



**An Effective Regulator Assuring Engineering Excellence**  
**Discipline-specific Training Guide for Registration as a**  
**Professional Engineer, Technologist and Technician in**  
**Agricultural Engineering**


**R-05-AGR-PE/PT/PN**

**REVISION 0: 19 September 2025**

**ENGINEERING COUNCIL OF SOUTH AFRICA**

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<b>Subject: Discipline-specific Training Guide for Registration as a Professional Engineer, Technologist and Technician in Agricultural Engineering</b>			
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## INTRODUCTION

All persons applying for registration as a Professional Engineer, Technologist or Technician are expected to demonstrate the competencies specified in document **R-02-STA-PE/PT/PN** through work performed at the prescribed level of responsibility, irrespective of the trainee's discipline.


The *Training and Mentoring Guide for Professional Categories (R-04-T&M-GUIDE-PC)* provides key aspects of training:

- Duration of training and length of time working at level required for registration.
- Principles of planning, training and experience.
- Progression of training programme.
- Documenting training and experience.
- Demonstrating responsibility.

It is therefore important to standardise the framework for all engineering disciplines to ensure that all ECSA registration categories are aligned

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## DEFINITIONS

**Applicant:** A person applying to the ECSA for registration in any of the categories according to Section 18 of the Engineering Profession Act, 46 of 2000.

**Candidate:** A person who is registered with ECSA in a Candidate Category of registration.

**Broadly defined engineering problems:** Composed of many interrelated conditions and requiring underpinning methods, procedures and technical judgement to create a solution within a set of originally broadly defined circumstances

**Commitment and Undertaking (C&U):** An agreement entered into between an employer and ECSA under which the employer commits to the training of a candidate to the standard required for registration in an identified Professional Category. A C&U may be entered into for one or more of the Professional Categories; more information is in ECSA document **R-11-PRO-PC**.

**Competency assessment:** A summative assessment of an applicant's competence against the prescribed standard based on evidence from the applicant's work and other assessments that include a Professional Review.


**Complex engineering work:** This work is characterised by the following:

- Scope of activities that may encompass entire complex engineering systems or complex subsystems.
- A context that is complex and varying, is multidisciplinary, requires teamwork, is unpredictable and may need to be identified.
- It requires diverse and significant resources including people, money, equipment, materials and technologies.
- Significant interactions exist among wide-ranging or conflicting technical, engineering or other issues.
- It is constrained by time, finance, infrastructure, resources, facilities, standards and codes, and applicable laws.
- It has significant risks and consequences in a range of contexts.

**Competency Standard:** Statement of competency required for a defined purpose.

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**Continuing professional development:** 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 an engineering practitioner

**Engineering problem:** A problematic situation that is amenable to analysis and solution using engineering sciences and methods

**Engineering science:** A body of knowledge based on the natural sciences, using mathematical formulation where necessary, that extends knowledge and develops models and methods to support its application, to solve problems, and to provide the knowledge base for engineering specialisations

**Ill-posed problem:** A problem whose requirements are not fully defined or may be defined erroneously by the requesting party

**Integrated performance:** The overall satisfactory outcome of an activity requires several outcomes to be satisfactorily attained; for example, a design requires analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.


**Level descriptor:** A measure of performance demands at which outcomes must be demonstrated.

**Management of engineering works or activities:** The co-ordinated activities required are to:

- direct and control everything that is constructed or results from construction or manufacturing operations
- operate engineering works safely and in the manner intended
- return the engineering works, the plant and the equipment to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts
- direct and control the engineering processes, systems, commissioning, operation and decommissioning of equipment
- maintain engineering works or equipment in a state in which it can perform its required function.

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**Mentor:** A professionally registered person who guides the competency development of an applicant in an appropriate category.

**Over-determined problem:** A problem for which the requirements are defined in excessive detail, making the required solution impossible to attain in all its aspects.

**Outcome:** At the professional level, outcome means a statement of the performance that a person must demonstrate to be judged competent.

**Practice area:** A generally recognised or distinctive area of knowledge and expertise developed by an engineering practitioner by virtue of the path of education, training, and experience followed.

**Range statement:** The required extent of or limitations on expected performance stated in terms of situations and circumstances in which outcomes are to be demonstrated.


**Specified category:** A category of registration for persons registered through the Engineering Profession Act, 46 of 2000, or through a combination of the Engineering Profession Act and external legislation with specific Engineering competencies at NQF Level 5 regarding an identified need to protect the safety, health and interest of the public and the environment, in relation to an engineering activity.

**Supervisor:** A person who oversees and controls engineering work performed by an applicant.

**Well-defined engineering problems:** Problems composed of interrelated conditions and requiring underpinning methods, procedures and techniques to create a solution within a set of originally well-defined circumstances.

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## ABBREVIATIONS

<b>BEng</b>	Bachelor of Engineering
<b>BEng (Tech)</b>	Bachelor of Engineering in Technology
<b>BSc (Eng)</b>	Bachelor of Science in Engineering
<b>CPD</b>	Continuing Professional Development
<b>C&amp;U</b>	Commitment and Undertaking
<b>DSTG</b>	Discipline-specific Training Guide
<b>ECSA</b>	Engineering Council of South Africa
<b>GIS</b>	Geographic Information Systems
<b>GPS</b>	Global Positioning System
<b>IDoEW</b>	Identification of Engineering Work
<b>IPD</b>	Initial Professional Development
<b>JBCC</b>	Joint Building Contract Committee
<b>MHSA</b>	Mine Health and Safety Act, 29 of 1996
<b>NDip</b>	National Diploma
<b>NEC</b>	New Engineering Contract
<b>OHS</b>	Occupational Health and Safety
<b>PE</b>	Professional Engineer
<b>PN</b>	Professional Engineering Technician
<b>PT</b>	Professional Engineering Technologist
<b>TER</b>	Training and Experience Report
<b>TES</b>	Training and Experience Summary

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## BACKGROUND

The illustration 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.

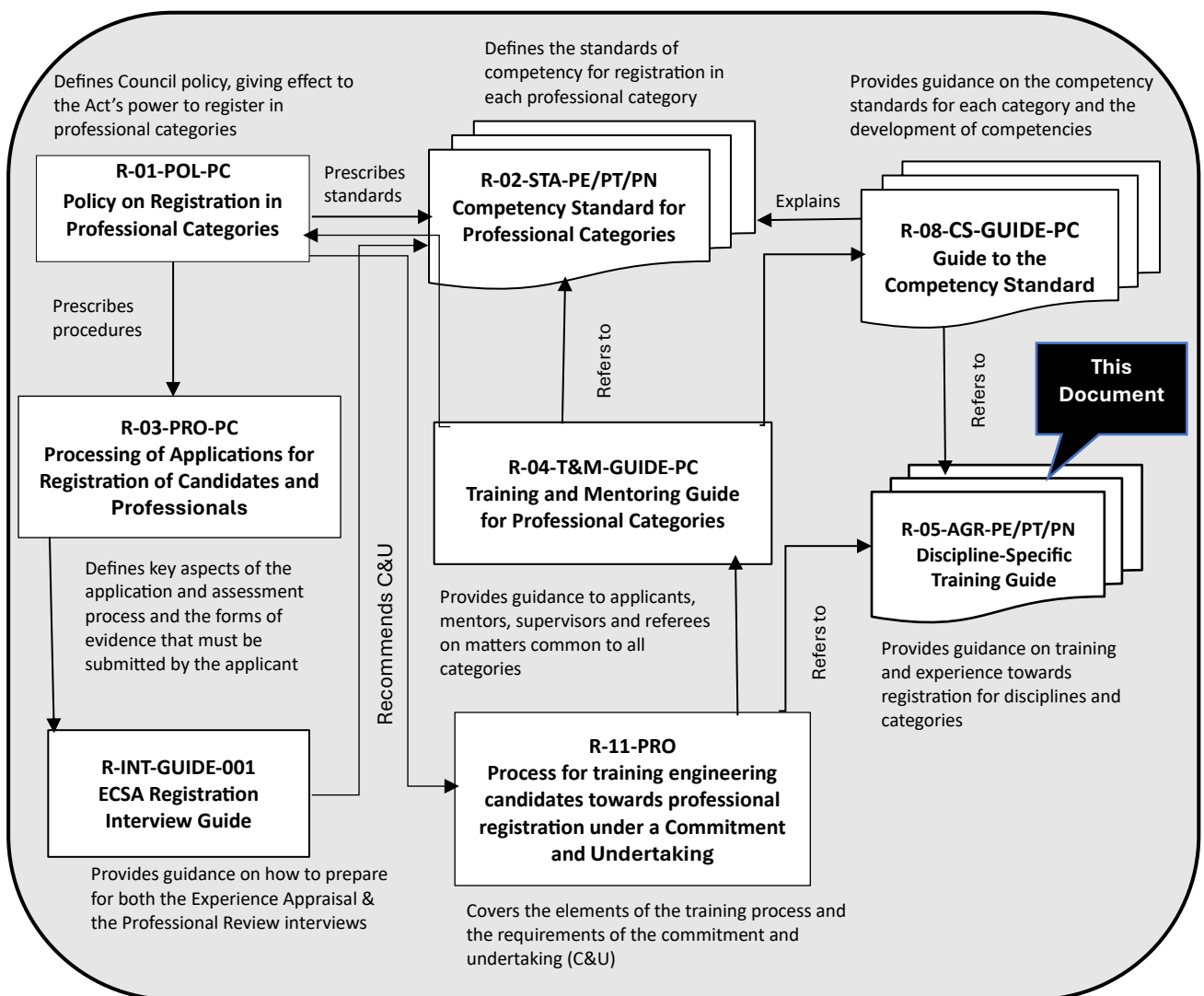



Figure 1: Documents defining the ECSA registration system

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## 1. PURPOSE OF THE DOCUMENT

All persons applying for registration as Engineering Professionals are expected to demonstrate the competencies specified in document **R-02-STA-PE/PT/PN** through work performed by the applicants at the prescribed level of responsibility, irrespective of the trainee's discipline.

This document supplements the generic *Training and Mentoring Guide (R-04-T&M-GUIDE-PC)* and the *Guide to the Competency Standards for Registration in Professional Categories (R-08-CS-GUIDE-PE/PT/PN)* for Applicant Engineers, Technologists, and Technicians or any other person who intends to register as a Professional with ECSA in the respective discipline.

This document must be read in conjunction with the following documents:

- *Policy on Registration in Professional Categories (R-01-POL-PC)*
- *Processing of Applications for Registration of Applicants and Professionals (R-03-PRO-PC)*
- *Training and Mentoring Guide for Professional Categories (R-04-TM-GUIDE-PC)*

## 2. AUDIENCE


This Discipline-specific Training Guide (DSTG) is directed towards Trainees and their Supervisors and Mentors in the discipline of Agricultural Engineering. It is intended to support a programme of training and experience incorporating elements of good practice.

The guide applies to persons who:

- have registered with the ECSA as a Candidate Engineer, Technologist, or Technician in Agricultural Engineering
- hold an ECSA-accredited qualification or an acceptable combination of accredited qualifications prescribed for the category
- have met the minimum education in a specific category through ECSA educational qualification evaluation or assessment
- have qualifications recognised by the Washington, Sydney and Dublin Accords for which the ECSA is a signatory thereof
- hold a qualification or combination of qualifications recognised under an international academic agreement relevant to the category, or

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- hold a qualification or a combination of qualifications that has been determined on a case-by-case evaluation to satisfy criteria for substantial equivalence to an accredited qualification for the category by virtue of the qualifications being awarded in a jurisdiction or a quality assurance system by the ECSA, or
- examination of detailed documentation on the qualifications reflecting substantial equivalence.

## 2.1 Persons registered as a Candidate with ECSA

Candidate engineering practitioners refers to persons registered with the ECSA after completing the relevant engineering undergraduate programme as accredited or substantially assessed to be equivalent by the ECSA. Training and development can be done under a Commitment and Undertaking (C&U) candidacy programme according to document **R-11-PRO-PC** or through a training academy's programme as outlined in document **A-01-POL**.

The training under a C&U or through a training academy is structured to align with the ECSA standard competency outcomes for the benefit of the Candidate. The professional Mentor, Supervisor, Coach and the Candidate must ensure that the training covers all developmental aspects aligned with the competency outcomes required for registration as a Professional.

Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development.


## 2.2 Persons not registered as a Candidate with ECSA

Regardless of the training development path any individual follows, all persons wishing to register with ECSA must present the same evidence of having met the ECSA-prescribed competency standard when assessed. Application for registration as a professional in a specific category is accepted without being registered as a Candidate Engineer, Technologist or Technician, or without training through a C&U candidacy programme or a training academy. However, mentorship and adequate supervision are critical in ensuring effective development towards achieving the competencies required for professional registration.

If the trainee's employer does not offer a C&U programme, the trainee should establish the level of mentorship and supervision that the employer is able to provide. In the absence of an

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internal Mentor, the services of an external Mentor should be secured. The Voluntary Association (VA) for the discipline may be consulted for assistance in finding an external Mentor. A Mentor must keep abreast of all stages of the development process and the ECSA registration requirements.

This DSTG is written for the trainees gaining experience towards registration. Applicants who have not enjoyed mentorship are advised to request an experienced Mentor (internal or external) to act as an adviser while they prepare their applications for registration.

This Discipline-specific Training Guide supplements the **R-08-CS-GUIDE-PE/PT/PN** document, and the **R-08-CS-GUIDE-PE/PT/PN** document indicates ways of developing the requisite competencies and how the competencies can be demonstrated through engineering work/ activities/tasks/projects to determine if an applicant is ready for professional registration.


