concerned with the solution.

### Learning Outcome 2:

Design or develop solutions to complex engineering problems

**Assessment Criteria:** This outcome is normally demonstrated after a problem analysis as defined in outcome 1. The candidate is expected to work systematically to synthesise a solution to a problem, typified by the following performances:

1. Analyse the design/ planning /solution requirement and draw up detailed requirements specification;
2. Synthesise a range of potential solutions to problem or approaches to developing a solution
3. Evaluate the potential approaches against requirements, including cost, and impacts outside requirements;
4. Presents reasoned arguments and proposal for preferred option;
5. Fully develop design of selected option;

6. Evaluate resulting solution;
7. Produce design documentation for implementation.

**Range Statement:** The solution may be the design of a component, system or process or a recommendation of the remedy to a problematic situation.

### **Learning Outcome 3:**

Comprehend and apply advanced knowledge of the widely-applied principles underpinning good engineering practice, specialist knowledge and knowledge specific to the jurisdiction and local conditions.

**Assessment Criteria:** 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;
5. Applies related knowledge: financial, statutory, safety, management.

**Range Statement:** Specialist knowledge has depth in the practice area and is underpinned by the fundamental knowledge of an engineering discipline or cross-disciplinary area. Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice.

### **Learning Outcome 4:**

Manage part or all of one or more complex engineering activities

**Assessment Criteria:** 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.

**Range Statement:** Management is demonstrated in the context of *complex engineering activities*. The team is in general multi-functional or multidisciplinary. Relationships may be primarily as a supplier or recipient of goods or services. Parties to relationship include engineers in same and other practice areas, other professionals, clients, customers.

### **Learning Outcome 5:**

Recognise and address the reasonably foreseeable social, cultural and environmental effects of complex engineering activities.

**Assessment Criteria:** This outcome is normally displayed in the course of analysis and solution of problems. The candidate typically:

1. Identifies interested and affected parties and their expectations;
2. Identifies interactions between technical 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.

**Range Statement:** Impacts considered extend over the lifecycle of the project and include direct and indirect effects.

**Learning Outcome 6:**

Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his or her complex engineering activities.

**Assessment Criteria:** The candidate is expected to:

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

**Range Statement:** Requirements include both explicitly regulated factors and those that arise in the course of particular work. Persons whose health and safety are to be protected are both inside and outside the workplace.

**Learning Outcome 7:**

Conduct his or her engineering activities ethically.

**Assessment Criteria:** The candidate is expected to be sensitive to ethical issues and 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.

**Range Statement:** Ethical behaviour is at least that defined by the Code of Conduct.

**Learning Outcome 8:**

Exercise sound judgement in the course of complex engineering activities.

**Assessment Criteria:** A candidate typically exhibits judgement 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.

**Range Statement:** Situations in which judgement must be applied involve interactions between wide-ranging or conflicting technical, engineering or other issues.

**Learning Outcome 9:**

Be responsible for making decisions on part or all of complex engineering activities.

**Assessment Criteria:**

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<sup>1</sup> on and takes responsibility for work output.

**Range Statement:** The candidate is expected to demonstrate adequately discharging responsibility for significant parts of a one or more *complex engineering activity*.

**Note 1:** While the candidate may not have taken actual responsibility for the work due to statutory or other requirements for a professional Engineer to take such responsibility, the candidate must show evidence of responsible recommendations and judgement.

**Learning Outcome 10:**

Communicate clearly with others in the course of his or her engineering activities

**Assessment Criteria:** The candidate demonstrates effective communication 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.

**Range Statement:** Material relates to technical aspects and wider impacts of professional work. Audience includes peers, other disciplines, client and stakeholders audiences. Appropriate modes of communication must be selected.

**Learning Outcome 11:**

Undertake professional development activities sufficient to maintain and extend his or her competence

**Assessment Criteria:** The candidate manages his or her own professional development by typically:

1. Plans own professional development strategy;
2. Selects appropriate professional development activities;
3. Keeps record of professional development strategy and activities;
4. Displays independent learning ability;
5. Completes professional development activities.

**Range Statement:** In proceeding from Stage 1 to Stage 2, the candidate must bear the compulsory Unit Standards and the targeted elective in mind in developing the strategy and activities. A candidate in a structured programme is expected to take ownership of the strategy.

### **3 General Range Statement:**

**Practice Area:**

Each engineer, by the time of reaching the point of assessment against this standard, will have followed a programme of education, training and experience that may conform to an established pattern or may be distinctive. Each individual therefore develops an area of knowledge and expertise that may be distinctive. This pattern of knowledge and expertise is termed the individual's *practice area*.

**Complex Engineering Activities:** are characterized by several or all of the following:

- *Activities* involve one or more of: design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; project management; research, development and commercialisation.
- *Boundaries* of practice area change over time, formulate new engineering principles, new procedures, standards or codes, or advancing engineering practice

- *Context* is complex and varying, is multidisciplinary, requires teamwork, may be unpredictable and may need to be identified
- Involve the use of diverse *resources* (including people, money, equipment, materials, technologies), high risk or resource intensive projects
- Require resolution of significant problems arising from *interactions* between wide- ranging or conflicting technical, engineering or other issues
- Are *constrained* by time, finance, infrastructure, resources, facilities, standards & codes, applicable laws

**Complex Engineering Problems** are characterized by several or all of the following:

- Requires a fundamental and specialist underpinning knowledge
- May encompass entire complex engineering systems or complex subsystems
- Ill posed, unpredictable, under- or overspecified problems, requiring identification and refinement
- Information from variety of sources is complex, abstract and possibly incomplete & requires analysis, abstraction, structuring and evaluation
- Have no obvious solution and require originality and analysis
- Involves wide-ranging or conflicting technical, engineering and other issues
- Involve infrequently encountered issues
- Problems may be outside those encompassed by standards and codes; operate outside where justified.
- Involves wide ranges of interested and affected parties with widely varying needs
- Have significant consequences in a range of contexts
- Requires judgment in decision making taking diverse factors into account

**Knowledge:**

1. Requires in-depth specialist knowledge in practice area that allows a fundamentals-based, first principles analytical, approach building models as required
2. As required for practice area, a selection of: law of contract, Health and Safety, Environmental, IPR, contract administration, quality management, risk management maintenance management, regulation, project & construction management
3. Working knowledge of interacting disciplines (engineering and other) to underpin teamwork

**4 Revision History**

<b>Version</b>	<b>Date</b>	<b>Status/Authorised by</b>	<b>Nature of Revision</b>
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