### 3. TYPES OF ENGINEERING WORK

Agricultural Engineering involves the application of engineering principles to agriculture and other bio-based industries. It integrates scientific principles and engineering practice to solve practical problems in the production and processing of bio-based products such as food, feed, fibre and fuels. The core services and practice areas in the Agricultural Engineering discipline are diverse as described below in alignment with the ECSA *Identification of Engineering Work* (IDoEW) document (**IDoEW-01-STD**).

#### 3.1 Agricultural Engineering

Agricultural Engineers, Technologists and Technicians have unique skills to connect the living world of plants, soil, water and animals with the technology of engineering (i.e., systems, structures and machines). Agricultural Engineers, Technologists and Technicians are required to ensure sustainable environments with adequate energy, water supplies and food production and processing systems. Agricultural Engineers, Technologists and Technicians thus operate at the interfaces among engineering science and practice, agricultural production and processing and rural environmental management. The implication is that Agricultural Engineers, Technologists and Technicians must be aware of the factors that are important in agricultural production and processing and environmental sustainability. This is promoted by including introductory agricultural courses in the tertiary education of Agricultural Engineers,

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Technologists and Technicians. Applicants who have degrees in engineering disciplines other than Agricultural Engineering will have to show that they have attained this knowledge through practical experience in at least one of the many diverse areas of sustainable agricultural production and processing if they are to be registered as Agricultural Engineers, Technologists and Technicians.

Agricultural Engineers, Technologists and Technicians plan, perform and supervise engineering work related to the development or improvement of infrastructure, machinery and processes for agricultural production. In addition, they are responsible for post-harvest handling and processing of agricultural produce and similar engineering processes in associated environmental and biological contexts. This may include the use and development of agricultural land, the environment, infrastructure (buildings, roads, river crossings, dams, irrigation systems, electrification, etc.), machines, equipment and processes.


### **3.2 Areas of Agricultural Engineering**

Due to the multi-disciplinary nature of Agricultural Engineering, practising Agricultural Engineers, Technologists and Technicians generally concentrate on one or more of the following areas:

- Agricultural Energy Engineering
- Agricultural Renewable Energy Engineering
- Agricultural Product Processing Engineering
- Agricultural Structures and Facility Engineering
- Agricultural Waste Handling and Management
- Aquaculture Engineering
- Mechanisation Engineering
- Irrigation Engineering
- Hydrology and Agricultural Water-use Management
- Natural Resources Engineering (soil and water conservation)
- Food Engineering
- Environmental Engineering
- Rural Infrastructure Engineering

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Practitioners with the requisite engineering qualifications in the following special sectors can also register with ECSA, provided they satisfy all the outcomes in their respective sectors and agricultural fields:

- **Research and Development:** This type of work may be performed in research and product development centres of business organisations or at academic institutions. Trainees must undertake research and development work that is predominantly Agricultural Engineering in nature, and this work should include an in-depth application of the various aspects of Agricultural Engineering, including product or system testing under controlled experimental conditions.
- **Education and training:** This work may include training of undergraduate and postgraduate students, postgraduate or contracted research, or external engineering consulting projects.
- **Consulting/consultancy work:** The applicant whose education, experience, expertise and training qualify them to be a specialist in a unique competency may provide consulting services in one or more of the practice areas in Agricultural Engineering.


### 3.2 Typical tasks an Agricultural Engineering Professional may undertake

Typical tasks an agricultural engineering professional may undertake include the following:

- Advising or lecturing on and/or conducting research and developing new or improved theories, methods and technologies relating to the fields of agricultural infrastructure, agri-processing, irrigation and drainage engineering, mechanisation and precision agriculture and renewable energy (i.e., soil and water, power and machinery, the processing and handling of agricultural/biological products, structures, the environment, energy, particularly renewable energy, and biological systems).
- Designing, managing and/or advising on technology for food, fibre- and energy-production systems, including the design, sizing, selection and management of agricultural machinery, implements and equipment for field operations (e.g., soil preparation, planting, crop protection, harvesting, storage and transport of produce).
- Testing and evaluating agricultural machinery and equipment.
- Applying precision agriculture technologies (e.g., GIS, GPS) to ensure optimal and sustainable agricultural production systems that consider the environment.

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- Designing and overseeing the operation of transportation systems that move produce from fields to storage facilities, factories and market.
- Designing and managing irrigation systems to irrigate plants efficiently, ensuring optimal yield per unit of water applied and sustainability of the water resource.
- Designing and installing drainage systems for land conservation and optimal crop production.
- Designing and managing agricultural and rural water-resource systems through the design of dams, canals, boreholes, extraction works and pipe networks for water supply to agriculture and for domestic use.
- Assessing the availability of water resources and developing supporting infrastructure:
  - **Water Resource Planning** – managing water resources by reconciling water requirements and availability to ensure water balance.
  - **Options Analysis** – carrying out feasibility studies to identify the best technical solution for a water supply project to meet public needs
  - **Systems Operation** – allocation of the water resource with respect to the existing requirements as determined by the supply, which is influenced by natural occurrences and developments
  - **Reserve Determination** – determination of water requirements for ecological and basic human needs to ensure sustainability and equity which are identified as central guiding principles in the protection, use, development, conservation, management and control of the water resources as influenced by the variable climate of South Africa.
- Designing soil and water conservation systems to control runoff, thus minimising erosion, maximising agricultural production and sustaining the environment through minimising the negative impacts of agricultural practices.
- Designing and overseeing the operation of agricultural structures and infrastructure (e.g., farm buildings, farm roads, minor river crossings and bridges, soil retaining structures, animal handling facilities, agricultural waste handling and management facilities, spray races and dips).
- Designing and managing food processing and storage systems (e.g., storage structures, cold stores, pack houses, factories and plants for agricultural-produce value addition; food

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preservation, cooling, heating, dehydration and pasteurisation facilities; grain handling, storage and silo facilities; abattoirs; marketing structures) to add value to raw products, thus ensuring products are safe for human consumption.

- Designing and managing intensive animal handling and plant production structures and control systems that may have controlled environments for optimal plant production (e.g., greenhouses), animal breeding (e.g., housing structures, broiler units) and generation of animal products (e.g., dairy plants, milking parlours).
- Utilising renewable sources of energy (e.g., hydro, biofuels, solar, wind) to design and develop technology for agricultural uses like processing of agricultural products and biomass into bioenergy (e.g., anaerobic digesters).
- Designing, managing and advising on power and energy systems for agricultural production, including the designing, testing, evaluation and management of agricultural machinery and equipment (e.g., engines, motors, pumps, fans, pipes).
- Determining and specifying construction methods, materials and quality standards for agricultural purposes.
- Establishing control systems to ensure efficient functioning of infrastructure, including safety and environmental protection.
- Organising and directing the operation, maintenance and repair of agricultural production structures and facilities.
- Analysing the stability of structures, machinery and implements, including testing the behaviour and durability of the materials used in their construction.


### 3.3 Nature and organisation of the industry

The close association of Agricultural Engineering with biological and environmental systems requires specific attention to risk and impact mitigation, which in turn requires the Engineers, Technologists and Technicians to develop a good working knowledge of specific laws and regulations, including but not limited to the following:

- Atmospheric Pollution Prevention Act, 45 of 1965
- Conservation of Agricultural Resources Act, 43 of 1983 (CARA)
- Land Reform legislature
- Land Use Planning Ordinance Act, 15 of 1985 (LUPO)

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- National Environmental Management Act, 107 of 1998
- National Environmental Management Biodiversity Act, 10 of 2004
- National Environmental Management Waste Act, 59 of 2008
- National Water Act, 36 of 1998
- Occupational Health and Safety Act, 85 of 1993.

Trainees should ensure that the work in which they engage during the training period gradually increases their degree of responsibility and is relevant to their progression towards registration. Trainees should further ensure they gain experience in all the typical tasks that are present in the lifecycle of agricultural engineering projects, specifically including practical site work and engineering design. The tasks in the engineering project lifecycle listed below are elaborated upon in **Appendix A: Training Elements**:


- Solving complex, broadly and well-defined engineering, problems using engineering and contextual knowledge.
- Planning, implementing and operating engineering projects, systems, products and processes.
- Mitigating risk and impact.
- Managing engineering activities.

It should be noted that design is not restricted to physical infrastructure and artefacts and may involve new processes and operating systems.

Agricultural engineering encompasses a diverse range of fields, so it would be unrealistic to expect trainees to gain exposure to the full range of fields during the training period. However, it is important that trainees:

- are exposed to and demonstrate a good understanding of the context within which they are applying their knowledge, skills and engineering judgement
- gain experience across the full spectrum of tasks in the typical lifecycle of engineering projects
- are familiar with the statutory requirements related to their field of operation.

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#### 4. DEVELOPING ENGINEERING COMPETENCIES

Applicants can demonstrate competency in their field by compiling a portfolio of evidence that is structured according to the 11 outcomes mentioned in document **R-02-STA-PE/PT/PN** and further described in document **R-08-CS-GUIDE-PC**. The 11 outcomes are organised into five groups (groups A–E), nested as shown below:

##### **Group A: Knowledge-based problem-solving**

Trainees may develop and demonstrate competence in outcomes 1, 2 and 3 by providing evidence of problem identification and analysis that successfully interprets a diversity of factors affecting possible engineering solutions in farming, rural development or agri-industrial contexts. Examples of evidence for competency include identification, evaluation, selection, design, implementation of suitable engineering solutions (may include infrastructure and/or processes) and application of engineering and non-engineering knowledge and insight to achieve workable solutions.

##### **Group B: Management and communication**


Evidence for competency of the applicants in outcomes 4 and 5 (management and communication in Agricultural Engineering) includes examples of planning and organising, human resource management, plus fundsw, machinery, methods and materials in site work and Agricultural Engineering office contexts. Also included is professional and effective communication with farmers, rural communities, contractors, persons engaged in the agro-industry, relevant government departments, clients and peers.

##### **Group C: Identifying and mitigating the impacts of engineering activity**

Examples demonstrating competency in outcome 6 (identifying and mitigating the impacts of engineering activity) include responsible development, utilisation and protection of natural resources related to agriculture, including water, soil, biodiversity and air quality. Competence may further include mitigation of non-regulated impacts such as disturbances to social and economic stability through ill-considered engineering developments, particularly in remote rural areas.

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Evidence of competence in outcome 7 includes examples of human, animal and plant health protection in farming and agro-industrial contexts and compliance with the relevant regulatory requirements in the design of engineering solutions.

#### **Group D: Judgement and responsibility**

For outcomes 8, 9 and 10, applicants should demonstrate they are willing and able to take responsibility for decisions and are competent in judgement and responsible conduct in accordance with the ECSA Code of Conduct.

#### **Group E: Independent learning**

Towards the achievement of Outcome 11, Trainees should develop the ability and habit of independent and lifelong learning. Using the Continuous Professional Development (CPD) guidance documentation available on the ECSA website, applicants should provide evidence of relevant Initial Professional Development (IPD) activities completed during the training period.

### **4.1 Training for registration as a Professional Engineer**


#### **4.1.1 Outcome 1: Define, investigate and analyse complex engineering problems (Responsibility level E)**

According to the outcomes, engineers are expected to be able to define, investigate and analyse complex engineering problems by identifying systems and sub-systems in resolving complex problems and using data and information technologies where applicable. A complex engineering problem may be defined as a design requirement, an applied research and development requirement or a problematic situation in an existing component, system or process.

Defining a complex engineering problem involves identifying a complex engineering problem to solve and specifying clear goals or criteria that the final product or system must meet. This process must lead to a better understanding of the problem through investigation and analysis.

The investigation and analysis of complex engineering problems requires in-depth fundamental and specialised engineering knowledge, including the collection, organisation and evaluation of the information from all applicable sources. Analysis of an engineering problem

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means the “separation into parts possibly with comment and judgement”. Investigation and analysis of a complex engineering problem cannot be solely a desktop exercise as it requires in-depth knowledge and history of the system, other attempted or successful solutions and how far-reaching a solution to the problem may be.

As an example, engineers conduct research, advise on the design and direct the construction and operation of an automated irrigation system for a large-scale farm that grows a variety of crops, including vegetables, fruits and grains. They advise on processes, site assessment, system design, component selection, installation, automation and control, and monitoring and maintenance with a view to achieving improved water efficiency, labour savings, increased crops yield and sustainability.

*Complex* means “engineering systems in a context that is complex and varying, is multidisciplinary, requires teamwork, is unpredictable, and may need to be identified. It may also require diverse and significant resources”.

Typical tasks may include the following:


- Coherent and detailed engineering knowledge for Engineers means the encountered problem cannot be solved without the combination of all the relevant details, including the engineering principles applicable to the situation.
- The nature of the problem is not immediately obvious, is unfamiliar or involves infrequently encountered issues.

The problem is not easily recognised as part of the larger engineering task, project or operation and may be obscured by the complexity of the larger system.

- The problem is not obvious and requires abstract thinking or originality in analysis to formulate suitable models.
- Solving the problem requires a step-by-step approach.
- The problem falls outside the scope of usual standards and codes.
- The responsibility lies with the Engineer to verify that some information from a variety of sources is complex, abstract or incomplete, and solutions to problems may need justified assumptions.

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- The problem handled by an Engineer may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, unmaintainable, unsustainable, etc., and the Engineer will have to justify the recommendation.
- Practical solutions to problems include knowledge and judgement of the roles displayed by the multidisciplinary team and the impact of one's own work on the interactive environment.

#### 4.1.2 Outcome 2: Design or develop solutions to complex engineering problems (Responsibility Levels C and D)


The engineering design of a solution to a complex engineering problem includes having a detailed requirements specification that aligns with the required design and having potential solutions or methods that can be used to approach and resolve the complex problem. The preferred option or way forward is influenced by factors that best fit the solution, considering cost, practicability, innovation and any impact outside the requirements.

After the received task is fully understood and interpreted, a solution to the problem posed can be developed or designed. To synthesise a solution means “the combination of separate parts, elements, substances, etc. into a whole or into a system” by the following:

- The development (design) of more than one way to solve an engineering task or problem should always be done and should include the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out to address the defined complex problem, and theoretical calculations to support each alternative must be done and submitted as part of the engineering report.
- In some cases, the Engineer will be unable to support proposals with the complete theoretical calculation to substantiate every aspect. The alternatives, particularly the recommended alternative, must be detailed for the client and interested stakeholders to understand the options better. The selection of alternatives might be based on tenders submitted with the possibility of alternatives deviating from those specified to a certain extent.
- The complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc., for the execution of work to meet customer requirements.

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4.1.3 Outcome 3: Comprehend and apply advanced and local knowledge of the widely applied principles underpinning good practice that is specific to the jurisdiction in which the Engineer practises (Responsibility level E)

Applicants should be able to provide evidence that they have comprehended and mastered the engineering principles and technologies for their practice areas and that they apply first-principle analytical thinking in demonstrating this competency for the associated complex programme. This includes the application of fundamental principles, practices, sound testable assumptions or previously encountered techniques that the applicant or other engineers have used to solve the problem.

The theoretical knowledge gained from completing a BEng/BSc(Eng) degree should also be applied in addition to knowledge of applicable engineering standards, codes of practice, legislation and regulations.


The strong contextual nature of agricultural engineering solutions has specific implications for training engineers. It is strongly recommended that trainees also acquire first-hand exposure and experience of the non-engineering context (farms, rural communities, agri-businesses) within which agricultural engineering solutions need to be relevant. Adequate first-hand exposure enables trainees to:

- understand that they are working with the uncertainties of economy, climate, social contexts and farming environments
- understand, respect and be able to collaborate with related disciplines in a complex environment, including specialists in crops, soils, food science and health, in addition to chemical suppliers and environmental experts and authorities
- appreciate the economic realities in agriculture, including low margins and resource-poor communities, plus the socio-economic impacts of and on engineering interventions.

By nature, work in the Agricultural Engineering sector is tightly integrated with biological systems and the natural environment. Thus, an Agricultural Engineer requires a thorough understanding of the people and circumstances when developing a suitable agricultural engineering solution.

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4.1.4 Outcome 4: Manage part or all of one or more complex engineering activities  
(Responsibility level D)

Agricultural Engineers manage teams, processes, resources, priorities and relationships when conducting a complex project study or detailed engineering design.

Agricultural Engineers have to consider the following when conducting their projects.


- Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines.
- Quality, safety and environment management are important aspects of managing Agricultural Engineering activities.
- The basic elements of management must be applied to complex engineering work.
- Depending on the project, engineers can be team leaders or team members, or they can supervise appointed contractors. To achieve this, maintaining relationships is important and must be demonstrated.
- Continuous evaluation is necessary to ensure that the task given is correctly done on time and within budget.

The area in which Agricultural Engineers work generally follows the conventional stages of the life cycle of the project or product as follows:

- Research and development of new products or systems, advancement of solutions to system problems, or system obsolescence.
- System or product design to establish a new system or product to solve system or product problems, to achieve a particular desired result or to select equipment for a particular purpose.
- Operation, maintenance and support of the system or product.
- Installation, testing and commissioning the necessary equipment or system to achieve the desired result.
- Decommissioning the system.

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4.1.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities  
(Responsibility level C)

Beyond technical skills, trainees are expected to refine their communication skills to communicate clearly with others in the course of their engineering activities. This entails demonstrating that they are able to do the following:

- Write clear, concise, effective and technically, legally and editorially correct reports using a structure and a style that meet communication objectives and user/audience requirements.
- Issue clear instructions to subordinates using appropriate language and communication aids, ensuring that language and other communication barriers are overcome.
- Give oral presentations using structure, style, language, visual aids and supporting documents that are appropriate to the audience and purpose.


4.1.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural and environmental effects of complex engineering activities seeking to achieve sustainability (Responsibility level B)

Agricultural Engineering problems may have an impact on the economic, social, environmental and cultural components. Trainees should be able to recognise and address the impact of their complex engineering activities on these components and where there are negative effects, provide mitigating measures. Furthermore, the trainees should develop the ability to identify interested and affected parties and their expectations with regard to technical, economic, social, cultural and environmental effects as listed below, and be able to put in measures to mitigate the negative effects of complex engineering activities.

- Economic effects include how the engineering activities can affect any economic aspect of people's livelihoods, e.g., employment, standards of living, movement of people, price fluctuations, business operations, salary levels, supply and demand
- Social effects encompass all issues that affect people and their livelihoods, directly or indirectly. Engineering activities may affect people's way of life, their political system, their health and wellbeing, and their personal and property rights.

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- Environmental effects include the effects on people's environment (i.e., air and water quality, dust and exposure to noise, and adequacy of sanitation) and the effects on large ecosystems. These may include disruption of ecosystems, disruption of fauna and flora and increased land temperatures.
- Cultural effects include people's customary beliefs, religion, language and norms, for example, the ceremonies and customs of a particular group or society.

Risk and impact mitigation measures must be considered, and the risk register must include the probability and impact of all the risks connected with the project. Mitigating measures taken may include environmental impact studies, awareness campaigns, environmental impact management, community involvement and communication, barricading and warning signs, and press releases.


4.1.7 Outcome 7: Meet all legal, regulatory and cultural requirements and protect the health and safety of persons during all engineering activities (Responsibility level E)

The IDoEW (**IDoEW-01-STD**) also promotes safety and the protection of the public and the environment by ensuring that registered professionals in the different categories of registration have demonstrated the required competence and academic qualifications and have performed engineering work or have taken responsibility for engineering work performed per category. Applicants wishing to register with ECSA as Professional Engineers are expected to have a working knowledge of the related regulations and Acts and to be able to demonstrate how this legislation affects their engineering activities at Responsibility Level E (performing). The list of regulatory requirements below is not exhaustive. The most commonly used engineering regulating standards and Acts that Trainees encounter in the course of executing the engineering work are as follows:

- Engineering Profession Act, 46 of 2000
- Occupational Health and Safety Act, 85 of 1993
- National Building Regulations and Building Standards Act, 103 of 1977
- National Environmental Management Act, 107 of 1998
- Employment Equity Act, 55 of 1998
- Environment Conservation Act, 52 of 1994 and Environment Conservation Amendment Act, 50 of 2003
- Specific work instructions, standards and/or specifications of the enterprise.

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Other Acts not listed here may also be pertinent to the trainee's specific work environment. Trainees are expected to have a basic knowledge of the relevant Acts and to investigate whether any Acts are applicable to their work environment. All engineering work must be carried out in accordance with the norms of the profession. Such norms are generally represented by national and international standards, industry standards, codes of practice and best practice guidelines.

Industry-specific regulations and requirements may or may not be applicable in all fields of Agricultural Engineering. However, trainees may find that each industry or aspect of design has developed 'good engineering practices' or has mandated statutory requirements. The onus is, once again, on Trainees and their Mentors/Supervisors to familiarise themselves with these practices in the South African industry.

All engineering work must be carried out in accordance with the norms of the profession, generally represented by national and international standards, industry standards, codes of practice and leading practice guidelines.


#### 4.1.8 Outcome 8: Conduct engineering activities ethically (Responsibility level E)

Trainees are involved in tender preparations, evaluations and adjudications, and contract management. Ethical problems such as tender fraud and corruption, bribery payment, favouritism, defamation, alcohol abuse, sexual harassment, absenteeism, fraudulent overtime claims, fraudulent variation orders, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, and overstating of compensation events may occur. Trainees are expected to identify ethical problems, affected parties and the best solution to resolve the problem at Responsibility Level E (i.e., performing).

Most engineering projects are multidisciplinary in nature, with many role players performing speciality work that could result in individuals conducting engineering activities for which they have no education, training, or competency. This is addressed to a certain extent by the enforcement of IDoEW (**IDoEW-01-STD**), which was gazetted in 2021. This is even more relevant in Agricultural Engineering which is a much broader discipline covering the following range of fields: agricultural infrastructure, agri-processing, irrigation and drainage engineering, mechanisation and precision agriculture and renewable energy. It is imperative that trainees familiarise themselves with ECSA IDoEW document (**IDoEW-01-STD**), Code of Conduct, a

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listing of ethics including integrity, competency, public interest and administrative expectations. Attention to the health and safety of persons and the areas of competency, truth, integrity and honest behaviour are of paramount importance.

4.1.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of complex engineering activities (Responsibility level E)

Agricultural Engineers are expected to exercise sound judgement during the course of engineering activities by considering several factors based on consequences they foresee and the regulatory requirements, policies and standards.

Applicants are, therefore, expected to demonstrate this competency by evaluating a situation presented to them, even in the absence of full evidence. The requirement is that engineers thoroughly investigate, analyse and identify several factors and understand the risks associated with certain decisions.

In engineering activities that are classified as complex, Agricultural Engineers apply their minds diligently through a logical thinking process to bring solutions to technically complex problems. This process involves the analysis of Agricultural Engineering Systems or components through the application of basic and engineering sciences. The extent of a project given to a trainee is characterised by complex engineering system factors or complex sub-system factors and their resulting interdependence.


Taking risky decisions may lead to equipment failure, excessive installation and maintenance cost, fruitless expenditure, damage to property or even fatalities, etc. It is therefore important to have proper evaluation, which includes engineering calculations to substantiate the decisions taken and the assumptions made.

Judgement is displayed in a number of ways:

- Engineering Professionals must assess design work against set criteria.
- Performing the work, despite numerous risk factors, needs good judgement and substantiated decision-making.
- Consequences are a result of the activities, such as extra cost due to unforeseen conditions, incompetent contractors or long-term environmental damage.

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- Interested and affected parties with differing requirements that may be in conflict need sound management and judgement, for example the need for a service irrespective of environmental damage, local traditions and preferences.

Judgement is exercised in making decisions by considering the interactions among conflicting technical, engineering, social or other issues and their impact on stakeholders and affected parties, typified by the following:

- Developing options and solutions or approaches that consider impacts, interrelationships with other disciplines, time, cost and other constraints, at times with incomplete information.
- Taking a holistic view of the solution while considering risks, their consequences and their implications.

#### 4.1.10 Outcome 10: Be responsible for making decisions on part or all of complex engineering activities (Responsibility level E)

Having the contextual knowledge and operating at Level E of the Degree of Responsibility affords applicants an opportunity to demonstrate how they were able to make decisions and take on responsibility for significant parts of one or more complex engineering activities. Seeking advice or guidance from the relevant superiors assists trainees to make informed decisions and assume responsibility for those decisions.


Responsible means “legally or morally liable for carrying out a duty; for the care of something or somebody in a position where one may be blamed for loss, failure, etc.” in the field of Agricultural Engineering.

Taking responsibility for outcomes of significant parts of one or more engineering activities is typified by the following:

- Systematic gathering of relevant information and checking of facts and inputs required for the decision-making process.
- Making a decision, based on knowledge and experience, and seeking advice on matters falling outside the Applicant’s education and experience.
- Keeping a record of the decision-making process and the reasons for the decision.
- Being held accountable for consequences, whether positive or negative.

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- All considered inter-related factors are indicative of professional responsibility accepted when working on complex engineering activities.
- Engineers operate on tasks at all levels of engineering complexity within their education and experience (e.g., irrigation system design).
- Continuous feedback to the originator of the task instruction and corrective action, if necessary, form important elements. The calculations, for example, fault levels, load calculations and losses, are done to ensure that correct material and components are used.

4.1.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work (Responsibility level D)

A trainee can focus on the sub-discipline first, then available developmental alternatives are established, a programme is drawn up (in consultation with employer if costs are involved), before they then look into options for expanding knowledge into additional fields in the discipline. A variety of work activities is necessary for the proper development of a trainee. The object of having a variety of work is to broaden the experience of the trainee and to ensure that all aspects of competency are developed and ultimately assessed.


Record-keeping must not be left to the employer or anybody else. Trainees must manage their own training independently by taking initiative and being in charge of experiential development towards the level of Professional Engineer. Applicants must demonstrate a commitment to IPD by:

- adopting a plan for their professional development
- selecting appropriate professional development activities
- keeping records of professional development activities
- demonstrating independent learning ability through completing developmental activities.

The following list of formal learning activities is by no means extensive or comprehensive; it is simply a sample of useful courses:

- Project management
- General Conditions of Contract for Construction Works (GCC), New Engineering Contract (NEC), Joint Building Contract Committee (JBCC), etc.

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- Standards
- Specifications
- Preparation of specifications
- Negotiation skills
- Engineering finance
- Risk analysis
- Quality systems
- Occupational health and safety
- Engineering ethics
- Discipline-specific courses
- Energy efficiency
- Maintenance engineering
- Environmental impacts
- Management
- Report writing
- Planning methods
- System Engineering
- Industrial relations
- Public speaking


Training and courses that do not carry official continuing professional development (CPD) points such as courses or training offered within the employer organisation or by other organisations are also appropriate.

Examples of intermediate professional development activities and programmes include:

- intermediate project management
- conditions of contract and value engineering
- preparation of standards and specifications
- negotiation skills
- risk analysis and quality systems
- OHS
- agricultural-related conferences and short courses

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- engineering maintenance systems
- environmental impact management
- technical and business report writing
- intermediate industrial and public relations
- business presentation skills.

Examples of more advanced professional development activities and programmes include:

- post-graduate qualification in agricultural engineering related subjects, project management, finance, marketing or business administration
- advanced business and project management
- advanced safety, health and environmental/sustainable development
- systems engineering
- digital technologies
- Applicants/Trainees managing their own training independently by taking the initiative and being in charge of experiential development towards the appropriate level of Professional Registration.

## **4.2 Training for registration as a Professional Engineering Technologist**

### **4.2.1 Outcome 1: Define, investigate and analyse broadly defined engineering problems (Responsibility level E)**


Trainees are involved with broadly defined engineering activities and solve broadly defined engineering problems. It is critical to understand the problem and its extent properly before attempting to solve such a problem. It is, therefore, critical to define, investigate and analyse broadly defined engineering problems before deciding on solutions.

Defining engineering problems involves identifying the problem to be solved and specifying clear goals or criteria the final product or system must meet. This process must lead to an agreed-upon definition of the problem to be solved.

Trainees are expected to be exposed to the technical investigation process of broadly defined engineering systems, processing plants, irrigation system designs, mechanisation system design, management of machinery, land development, etc. The nature of the engineering problem is ill-posed and requires identification and refinement into the technological area under

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investigation. Investigating a broadly defined engineering problem cannot be a desktop exercise because it requires in-depth knowledge and history of the systems, evidence of other attempted or successful solutions and determination of how far-reaching the solution to the problem may be.


Analysis of a broadly defined engineering problem means the “separation into parts, possibly with comment and judgement” and broadly means, “not minute or detailed” and “not kept within narrow limits”.

Coherent and detailed engineering knowledge for Engineering Technologists means the following:

- The encountered problem cannot be solved without all the relevant details, including the engineering principles applicable to the situation.
- The nature of the problem is not immediately obvious and further investigation is necessary to identify and interpret the real nature of the problem.
- The problem is not easily recognised as part of the larger engineering task, project or operation and it may be obscured by the complexity of the larger system.
- There is recognition that the problem can be classified as falling within a typical solution requiring innovative adaptation to meet the specific situation.
- The solution to the problem requires a step-by-step approach that adheres to proven logic.
- The standards, codes and documented procedures must be analysed to determine the extent to which they are applicable to solving the problem, and justification must be given to operate outside these.
- The responsibility lies with the trainees to verify that some information received as part of the encountered problem may remain incomplete and solutions to problems may need justified assumptions.
- The problem handled by trainees may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, unmaintainable and unsustainable, etc. Trainees will have to justify their recommendations.
- Practical solutions to problems include knowledge and judgement of the roles displayed by the multidisciplinary team and the impact of one’s work on the interactive environment.
- Trainees must realise that their actions may seem to be of local importance only but may develop significant consequences that extend beyond their ability and practice area.

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#### 4.2.2 Outcome 2: Design or develop solutions to broadly defined engineering problems (Responsibility levels C and D)

Engineering design and development of a solution are critical steps because they result in a system or components that must operate within acceptable engineering and safety parameters. Engineering problems are solved by applying standards, codes and procedures, and justification for operating outside these standards and codes must be provided. Applicants are expected to demonstrate different options for developing a solution. Engineering principles and concepts should support the solution. Trainees should strive to solve engineering problems by demonstrating a step-by-step approach that adheres to proven logic. Before a solution is selected, Trainees should indicate alternatives or approaches towards solving the problem that have been tested against factors that encompass but are not limited to costs, engineering parameters, and sustainability and environmental considerations. There are always multiple solutions to solving a broadly defined engineering problem.


Design means “drawing or outline from which something can be made”. Develop means, “come or bring into a state in which it is active or visible”.

After the received task is fully understood and interpreted, a solution to the posed problem can be developed (designed). To synthesise a solution means “the combination of separate parts, elements, substances, etc. into a whole or into a system” by the following:

- The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instructions received, and the theoretical calculations to support each alternative must be done and submitted as an attachment.
- The Engineering Technologist will, in some cases, be unable to support proposals with the complete theoretical calculation to substantiate every aspect and must, in these cases, refer alternatives to an Engineer for scrutiny and support. The alternatives, particularly the recommended alternative, must be convincingly detailed to win customer support. The selection of alternatives might be based on tenders submitted with alternatives that deviate from those specified.

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- The complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc., for the execution of work to meet customer requirements.

4.2.3 Outcome 3: Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems and methodologies that is specific to the jurisdiction in which the Engineering Technologist practises (Responsibility level E)

In solving broadly defined engineering problems, Trainees must comprehend and apply knowledge and accepted engineering procedures, systems and methodologies. Trainees should understand and demonstrate that during engineering problem-solving, they have:


- applied engineering principles, practices and technologies, including the application of BTech or BEngTech theory in the practice area
- indicated a working knowledge of areas of practice that interacts with the practice area to underpin teamwork
- applied related knowledge of finance, statutes, safety and management.

Design work for Engineering Technologists is based on BTech or BEngTech theory and mainly involves the use and design of systems or components and selected materials, together with the associated novel technology. Engineering Technologists develop and apply codes and procedures in their design work. Investigations are into broadly defined engineering problems, mainly regarding developing and improving engineering systems and operations. In this regard, Engineering Technologists:

- perform calculations at theoretical level confirming the correct application and use of machinery, equipment, materials and systems must be done on broadly defined activities
- demonstrate an understanding of broadly defined procedures and techniques that must be based on fundamental mathematical, scientific and engineering knowledge as part of the personal contribution to the engineering team
- manage the resources within legal and financial constraints.

The specific location of the task to be executed is the most important determining factor in the layout design and use of equipment. A combination of educational knowledge and practical

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experience must be used to substantiate decisions taken and a comprehensive study of systems, materials, components and projected customer requirements and expectations must be included. New ideas, materials, components and systems must be investigated, evaluated and applied, accompanied by complex theoretical motivation.

Despite having a working knowledge of interacting disciplines, Engineering Technologists take responsibility in a multidisciplinary team of specialists such as Civil Engineers, Agricultural Engineers, Technicians and Architects on buildings, Soil and Plant Scientists and Project Managers.


Jurisdictional in this instance means, “having the authority”, and Engineering Technologists must be aware of and decide on the relevant requirements applicable to each specific project for which they are responsible. Engineering Technologists are usually appointed as the “responsible person” for specific projects in terms of the OHS Act.

#### 4.2.4 Outcome 4: Manage part or all of one or more broadly defined engineering activities (Responsibility level D)

The practice areas under which Trainees work generally follow a conventional project or product development life cycle model, but the focus is on broadly defined engineering activities, which includes the following:

- Research and development of new products or systems to solve a system problem or a problem due to obsolescence.
- System or product design to solve a system or product problem, to achieve a particular desired result or to select equipment for a particular purpose.
- Interpretation and evaluation of a design.
- Plan layouts for new technologies and machinery.
- Install, test and commission the necessary equipment or system for the desired result.
- Operation and maintenance of the system or support of the product.
- Decommissioning of the system.

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In relation to the above engineering activities, Trainees are expected to display personal and work-process management abilities for the following:

- Managing self, people, work priorities, processes and resources in broadly defined engineering work.
- Evident role in planning, organising, leading, and controlling broadly defined engineering activities.
- Knowledge of conditions, activities and performance standards during a contract.

4.2.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities  
(Responsibility level C)

Engineering Technologists write specifications for the purchase of materials and/or work to be done, make recommendations on tenders received, place orders and variation orders, write work instructions, and report on work done. In addition, they draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write work procedures, write inspection and audit reports, write commissioning reports, and prepare and present motivations for new projects. Furthermore, Engineering Technologists compile budget reports and report on various issues such as studies done and calculations carried out, customer requirements, safety incidents and risk analysis, equipment failure, proposed system improvement, new techniques and cost control.


Professional communication is a vital skill for Trainees to possess since all their decisions are communicated to different parties. Engineering Technologists communicate engineering activities to relevant stakeholders, managers and supervisors on the work deliverables.

Effective communication plays a vital role in ensuring that expectations are clearly understood. It is expected that Applicants demonstrate the ability to:

- write clear, concise and effective technical, legal, and editorially correct reports
- issue clear instructions to stakeholders using appropriate language and communication skills
- conduct oral presentations using a structured style, language and visual aids.

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4.2.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural and environmental effects of broadly defined engineering activities seeking to achieve sustainability (Responsibility level B)

Broadly defined Agricultural Engineering problems may have an impact on social, environmental and cultural components. Trainees should be able to recognise and address the impact of their broadly defined engineering activities on these components, and where there are negative effects, provide mitigating measures. The details for the different components are as follows:

- **Economic effects** include how the engineering activities can affect any of the economic aspects of people's livelihoods, e.g., employment, standard of living, movement of people, price fluctuations, business operations, salary levels, supply and demand
- **Social effects** encompass all issues that affect people and their livelihoods, directly or indirectly. Engineering activities may affect people's way of life, their political system, their health and wellbeing, and their personal and property rights.
- **Environmental effects** include the effects on people's environment (i.e., air and water quality, dust and exposure to noise and adequacy of sanitation) and the effects on large ecosystems. This might include disruption of ecosystems and fauna and flora in addition to increased land temperatures and damage to historical buildings.
- **Cultural effects** include people's customary beliefs, religion, language and norms, for example, the ceremonies and customs of a particular group or society.


Risk and impact mitigation measures must be considered, and the risk register must include the probability and impact of all the risks connected with the project. Mitigating measures may include environmental impact studies, awareness campaigns, environmental impact management, community involvement and communication, barricading and warning signs, and press releases.

4.2.7 Outcome 7: Meet all legal, regulatory and cultural requirements and protect the health and safety of persons during all engineering activities (Responsibility level E)

The IDoEW (**IDoEW-01-STD**) promotes safety and protection of the public and the environment by ensuring that registered professionals in the different categories of registration have demonstrated the required competence and academic qualifications and have performed

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engineering work or have taken responsibility for engineering work performed per category. Applicants wishing to register with the ECSA as Professional Engineering Technologists are expected to have a working knowledge of the related regulations and Acts and to be able to demonstrate how this legislation affects their broadly defined engineering activities at Responsibility Level E (performing). The most commonly used engineering regulating standards and Acts that Trainees encounter in the course of executing engineering work are the following:


- Engineering Profession Act, 46 of 2000
- Occupational Health and Safety Act, 85 of 1993
- National Building Regulations and Building Standards Act, 103 of 1977
- National Environmental Management Act, 107 of 1998
- Employment Equity Act, 55 of 1998
- Environment Conservation Act, 52 of 1994 and Environment Conservation Amendment Act, 50 of 2003
- Specific work instructions, standards and/or specifications of the enterprise.

Other Acts not listed here may also be pertinent to Trainees' specific work environment. Trainees are expected to have a basic knowledge of the relevant Acts and to investigate whether any Acts are applicable to their work environment. All engineering work must be carried out in accordance with the norms of the profession. Such norms are generally represented by national and international standards, industry standards, codes of practice and best practice guidelines.

Depending on the working environment, the provisions of the OHS Act and/or the Mine Health and Safety Act, 29 of 1996 (MHSA) must be followed by employers and employees. Trainees should obtain a functional understanding of these provisions in their specific workplaces.

Industry-specific regulations and requirements may or may not be applicable in all fields of Agricultural Engineering. However, trainees may find that each industry or aspect of design has developed 'good engineering practices' or has mandated statutory requirements. The onus is, once again, on Trainees and their Mentors/Supervisors to familiarise themselves with these practices in the South African industry.

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#### 4.2.8 Outcome 8: Conduct engineering activities ethically (Responsibility level E)

Trainees are involved in tender preparations, evaluations and adjudications, and contract management. Ethical problems such as tender fraud and corruption, bribery payment, favouritism, defamation, alcohol abuse, sexual harassment, absenteeism, fraudulent overtime claims, fraudulent variation orders, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, and overstating of compensation events may occur. Trainees are expected to identify ethical problems, affected parties and the best solution to resolve the problem at Responsibility Level E (i.e., performing).

Most engineering projects are multidisciplinary in nature, with many role players performing speciality work that could result in individuals conducting engineering activities for which they have no education, training or competence. This is addressed to a certain extent by the enforcement of IDoEW (**IDoEW-01-STD**) as gazetted in 2021. This is more relevant in Agricultural Engineering, which is a much broader discipline covering the following range of fields: agricultural infrastructure, agri-processing, irrigation and drainage engineering, mechanisation and precision agriculture and renewable energy. It is imperative for Trainees to familiarise themselves with ECSA's Code of Conduct, a listing of ethics regarding integrity and competency.


#### 4.2.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of broadly defined engineering activities (Responsibility level E)

Taking risky decisions may lead to equipment failure, excessive installation and maintenance costs, and damage to persons and property. Evaluation of engineering solutions may include engineering calculations to substantiate decisions taken and assumptions made. Therefore, judgement exercised by the Applicant in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies is crucial.

The design of a new product or equipment has technical risk that needs to be considered in the acquisition of any new technologies. While the application of developmental technology potentially offers significantly enhanced capability over existing systems, it can also lead to excessive delays and cost 'blow-outs'. Furthermore, technical risk can have negative impacts

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on the project, system or the entire infrastructure if the implementation is not as successful as anticipated.

In developing engineering solutions, trainees should be able to demonstrate the factors that were considered, bearing in mind the risk, the consequences in technology application, and the affected parties. Failure to identify or manage this risk properly may result in performance degradation, security breaches, system failures, increased maintenance time and a significant amount of technical debt for the organisation. It is essential to have a reliable analysis solution for technical-risk management to ensure early detection of problems.

Trainees must therefore familiarise themselves with the organisational risk policies and standards. These risks may be identified or demonstrated under practice areas such as research and development, engineering systems design, advisory, planning and directing the construction and operation of components, rotating machines and projects related to equipment and building services.


The extent of the projects given to Trainees is characterised by several broadly defined factors and a few well-defined factors and their resulting interdependence. If the task surpasses their educational or experiential capabilities, they will need to seek guidance. Taking risky decisions may lead to problems like equipment failure, excessive installation and maintenance costs, and damage to persons or property. Evaluation includes engineering calculations to substantiate the decisions taken and the assumptions made.

In engineering activities that are classified as broadly defined and in which the Trainee uses standard procedures, codes of practice, specifications, etc., but may develop variations and completely unique standards when needed, judgement must be displayed to identify any activity falling inside the broadly defined range (defined above). The following needs to be considered:

- Getting the work done despite numerous risk factors needs good judgement and substantiated decision-making.
- Consequences are part of the project (e.g., extra cost due to unforeseen conditions, incompetent contractors, long-term environmental damage, etc.).

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- The presence of interested and affected parties with defined needs that may be in conflict (e.g., need for a service irrespective of environmental damage, local traditions, preferences, etc.) requires sound management and judgement.

#### 4.2.10 Outcome 10: Be responsible for making decisions on part or all of broadly defined engineering activities (Responsibility level E)

Responsible decision-making includes applying engineering knowledge acquired from accredited engineering programmes. It includes considerations from engineering, social, environmental and sustainable development factors in solving a broadly defined engineering problem. Applicants should be able to demonstrate recognition of social and environmental issues and application of relevant academic-level knowledge in formulating decisions. The responsibility is mostly allocated within a team environment, with an increasing designation as experience is gathered.


Trainees should discharge responsibilities for significant parts of one or more considered activities relating to the impact of engineering, social, environmental and sustainable development at Responsibility Level E. It is important for Applicants to demonstrate how they sought advice from a responsible authority on matters outside their area of competence:

- If possible, a specific field of the sub-discipline is chosen; available developmental alternatives are established; a programme is drawn up (in consultation with employer if costs are involved); and options that are open to expand knowledge into additional fields are investigated.
- Record-keeping must not be left to the employer or anybody else. Trainees must manage their own training independently by taking initiative and being in charge of experiential development towards the level of Professional Engineering Technologist.

#### 4.2.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work (Responsibility level D)

Trainees intending to register as Professional Engineering Technologists are expected to undertake sufficient independent learning activities to maintain and extend their competence.

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The following list of formal learning activities is by no means exhaustive; it is simply a sample of useful courses to assist trainees:

- Project management
- General Conditions of Contract for Construction Works (GCC), New Engineering Contract (NEC), Joint Building Contract Committee (JBCC), etc.
- Standard specifications
- Preparation of specifications
- Negotiation skills
- Engineering finance
- Risk analysis and quality systems
- Occupational health and safety
- Discipline-specific courses
- Energy efficiency
- Electrical tariffs
- Maintenance engineering
- Environmental impact management
- Technical and business report writing
- Planning methods
- Systems Engineering
- Industrial relations
- Business presentation skills / public speaking
- Artificial intelligence
- Internet of things
- Cyber security
- Systems resilience.

Training and courses that do not carry official CPD points such as courses or training offered within the employer organisation or by other organisations are also appropriate.

If possible, a specific field of the sub-discipline is chosen; available developmental alternatives are established; a programme is drawn up (in consultation with the employer if costs are

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involved); and options that are open to expand knowledge into additional fields are investigated.

Record-keeping must not be left to the employer or anybody else. Trainees must manage their own training independently by taking initiative and being in charge of experiential development towards the level of Professional Engineering Technologist.


### 4.3 Training for registration as a Professional Engineering Technician

#### 4.3.1 Outcome 1: Define, investigate and analyse well-defined engineering problems (Responsibility level E)

During training, Trainees should be exposed to the technical investigation of equipment, plant and product failure. The intent is for Trainees to be able to define the engineering problem clearly and to investigate and analyse well-defined engineering problems. For Engineering Technicians to solve well-defined engineering problems, it is imperative to understand the nature of the engineering problem. Inability to understand the engineering problem could lead to incorrect design or incorrect development of solutions. Defining an engineering problem requires in-depth knowledge and history of the system, evidence of other attempted or successful solutions and determination of how far-reaching the solution to the problem may be. Investigation of the engineering problem could be in the form of equipment failure in the system, development of new products or provision of services.

Engineering problems should be thoroughly investigated through site visits, collecting technical information and checking engineering drawings. No investigation can be completed using desktop information only. Sufficient technical and business information about a plant or system should be collected, evaluated and analysed for accuracy and reliability. Analysis of the information assists Trainees to review the instructions given in the initial engineering problem and assess whether the work instruction was well understood. Engineering analysis involves applying scientific, analytic principles and processes to reveal the properties and state of the system, device or mechanism under study. Applicants or persons desirous of registering as Professional Engineering Technicians should be able to demonstrate how the well-defined engineering problem/s were defined and investigated.

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A practical problem for trainees means the encountered problem cannot be solved by artisans because theoretical calculations and engineering decisions are necessary to substantiate the proposed solution. This requires the following:

- Further investigation to identify the nature of the problem is seldom necessary.
- The problem is easily recognised as part of the larger engineering task, project or operation.
- It is recognised that the problem occurred in the past or the possibility exists that it may have happened before – definitely not something new.
- Solving the problem does not require development of a new solution – establish how it was solved before.
- The standards, codes and documented procedures must be obtained to solve the problem, and authorisation from the Supervisor or Mentor must be obtained to waive the stipulations.
- The responsibility lies with the Engineering Technician to check that the information received as part of the encountered problem is correct and added to as necessary to ensure the correct and complete execution of the work.
- The problem handled by an Engineering Technician must be limited to well-known matters, preferably needing standardised solutions without possible complications.
- Practical solutions to problems include knowledge of the skills displayed by Specified Category Practitioners and Engineering Artisans without sacrificing theoretical engineering principles and/or cutting corners to satisfy the involved parties.

Trainees' actions can have broader implications. For example, a small error in a localised task could potentially escalate into a larger problem that affects an entire system or project. When such situations arise, it may be necessary to involve Professional Engineers and Professional Engineering Technologists. These professionals typically have a broader scope of knowledge and are equipped to handle engineering problems requiring specialist knowledge. Professional Technologists and Engineers can provide guidance, support and solutions to address these larger issues.

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#### 4.3.2 Outcome 2: Design or develop solutions to well-defined engineering problems (Responsibility levels C and D)

Once the analysis of the engineering problems has been established as well-defined, Engineering Technicians are expected to either design or develop engineering solutions to resolve the well-defined engineering problems. Well-defined engineering problems can be solved in standardised or prescribed ways. They are encompassed by standards, codes and documented procedures. Engineering Technicians encounter various engineering problems and should provide solutions to return the machinery, equipment and components of the plants or systems to their normal functioning state. Designing or developing solutions for a well-defined engineering problem typically follows the steps presented below:


- List possible solutions.
- Evaluate and rank the possible solutions.
- Develop a detailed plan for the most attractive solutions.
- Re-evaluate the plan to check desirability.
- Check the result through calculations.
- Implement the plan.
- Communicate the results.

Applicants must be able to demonstrate the application of calculations and engineering concepts in designing or developing solutions to a well-defined engineering problem. Engineering norms and standards should be applied in the process of developing well-defined engineering solutions.

Once the received task is fully understood and interpreted, a solution to the posed problem can be developed (designed). To synthesise a solution means, “the combination of separate parts, elements, substances, etc. into a whole or into a system” by the following:

- Design work for trainees mainly involves the use and configuration of manufactured components and repetitive design work using an existing design as an example. Engineering Technicians apply existing codes and procedures in their design
- Defined incidents and condition monitoring and operations would be mainly on controlling, maintaining and improving engineering systems and operations.

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- The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an attachment.
- Trainees will, in some cases, be unable to support proposals with the complete theoretical calculation to substantiate every aspect and must, in these cases, refer their alternatives to a Supervisor or Mentor for scrutiny and support. The alternatives, particularly the recommended alternative, must be convincingly detailed to win customer support. The selection of alternatives might be based on tenders submitted with alternatives deviating from those specified.

#### 4.3.3 Outcome 3: Comprehend and apply knowledge that is embodied in established engineering practices that is specific to the jurisdiction in which the Engineering Technician practises (Responsibility level E)


Trainees are required to apply engineering knowledge acquired during the accredited undergraduate programmes to resolve well-defined engineering problems and subsequently, to provide solutions to such problems. During training, Trainees are expected to be introduced to engineering standards, procedures and the different systems that are used in the process of engineering problem-solving. It is imperative that Trainees are able to understand and demonstrate the application of acceptable engineering theory, engineering standards, engineering procedures, systems and governing laws in solving well-defined engineering problems.

Engineering problem-solving of well-defined activities involves justifying the reason why National Diploma (NDip) theory is applied and, in most cases, requires an Engineering Technician to perform calculations to justify certain engineering decisions and assumptions.

Trainees are expected to work within prescribed engineering standards and codes in solving engineering problems or to justify operating outside these standards and codes. Engineering Technicians may also rely on knowledge from the National Standards (SANS) and Rationalised Specifications (NRS) of the South African Bureau of Standards (SABS) and other

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technical standards and specifications to develop solutions to well-defined engineering activities.

The understanding of well-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge. The specific procedures and techniques that are applied to do the work, accompanied by the underpinning theory, must be provided. Calculations confirming the correct application and use of equipment must be done on practical, well-defined activities. Reference must be made to the standards and procedures that were used and how calculations were derived from NDip theory.


- The specific location of the task to be executed is the most important determining factor in the layout design and the use of equipment. A combination of educational knowledge and practical experience must be used to substantiate any decisions taken, including a comprehensive study of materials, components and projected customer requirements and expectations.
- Despite having a working knowledge of interacting disciplines, Engineering Technicians must appreciate the importance of working with specialists, for example, Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings and Electrical Engineers on communication equipment. The codified knowledge in the related areas means working to and understanding the requirements set out by specialists in these areas.
- Jurisdictional in this instance means, “having the authority”, and Engineering Technicians must adhere to the terms and conditions associated with each task that is undertaken. They may even be appointed as the ‘responsible person’ or the ‘competent person’ for specific duties in terms of the OHS Act.

#### 4.3.4 Outcome 4: Manage part or all of one or more well-defined engineering activities (Responsibility level D)

The areas in which trainees work generally follow a conventional project or product development life cycle model, but focus is mainly on well-defined engineering activities.

Trainees may contribute to or participate in a project by managing one or more activities in the project life cycle. The key activities of project management involve time, cost and quality. Trainees should be able to manage their engineering work activities and minimise project

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delays in operations and maintenance and capital projects. Sometimes work priorities need to be tracked using project management software tools to manage the critical path of a project's activities.

Trainees must expose themselves to the tools/software used to manage well-defined engineering activities and understand their role within the team. Trainees wishing to register with ECSA as a Professional Engineering Technician must participate in and contribute to the work activities in a project life cycle. Trainees may not necessarily change their places of employment to acquire all the skills in the project life cycle.


In engineering projects, the following should be considered:

- Engineering Technicians are typically given the responsibility to carry out specific tasks and/or to complete projects:
- Resources are usually subdivided based on availability and are controlled by a work breakdown structure and scheduling to meet deadlines.
- Quality, safety and environment management are important aspects in the execution of projects.
- Depending on the task, Engineering Technicians can be the team leader or a team member, or they can supervise appointed contractors.
- Engineering Technicians collect data and execute solutions to Agricultural Engineering problems

4.3.5 Outcome 5: Communicate clearly using multiple media and collaborate inclusively with a broad range of stakeholders in the course of engineering activities  
(Responsibility level C)

While conducting engineering work, Engineering Technicians are expected to communicate with their team members, supervisors, clients and contractors effectively. Professional communication is a vital skill for Engineering Technicians to possess since all their decisions are communicated to different parties. Professional communication is important in running effective meetings, working with people who are not technical, working with different cultures, issuing and receiving instructions, reporting on engineering works and sharing ideas.

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The main types of professional communication include oral, written and graphical techniques or a combination thereof. During the execution of engineering work activities, Engineering Technicians hold meetings and develop technical reports, tender document specifications, and bills of quantity. These should be clear and concise in order to convey the message to the recipients. Creating presentations for colleagues, team members, supervisors, and clients using visual aids and supporting documents is also an important part of professional communication.


Trainees must therefore develop effective communication skills during training and be able to demonstrate such skills to be registered as Professional Engineering Technicians.

4.3.6 Outcome 6: Recognise the reasonably foreseeable economic, social, cultural and environmental effects of well-defined engineering activities seeking to achieve sustainability (Responsibility level B)

Well-defined engineering problems may have an impact on the economic, social, environmental and cultural components. Trainees should be able to recognise and address the impact of their well-defined engineering activities on these components and where there are negative effects, provide mitigating measures. The different components are explained below:

- **Economic effects** include how the engineering activities can affect any of the economic aspects of people's livelihoods, e.g., employment, standards of living, movement of people, price fluctuations, business operations, salary levels, supply and demand
- **Social effects** encompass all issues that directly or indirectly affect people and their livelihoods. Engineering activities may affect people's way of life, their political system, their health and wellbeing, and their personal and property rights.
- **Environmental effects** include the effects on people's environment (i.e., air and water quality, dust and exposure to noise, adequacy of sanitation) and the effects on large ecosystems. This might include disruption of ecosystems and fauna and flora in addition to increased land temperatures and damage to historical buildings.
- **Cultural effects** include people's customary beliefs, religion, language and norms, for example, the ceremonies and customs of a particular group or society.

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Agricultural Engineering has a heavy impact on the environment, e.g., emissions, waste, energy consumption, depletion of natural resources, noise and vibration, heat and friction, wear and tear, corrosion and erosion, accidents and injuries, harmful effects on humans and animals, complex and hazardous machinery, and maintenance and disposal.

Risk and impact mitigation measures must be considered, and the risk register has to include the probability and impact of all the risks connected with the project. Mitigating measures taken may include environmental impact studies, awareness campaign, environmental impact management, community involvement and communication, barricading and warning signs, and press releases.


4.3.7 Outcome 7: Meet all legal, regulatory and cultural requirements and protect the health and safety of persons during all engineering activities (Responsibility level E)

The IDoEW (**IDoEW-01-STD**) promotes safety and protection of the public and the environment by ensuring that registered professionals in the different categories of registration have demonstrated the required competence and academic qualifications and have performed engineering work or have taken responsibility for engineering work performed per category. Applicants wishing to register with ECSA as Professional Engineering Technicians are expected to have a working knowledge of the related regulations and Acts and to be able to demonstrate how this legislation affects their well-defined engineering activities at Responsibility Level E (performing). The most commonly used engineering regulating standards and Acts that trainees meet in the course of executing engineering work are as follows:

- Engineering Profession Act, 46 of 2000
- Occupational Health and Safety Act, 85 of 1993
- National Building Regulations and Building Standards Act, 103 of 1977
- National Environmental Management Act, 107 of 1998
- Employment Equity Act, 55 of 1998
- Environment Conservation Act, 52 of 1994 and Environment Conservation Amendment Act, 50 of 2003
- Mine Health and Safety Act, 29 of 1996
- Specific work instructions, standards and/or specifications of the enterprise.

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The list is not exhaustive as other Acts not listed here may also be pertinent to a Trainee's specific work environment. Trainees are expected to have a basic knowledge of the relevant Acts and to investigate whether any Acts are applicable to their work environment. All engineering work must be carried out in accordance with the norms of the profession. Such norms are generally represented by national and international standards, industry standards, codes of practice and best practice guidelines.

Depending on the working environment, the provisions of the OHS Act and/or the MHSA must be followed by employers and employees. Trainees should obtain a functional understanding of these provisions in their specific workplaces.

Industry-specific regulations and requirements may or may not be applicable in all fields of Agricultural Engineering. However, Trainees may find that each industry or aspect of design has developed 'good engineering practices' or has mandated statutory requirements. The onus is, once again, on Trainees and their Mentors/Supervisors to familiarise themselves with these practices in the South African industry.


#### 4.3.8 Outcome 8: Conduct engineering activities ethically (Responsibility level E)

Ethical problems arise during engineering activities, for example, using unsustainable material for a solution or contravening other regulations in the process of developing solutions. Other general ethical problems may also arise while performing engineering activities. Trainees should be able to identify ethical issues arising during engineering activities, identify affected parties and determine how such issues may affect them. The solution to an ethical problem must consider all affected parties.

Trainees must perform engineering work and make technical decisions while adhering to the ECSA Code of Conduct for registered persons. The following factors should be considered when performing engineering work:

- Make decisions within the limits of the practitioner's education, training and experience.
- Act with integrity and in accordance with the general norms of professional conduct.
- Strive to respect the interests of the public and health and safety and minimise environmental impact.

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If the scope of work falls outside the area of expertise of the Engineering Technicians, they should seek guidance from relevant parties. Conflicts of interest while conducting engineering activities should be avoided or declared so that decisions are made transparently.

4.3.9 Outcome 9: Exercise sound judgement by evaluating the outcomes, impacts and alternatives in the course of well-defined engineering activities (Responsibility level E)

Sound judgement and decision-making can be defined as the ability to assess situations or circumstances objectively, using all the relevant information and applying past experience to come to a conclusion. Trainees should be able to make a judgement on a sustainable solution to well-defined engineering problems after ensuring that all factors, including those from other disciplines, have been considered.


It is essential to have a reliable analysis solution for technical risk management to ensure early detection of problems. This prevents issues from occurring without warning and drastically decreases the effort required to alleviate sudden infrastructure or system problems. Trainees must familiarise themselves with organisational risk policies and standards. These risks may be identified or demonstrated in building services, product development or projects relating to research and development. Trainees should strive to acquire experience in all generic engineering competencies of problem-solving implementation, operation, risk and impact mitigation, and management of engineering activities.

The extent of a project or task given to Engineering Technicians is characterised by the limited number of factors and their resulting interdependence. If the task surpasses their educational or experiential capabilities, they will need to seek guidance. Taking risky decisions may lead to equipment failure, excessive installation and maintenance cost, or damage to persons and property.

For engineering activities classified as well-defined in which Engineering Technicians use standard procedures, codes of practice, specifications, etc., judgement must be displayed to identify any activity falling outside the well-defined range (defined above) by:

- seeking advice when risk factors exceed their capability
- determining any consequences outside the immediate work contexts (e.g., long-term, not normally handled)

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- accounting for interested and affected parties with defined needs outside the well-defined parameters.

4.3.10 Outcome 10: Be responsible for making decisions on part or all of well-defined engineering activities (Responsibility level E)

For engineering activities classified as well-defined in which Engineering Technicians use standard procedures, codes of practice, specifications, etc., judgment must be displayed to identify any activity falling outside the well-defined range.

Responsible decision-making includes applying engineering knowledge acquired from accredited engineering programmes. It includes using relevant calculations to justify why certain solutions are chosen to solve well-defined engineering problems. Where the required knowledge is limited, it is the Trainee's responsibility to ask for advice from a relevant authority or from those who possess the information. Any decisions taken should be evaluated for shortcomings to ensure no surprises at the end of the project/activity.

This is, in the first instance, continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction and corrective action, if necessary, form important elements.


4.3.11 Outcome 11: Undertake sufficient professional development activities to maintain, extend competence and enhance the ability to adapt to emerging technologies and the ever-changing nature of work (Responsibility level D)

Professional development refers to continuing education and career training after a person has entered the workforce. Professional development assists in developing new skills, broadening of knowledge, staying up to date on current trends and technologies, and advancing one's career. A registered Professional Engineering Technician is required to maintain and extend the level of competency through CPD activities to retain registration.

When applying for registration, Applicants should provide evidence of IPD that has been attained during the training period. These activities could include engineering courses, management courses or computer courses. Enrolling for a postgraduate engineering programme is considered part of the development activities.

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Trainees must be able to demonstrate professional development by:

- adopting a strategy for own professional development
- selecting appropriate professional development activities
- keeping thorough records of professional development activities
- demonstrating independent learning ability through completing developmental activities.

If possible, a specific field of the sub-discipline is chosen; available developmental alternatives are established; a programme is drawn up (in consultation with the employer if costs are involved); and options that are open to expand knowledge into additional fields are investigated.

Record-keeping must not be left to the employer or anybody else. Trainees must manage their own training independently by taking initiative and being in charge of experiential development towards the level of Professional Engineering Technician. Knowledge of the employer's policy and procedures on training is essential.

## 5. FUNCTIONS PERFORMED

Agricultural Engineering applies engineering principles to design, develop and optimise machinery, structures and systems for efficient crop production, soil and water management, bioenergy solutions and sustainable food processing. It integrates technology to enhance productivity while ensuring environmental conservation in agriculture and related biological systems.


### 5.1 Degrees of Responsibility

Progression throughout the candidacy period presented in document **R-04-T&M-Guide-PC** and below in **Table 1** refers to the gradual increase in the Degree of Responsibility that applicants are exposed to during professional training. Considering the nature of the work, specific examples and outcomes appropriate to training in Agricultural Engineering are presented in Table 1 below.

During development from the graduate level to meeting the competency requirements for registration, Applicants progress through levels of work capability until the required level for registration is attained. Progression throughout the candidacy period, presented in document

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**R-04-T&M-Guide-PC** and below in **Table 1**, refers to the gradual increase in the Degree of Responsibility to which Applicants are exposed during experience and training period.

Special consideration in the discipline, sub-discipline or specialty must be given to the competencies specified in the following groups:

- Knowledge-based problem-solving (this should be a strong focus)
- Management and communication
- Identifying and mitigating the impacts of engineering activity
- Judgement and responsibility
- Independent learning.

It is useful to measure the progression of an Applicant's competency using the Degree of Responsibility, and the Problem-Solving and the Engineering Activity scales as specified in document **R-02-STA- PE/PT/PN**.

Training Elements have been developed against the Degree of Responsibility Scale (see **Appendix A**). Activities should be selected to ensure Trainees reach the required level of competency and responsibility.


It should be noted that Trainees working at **Responsibility Level E** carry responsibility equivalent to that of a registered person, except that the Applicant's Supervisor is accountable for the Applicant's recommendations and decisions.

**Table 1: Progression throughout the candidacy period of applicants**

Degree of Responsibility	Nature of work	Activities/duties to be undertaken during training
A: Being exposed	Trainee undergoes induction and observes the processes and work of competent practitioners.	<ul style="list-style-type: none"> <li>• Understand the business environment and the dynamics that shape the businesses and the industries in which they operate.</li> <li>• Understand the business model, its key conversion processes and the critical outcomes.</li> <li>• Understand the value added by Agricultural Engineering Practitioners and other professionals in the business.</li> </ul>

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Degree of Responsibility	Nature of work	Activities/duties to be undertaken during training
B: Assisting	Trainee performs specific processes under close supervision.	<ul style="list-style-type: none"> <li>Develop insight and understanding of the different processes and systems in transforming inputs into goods and services.</li> <li>Develop an appreciation of the numerous resources at the disposal of Agricultural Engineering practitioners.</li> <li>Obtain experience in the day-to-day operations of the business to gain insight and understanding of the different processes and systems involved in transforming inputs into goods and services, with specific emphasis on productivity and quality measurements.</li> </ul>
C: Participating	Trainee performs specific processes as directed, with limited supervision.	<ul style="list-style-type: none"> <li>Gain first-hand experience of a broad range of Agricultural Engineering activities (e.g., process design and re-engineering, planning and control, work study, value engineering, materials and information management, people management skills, logistics, specialists' inputs, tools and equipment, and quality assurance).</li> <li>Note the problems and limitations of particular philosophies, methods and techniques, with emphasis on cost/effort and relative benefit.</li> </ul>
D: Contributing	Trainee performs specific work with detailed approval of work outputs.	<ul style="list-style-type: none"> <li>Be involved in activities such as the planning of production, the control of quality and costs of process study and work study, good material handling and workplace layout, activity-based costing, benchmarking, business cases, process re-engineering, maintenance practice and procedures, and project management and system specification. Of particular importance is the collective working of such activities in the economical use of people, materials and machines.</li> <li>Give specific attention to human aspects concerning communication, interpersonal relationships and teamwork, training, cost analysis, budget control and profit accountability. These should proceed in parallel, applying Agricultural Engineering techniques and employing computers in problem-solving.</li> </ul>

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Degree of Responsibility	Nature of work	Activities/duties to be undertaken during training
E: Performing	Trainee works in a team without supervision, recommends work outputs, and is responsible but not accountable.	<ul style="list-style-type: none"> <li>Assume escalating technical responsibility and increasingly co-ordinate the work of others.</li> <li>Gain exposure to and develop skills in management areas such as labour relations, management accounting, business law and general business management. This is important for developing well-rounded Engineering Practitioners.</li> <li>Seek assignments that require judgement, even if full information is unavailable. This leads to a position of professional responsibility, which is of great value and should be pursued.</li> </ul>

## 5.2 Applicant training programmes

No ideal training programme structure or unique sequencing constitutes best practice. The training programme for each Applicant depends on the available work opportunities the employer assigns to the Applicant at the time. Trainees must develop the skills required to demonstrate the advanced use of Agricultural Engineering knowledge in optimising the efficiency of operations or the constructability of projects.


It is suggested that Trainees work with their Mentors to determine appropriate projects to gain exposure to elements of the asset life cycle. In addition, Trainees need to ensure their designs are constructible and operable and are designed considering life cycle costing and long-term sustainability. A regular reporting structure with suitable recording of evidence of achievement against the competency outcomes and responsibility needs to be in place.

The training programme should be such that Trainees progress through the levels of work capability (described in document **R-04-T&M-GUIDE-PC**) to ensure that by the end of the training period, trainees exhibit Responsibility Level E and are able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

Applicants must be able to demonstrate they have been actively involved in an Agricultural Engineering work environment and have participated in the execution of practical work such that they have learnt sufficient details of basic in mechanisation, irrigation, soil conservation,

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food and process engineering, etc., procedures to be able to exercise judgement in the workplace.

Applicants must show evidence of adequate training in this function through project work carried out in the analysis of problems and the synthesis of solutions. Evidence is required in the form of a separate comprehensive Design Report that should accompany the application. This report should describe a synthesised solution to engineering problems to demonstrate that applicants have had an opportunity to apply their technical knowledge and engineering expertise gained through education and practical work experience. In applying technical and scientific knowledge gained through academic training, the Applicant must also demonstrate the financial and economic benefits of engineered solutions synthesised from scientific and engineering principles at a sufficiently advanced level.


Trainees are required to undertake engineering projects that significantly enhance the operability and constructability of integrated engineering systems and infrastructure. Such project work must not be a stand-alone type of assignment but should be part of a solution to integrated engineering systems that require a broader application of various theoretical aspects of Agricultural Engineering, ranging from fluid systems and energy systems to structures and machines.

The design or development is a logical process that requires Engineering Professionals to apply their minds carefully in bringing solutions to the various defined levels of engineering problems. This process involves the analysis of systems or subsystems together with the integration of various elements in Agricultural Engineering subdisciplines through the application of engineering sciences.

As part of demonstrating the advanced application of theoretical knowledge with respect to these systems, Trainees must incorporate calculations with clearly defined inputs regarding the formulae that were used and a detailed interpretation of the results that were obtained. Applicants must demonstrate how the calculated results have been used to provide the solution to the problem at hand and indicate the economic benefit to the project or the operating work environment.

Trainees must obtain experience in solving a variety of problems in their work environments, and the solutions to these problems should involve the use of fundamental and advanced

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Agricultural Engineering knowledge. The problems that require a scientific and engineering approach to solve may be encountered in any engineering work environment that consists of integrated engineering systems, equipment, machinery and infrastructure. From their early training years, Trainees must actively seek opportunities to obtain experience in synthesising solutions to the real-life engineering problems encountered in the workplace.

A suitable period of time and degree of practical participation should also be sought in the workshop environment, learning the basic practices that are the essence of the Agricultural Engineering discipline, so that the Applicant can judge the efficacy of such practices in the general workplace thereafter.

The DSTG assumes that Trainees enter a programme after graduation and continue with the programme until they are ready to apply for professional registration. The guide also assumes that Trainees are supervised and mentored by persons who meet the requirements stated in document **R-04-T&M-GUIDE-PC**. In the case of a person changing from one candidacy programme to another or moving into a candidacy programme from a less structured environment, it is essential that the following steps are completed:


- Applicants must complete the Training and Experience Summary (TES) and the Training and Experience Reports (TERs) for the previous programme or the unstructured experience. Regarding the latter, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant Supervisor or Mentor.
- On entering the new programme, the Mentor and Supervisor should review the Trainee's development while being mindful of past experience and the opportunities and requirements of the new programme. At minimum, the Mentor and the Supervisor should plan the next phase of the Trainee's programme.

## 6. CONCLUSION

To attain registration as professionals, Applicants should be able to meet the educational requirements for the category and demonstrate competency against the prescribed standards for the registration category. Demonstrating competency is achieved by meeting the requirements for the 11 ECSA outcomes. Applicants or persons who want to be registered as Professionals together with their Mentors must ensure that the training provided is geared towards achieving the ECSA competency outcomes. Focusing on one training aspect for the

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entire duration of training will not assist Trainees/Applicants to achieve the necessary skills to demonstrate all the standard competency outcomes.

The development of training remains the Applicant's responsibility, and the Applicant must ensure that the training plan being provided covers all aspects of the outcomes.

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## REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Rev 0 Draft A	19 March 2025	The DSTG has been merged into one Discipline-specific Training Guide for Registration as a Professional Engineer, Technologist and Technician in Industrial Engineering and to ensure that the DSTG clearly details how each outcome can be achieved.	RDDR BU
Rev 0 Draft B	16 May 2025	<p>The review has included an introduction section. The document further indicates the type of engineering work that the different categories should undertake.</p> <p>Section 4. Developing Competency: Document (R-08-PE/PT/PN) Under training for registration as a professional engineer, professional engineering technologist and professional engineering technician has been revised to ensure that each training element is aligned to each outcome,</p> <p><i>4.1.1 Investigation &amp; Analysis</i></p> <p>The content under this section is aligned with Outcome 1</p> <p><i>4.1.2 Engineering Design &amp; Development of solution</i></p> <p>The content under this section is aligned with Outcome 2</p> <p><i>4.1.3 Contextual Knowledge</i></p> <p>The content under this section is aligned with Outcome 3</p> <p><i>4.1.4 Engineering Project Management</i></p> <p>The content under this section is aligned with Outcome 4</p> <p><i>4.1.5 Professional Communication</i></p> <p>The content under this section is aligned with Outcome 5</p>	Working group

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		<p><i>4.1.6 Impact of Engineering Activities &amp; Risk Mitigation</i></p> <p>The content under this section is aligned with Outcome 6</p> <p><i>4.1.7 Statutory &amp; Regulatory Requirements</i></p> <p>The content under this section is aligned with Outcome 7</p> <p><i>4.1.8 Ethics of Engineering</i></p> <p>The content under this section is aligned with Outcome 8</p> <p><i>4.1.9 Exercising sound judgment</i></p> <p>The content under this section is aligned with Outcome 9</p> <p><i>4.1.10 Responsibility in Decision-making</i></p> <p>The content under this section is aligned with Outcome 10</p> <p><i>4.1.11 Professional Development</i></p> <p>The content under this section is aligned with Outcome 11</p>	
Rev 0 Draft C	22 May 2025	Document revised <u>and</u> sent to Registration BU for inputs and comments	RI BU, Registration BU and WG
Rev 0 Draft D	17 June 2025	RID BU reviewed comments and inputs from Registration BU and sent the document to WG to effect comments	RID BU and WG
Rev 0 Draft E	22 July 2025	Document submitted to the IEA Task Team for alignment to the IEA changes	IEA Review Task Team
Rev 0	5 September 2025	Reviewed and checked	Acting Executive: RSIR
Rev 0	19 September 2025	Approval	RPSC

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The Discipline-specific Training Guide for

**Registration as a Professional Engineer, Technologist, and Technician in Agricultural Engineering**

Revision 0 dated 19 September 2025 and consisting of 82 pages reviewed for adequacy by the Business Unit Assistant Manager and is approved by the Acting Executive: Regulatory Services & International Relations (**ERSIR**).

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Business Unit Assistant Manager


7 October 2025  
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Date

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Acting Executive: RSIR

7 October 2025  
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Date

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## APPENDIX A: TRAINING ELEMENTS

**Synopsis:** Applicants should achieve specific competencies at the prescribed level during their development towards professional registration, at the same time accepting more and more responsibility as experience is gained. The outcomes achieved and established during the candidacy phase should form the template for all engineering work performed after professional registration regardless of the level of responsibility at any particular stage of an engineering career:


1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical training to develop possible solutions: select the best and present to the recipient.
3. Apply theoretical knowledge to justify decisions taken and processes used.
4. Understand role in the work team and plan and schedule work accordingly.
5. Issue complete and clear instructions and report comprehensively on work progress.
6. Be sensitive about the impact of the engineering activity and take action to mitigate this impact.
7. Consider and adhere to legislation applicable to the task and the associated risk identification and management.
8. Adhere strictly to high ethical behavioural standards and ECSA's Code of Conduct.
9. Display sound judgement by considering all factors, their interrelationship, consequences and evaluation when all evidence is not available.
10. Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain and evaluating shortcomings.
11. Become conversant with your employer's training and development programme and develop your own lifelong development programme within this framework.

**Complex, broadly defined and well-defined** engineering work is usually characterised by the application of engineering deviating from standard procedures, codes and systems, the deviation verified by research, modelling and/or substantiated design calculations.

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing.

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Competency Standards for Registration as a Professional Engineering Technologist	Explanation and Responsibility Level
<p><b>1. Purpose</b></p> <p>This standard defines the competence required for registration as a <b>Professional Engineer, Technologist and Technician</b>. Definitions of terms having particular meaning within this standard is given in text in relevant section.</p>	<p>DSTGs give context to the purpose of the Competency Standards. The <b>Engineer, Technologist and Technician</b> operate within the 12 disciplines ECSA recognises. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given in section 4 of the specific DSTG. <u>DSTGs are used to facilitate experiential development towards ECSA registration and assist in compiling the required portfolio of evidence (specifically the Engineering Report in the application form).</u></p> <p><b>NOTE:</b> The training period must be used to develop the trainee's competence towards achieving the standards below at a Responsibility Level E, i.e., Performing. (Refer to the specific DSTG)</p>
<p><b>2. Demonstration of competence</b></p> <p>Competence must be demonstrated within Complex, broadly defined and Well-defined <i>engineering activities</i>, defined below, by integrated performance of the outcomes defined at the level defined for each outcome. Required contexts and functions may be specified in the applicable DSTG.</p> <p><b>Level Descriptor:</b> Complex engineering activities (<b>CEA</b>), Broadly defined engineering activities (<b>BDEA</b>), and Well-defined engineering activities (<b>WDEA</b>) have several of the following characteristics:</p> <p>a) Scope of practice area is linked to technologies used and changes by adoption of new technology into current practice.</p> <p>b) Practice area is located within a wider, complex context, requires teamwork, and has interfaces with other parties</p>	<p>Engineering activities can be divided into (approximately):</p> <ul style="list-style-type: none"> <li>5% Complex (Professional Engineers)</li> <li>5% Broadly Defined (Professional Engineering Technologists)</li> <li>10% Well-defined (Professional Engineering Technicians)</li> <li>15% Narrowly Well-defined (Registered Specified Categories)</li> <li>20% Skilled Workman (Engineering Artisan)</li> <li>55% Unskilled Workman (Artisan Assistants)</li> </ul> <p>Activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.</p> <p><b>Level Descriptor: CEA, BDEA and WDEA</b> in the various disciplines are characterised by several or all of the following:</p> <p>a) Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation.</p> <p>b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to</p>

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and disciplines.	identify the need for advice on <b>CEA, BDEA and WDEA</b> activities and problems. <b>CEA, BDEA and WDEA</b> activities in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team.
<ul style="list-style-type: none"> <li>c) Involves a variety of resources, including people, money, equipment, materials and technologies.</li> <li>d) Requires resolution of occasional problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues.</li> <li>e) Are constrained by available technology, time, finance, infrastructure, resources, facilities, standards and codes and applicable laws.</li> <li>f) Have significant risks and consequences in the practice area and in related areas.</li> </ul>	<ul style="list-style-type: none"> <li>c) The bulk of the work involves familiar, defined range of resources, including people, money, equipment, materials, but new technologies are investigated and implemented.</li> <li>d) Most of the impacts in the sub discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of broadly defined non-standard engineering principles.</li> <li>e) The work packages and associated parameters are constrained by operational context with variations limited to different locations only. (Cannot be covered by standards and codes.)</li> <li>f) Even locally important minor risks can have far reaching consequences.</li> </ul>
<b>Activities</b> include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; manufacture or construction; engineering operations; maintenance; project management; research; development and commercialisation.	<b>Activities</b> include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management. For <b>Engineers, Technologists and Technicians</b> , research, development and commercialisation happen more frequently in some disciplines but are seldom encountered in others.
<b>3. Outcomes to be satisfied:</b>	<b>Explanation and Responsibility Level</b>
<b>Group A: Engineering Problem Solving</b>	
<b>Outcome 1:</b> Define, investigate and analyse <i>Complex, broadly defined and Well-defined</i> , engineering problems	<b>Responsibility Level E</b> Analysis of an engineering problem means the 'separation into parts possibly with comment and judgement'. <i>Complex, Broadly, Well-defined</i> means: 'not minute or detailed' and 'not kept within narrow limits'.
<b>Complex, broadly defined and well-defined engineering problems</b> have the following characteristics. a) They require coherent and detailed engineering knowledge, underpinning the technology area;	a) Coherent and detailed engineering knowledge for <b>Engineer, Technologist and Technician</b> means the problem encountered cannot be solved without the combination of all the relevant detail including engineering principles applicable to the situation.

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<p>and one or more of the following:</p> <ul style="list-style-type: none"> <li>b) Are ill-posed, under- or over-specified, require identification and interpretation into the technology area.</li> <li>c) Encompass systems within complex engineering systems;</li> <li>d) Belong to families of problems which are solved in well-accepted but innovative ways. <i>and one or more of:</i></li> <li>e) Can be solved by structured analysis techniques</li> <li>f) May be partially outside standards and codes; must provide justification to operate outside.</li> <li>g) Require information from practice area and sources interfacing with practice area that is complex and incomplete.</li> <li>h) Involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties. <i>and one or both of:</i></li> <li>i) Require judgement in decision-making in practice area, considering interfaces to other areas.</li> <li>j) Have significant consequences which are important in practice area but may extend more widely.</li> </ul>	<ul style="list-style-type: none"> <li>b) The nature of the problem is not immediately obvious, and further investigation to identify and interpret the real nature of the problem is necessary.</li> <li>c) The problem is not easily recognised as part of the larger engineering task, project or operation and may be obscured by the complexity of the larger system.</li> <li>d) It is recognised that the problem can be classified as falling within a typical solution requiring innovative adaptation to meet the specific situation.</li> <li>e) Solving the problem needs a step-by-step approach adhering to proven logic.</li> <li>f) The standards, codes and documented procedures must be analysed to determine to what extent they are applicable to solve the problem, and justification must be given to operate outside these.</li> <li>g) The responsibility lies with the <b>Engineer, Technologist and Technician</b> to verify that some information received as part of the problem encountered may remain incomplete and solutions to problems may need justified assumptions.</li> <li>h) The problem handled by <b>Engineer, Technologist and Technician</b> may be solved by alternatives that are unaffordable, detrimental to the environment, socially unacceptable, not maintainable, not sustainable, etc; the <b>Engineer, Technologist and Technician</b> will have to justify his/her recommendation.</li> <li>i) Practical solutions to problems include knowledge and judgement of the roles displayed by the multi-disciplinary team and impact of own work in the interactive environment.</li> <li>j) <b>The Engineer, Technologist and Technician</b> must realise that their actions might seem to be of local importance only but may develop into significant consequences extending beyond their own ability and practice area.</li> </ul>
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<p><b>Assessment criteria:</b> A structured analysis of broadly defined problems typified by the following performances is expected:</p> <p>1.1 Performed or contributed to defining engineering problems leading to an agreed definition of the problems to be solved.</p> <p>1.2 Performed or contributed to investigating engineering problems including collecting, organising and evaluating information.</p> <p>1.3 Performed or contributed to analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results.</p>	<p>To perform an engineering task an <b>Engineer, Technologist and Technician</b> will typically receive an instruction from a senior person (customer) to do a specific task, and must:</p> <p>1.1 Ensure the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation.</p> <p>1.2 Ensure the engineering problem and related information are segregated from the bulk of the information, investigated and evaluated.</p> <p>1.3 Ensure that the instruction and information to do the work is fully understood and complete, including engineering theory needed to understand the task and acceptance criteria, and to carry out and/or check calculations. If needed supplementary information must be gathered, studied and understood. Concepts and assumptions must be justified by engineering theory and calculations, if applicable.</p>
<b>3. Outcomes to be satisfied:</b>	<b>Explanation and Responsibility Level</b>
<p><b>Range statement:</b> 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 problem is one amenable to solution by technologies known to the Candidate. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.</p>	Please refer to section 4 of the specific DSTG.
<p><b>Outcome 2:</b> Design or develop solutions to <b>complex, broadly defined and well-defined</b> engineering problems</p>	<p><b>Responsibility Levels C and D</b> Design means 'drawing or outline from which something can be made'. Develop means 'come or bring into a state in which it is active or visible'.</p>
<p><b>Assessment criteria:</b> This outcome is normally demonstrated after a problem analysis as defined in Outcome 1. Working systematically to synthesise a solution to a broadly defined problem, typified by the following performances is expected:</p>	<p>After the task received is fully understood and interpreted, a solution to the problem posed can be developed (designed). To synthesise a solution is 'the combination of separate parts, elements, substances, etc. into a whole or into a system' by the following:</p>

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<p>2.1 Designed or developed solutions to <b>complex, broadly defined and well-defined</b> engineering problems.</p> <p>2.2 Systematically synthesised solutions and alternative solutions or approaches to the problem by analysing designs against requirements, including costs and impacts on outside parameters. (requirements).</p> <p>2.3 Drawing up of detailed specification requirements and design documentation for implementation to the satisfaction of the client.</p>	<p>2.1 The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an attachment.</p> <p>2.2 The <b>Engineer, Technologist and Technician</b> will in some cases be unable to support proposals with the complete theoretical calculation to substantiate every aspect and must in these cases refer his / her alternatives to an engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified.</p> <p>2.3 The best complete and final solution selected must be followed up with a detailed technical specification, supporting drawings, bill of quantities, etc. for the execution of work to meet customer requirements.</p>
<p><b>Range Statement:</b> Solutions are those enabled by the technologies in the Candidate's practice area.</p>	<p>Applying theory to do <b>complex, broadly defined and well-defined engineering</b> work is mostly done in a way that has been used before, probably developed by engineers in the past, and documented in written procedures, specifications, drawings, models, examples, etc. <b>The Engineer, Technologist and Technician</b> must seek approval for any deviation from these established methods but must also initiate and/or participate in the development and revision of these norms.</p>
<p><b>Outcome 3:</b> Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems or methodologies and those specific to the jurisdiction in which he/she practices.</p>	<p><b>Responsibility Level E</b> Comprehend means 'to understand fully'. The jurisdiction in which an <b>Engineer, Technologist and Technician</b> practices is given in section 4 of the specific DSTG.</p>
<p><b>Assessment criteria:</b> This outcome is normally demonstrated in the course of design, investigation or operations.</p> <p>3.1 Apply engineering principles, practices, technologies,</p>	<p>Design work for <b>Engineer, Technologist and Technician</b> is based on B Eng, BTech, N Dip, theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel engineering., <b>Engineer, Technologist and Technician</b> develop and apply codes and procedures in their design work. Investigation would be on broadly defined incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations.</p> <p>3.1 Calculations at B Eng, BTech or B Eng (Tech) and/or NDip, theoretical level confirming the correct</p>

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<p>including the application of, B Eng, BTech or B Eng (Tech) and N Dip, theory in the practice area.</p> <p>3.2 Indicate working knowledge of areas of practice that interact with practice area to underpin teamwork.</p> <p>3.3 Apply related knowledge of finance, statutory, safety and management.</p>	<p>application and utilisation of equipment, materials and systems listed in section 4 of the specific DSTG must be done on broadly defined activities.</p> <p>3.2 The understanding of <b>complex, broadly defined, well-defined</b>, procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team.</p> <p>3.3 The ability to manage the resources within legal and financial constraints must be evident.</p>
<p><b>Range Statement:</b> Applicable knowledge includes:</p> <p>a) Technological knowledge that is well-established and applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others.</p> <p>b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.</p> <p>c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practice area, a selection of law of contract, health and safety, environmental, intellectual property, contract administration, quality management, risk management, maintenance management, regulation, project and construction management.</p>	<p>a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of systems, materials, components and projected customer requirements and expectations. New ideas, materials, components and systems must be investigated, evaluated and applied accompanied by complex theoretical motivation.</p> <p>b) In spite of having a working knowledge of interacting disciplines, <b>Engineer, Technologist and Technician</b> take responsibility for the multidisciplinary team of specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, architects on buildings, Electrical Engineers on communication equipment, etc.</p> <p>c) Jurisdictional in this instance means 'having the authority', and <b>Engineer, Technologist and Technician</b> must be aware of and decide on the relevant requirements applicable to each specific project that he/she is responsible for. They are usually appointed as the 'responsible person' for specific projects in terms of the OHS Act.</p>

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Group B: Managing Engineering Activities	Explanation and Responsibility Level
<b>Outcome 4:</b> Manage part or all of one or more <b>complex, broadly defined and well-defined</b> engineering activities.	<b>Responsibility Level D</b> Manage means 'control'.
<b>Assessment criteria:</b> The Candidate is expected to display personal and work process management abilities: 4.1 Managed self, people, work priorities, processes and resources in broadly defined engineering work. 4.2 Role in planning, organising, leading and controlling broadly defined engineering activities evident. 4.3 Knowledge of conditions and operation of contractors and ability.	In Engineering operations <b>Engineer, Technologist and Technician</b> are typically given the responsibility to carry out projects. 4.1 Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects. 4.2 The basic elements of managements must be applied to broadly defined engineering work. 4.3 Depending on the project, <b>Engineer, Technologist and Technician</b> can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.
<b>Outcome 5:</b> Communicate clearly with others in the course of his/her broadly defined engineering activities.	<b>Responsibility Level C</b>
<b>Assessment criteria:</b> Demonstrates effective communication by: 5.1 Ability to write clear, concise, effective technical, legal and editorially correct reports shown. 5.2 Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident. 5.3 Oral presentations made using structure, style, language, visual aids	Refer to Range Statement for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
<b>Range Statement for Outcomes 4 and 5:</b> Management and communication in <b>complex, broadly defined and well-defined engineering</b> involves:	

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<p>a) Planning <b>complex, broadly defined and well-defined</b> activities</p> <p>b) Organising <b>complex, broadly defined and Well-defined</b> activities</p> <p>c) Leading <b>complex, broadly defined and well-defined</b> activities</p> <p>d) Controlling <b>complex, broadly defined and well-defined</b> activities.</p>	<p>a) Planning means ‘the arrangement for doing or using something, considered in advance’</p> <p>b) Organising means ‘put into working order, arrange in a system, make preparations for’</p> <p>c) Leading means to ‘guide the actions and opinions of, influence, persuade’</p> <p>d) Controlling means the ‘means of regulating, restraining, keeping in order, check’</p> <p><b>The Engineer, Technologist and Technician</b> write specifications for purchase of materials and/or work to be done, recommendations on tenders received, place orders and variation orders, write work instructions, report on work done, draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write work procedures, write inspection and audit reports, write commissioning reports, prepare and present motivations for new projects, compile budget reports, report on studies done and calculations carried out, report on customer requirements, report on safety incidents and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report on cost control, etc.</p>
<b>Group C: Impacts of Engineering Activity</b>	<b>Explanation and Responsibility Level</b>
<p><b>Outcome 6:</b> Recognise the foreseeable social, cultural and environmental effects of <b>complex, broadly defined and well-defined</b> engineering activities generally</p>	<p><b>Responsibility level B</b> Social means ‘people living in communities; of relations between persons and communities’. Cultural means ‘all the arts, beliefs, social institutions, etc. characteristic of a community’. Environmental means ‘surroundings, circumstances, influences’.</p>
<p><b>Assessment criteria:</b> This outcome is normally displayed in the course of analysis and solution of problems. The candidate typically shows:</p> <p>6.1 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown.</p> <p>6.2 Measures taken to mitigate the negative effects of engineering</p>	<p>6.1 Engineering impacts heavily on the environment, e.g., servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wildlife, dangerous rotating and other machines, demolishing of structures, etc.</p> <p>6.2 Mitigating measures taken may include environmental impact studies, environmental impact management,</p>

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activities evident.	community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases, compensation paid, etc.
<b>Outcome 7:</b> Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her broadly defined engineering activities.	<b>Responsibility level E</b>
<b>Assessment criteria:</b> 7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity. 7.2 Circumstances stated where applicant assisted in or demonstrated awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.	7.1 The OHS Act is supplemented by a variety of parliamentary acts, regulations, local authority by-laws, standards and codes of practice. Places of work might have standard procedures, instructions, drawings and operation and maintenance manuals available. These documents, depending on the situation (emergency, breakdown, etc.) are consulted before work is commenced and during the activity. 7.2 It is essential to attend a Risk Management (Assessment) course, and to investigate and study the materials, components and systems used in the workplace. The <b>Engineer, Technologist and Technician</b> seeks advice from knowledgeable and experienced specialists if the slightest doubt exist that safety and sustainability cannot be guaranteed.
<b>Range Statement for Outcomes 6 and 7:</b> Impacts and regulatory requirements include the following: a) Requirements include both explicit regulated factors and those that arise in the course of particular work. b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied.	a) The impacts will vary substantially with the location of the task, e.g., the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly and may be complex. It is identified and studied by the <b>Engineer, Technologist and Technician</b> before starting the work. b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirms or checks that the instructions are in line with regulations. The <b>Engineer, Technologist and Technician</b> is responsible to see that this is done, and if not, establish which regulations apply, and ensure that they are adhered to. Usually, the people working on site are strictly controlled. W.r.t. health and safety, but the <b>Engineer, Technologist and Technician</b> checks that this is done, but may authorise unavoidable deviation after setting conditions for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained.

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<p>c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used.</p> <p>d) Safe and sustainable materials, components and systems.</p> <p>e) Regulatory requirements are explicit for the context in general.</p>	<p>c) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The <b>Engineer, Technologist and Technician</b> needs to identify, analyse and manage any long-term risks and develop strategies to solve these by using alternative technologies.</p> <p>d) The safe and sustainable materials, components and systems must be selected and prescribed by the <b>Engineer, Technologist and Technician</b> or other professional specialists must be consulted. It is the responsibility of the <b>Engineer, Technologist and Technician</b> to use his/her knowledge and experience to confirm that prescriptions by others are correct and safe.</p> <p>e) Application of regulations associated with the particular aspects of the project must be carefully identified and controlled by the <b>Engineer, Technologist and Technician</b>.</p>
<b>Group D: Exercise judgment, take responsibility, and act ethically</b>	<b>Explanation and Responsibility Level</b>
<b>Outcome 8:</b> Conduct engineering activities ethically.	<b>Responsibility level E</b> Ethically means 'science of morals; moral soundness'. Moral means 'moral habits; standards of behaviour; principles of right and wrong'.
<b>Assessment Criteria:</b> Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: 8.1 Conversance and operation in compliance with ECSA's Rules of Conduct for registered persons confirmed 8.2 How ethical problems and affected parties were identified, and the best solution to resolve the problem selected.	<p>Systematic means 'methodical; based on a system'.</p> <p>8.1 ECSA's Code of Conduct, as per ECSA's website, is known and adhered to.</p> <p>8.2 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.</p>

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<b>Outcome 9:</b> Exercise sound judgement in the course of <b>complex, broadly defined and well-defined</b> engineering activities	<b>Responsibility level E</b> Judgement means 'good sense: ability to judge'.
<b>Assessment criteria:</b> Judgement is displayed by the following: 9.1 Judgement exercised in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies. 9.2 Factors taken into consideration given, bearing in mind, risk, consequences in technology application and affected parties.	9.1 The extent of a project given to a junior <b>Engineer, Technologist and Technician</b> is characterised by the several broadly defined and a few well-defined factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded. 9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Evaluation includes engineering calculations to substantiate decisions taken and assumptions made.
<b>Range Statement for Outcomes 8 and 9:</b> <i>Judgement</i> in decision-making involves:  a) taking several risk factors into account; <b>or</b> b) significant consequences in technology application and related contexts; <b>or</b> c) ranges of interested and affected parties with widely varying needs.	In Engineering, about 5% of engineering activities can be classified as broadly defined where the <b>Engineer, Technologist and Technician</b> uses standard procedures, codes of practice, specifications, etc, but develops variations and completely unique standards when needed. Judgement must be displayed to identify any activity falling inside the broadly defined range, as defined above:  a) Getting work done despite numerous risk factors needs good judgement and substantiated decision-making. b) Consequences are part of the project e.g., extra cost due to unforeseen conditions, incompetent contractors, long-term environmental damage, etc. c) Interested and affected parties with defined needs that may be in conflict, e.g., need for a service irrespective of environmental damage, local traditions and preferences, etc. needs sound management and judgement.
<b>Outcome 10:</b> Be responsible for making decisions on part or all of all of one or more <b>complex, broadly defined and well-defined</b> engineering activities	<b>Responsibility level E</b> Responsible means 'legally or morally liable for carrying out a duty; for the care of something or somebody in a position where one may be blamed for loss, failure, etc.'.
<b>Assessment criteria:</b> Responsibility is displayed by the following performance: 10.1 Engineering, social, environment and sustainable	10.1 All interrelated factors taken considered are indicative of professional responsibility accepted working on

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<p>development taken into consideration in discharging responsibilities for significant parts of one or more activities.</p> <p>10.2 Advice sought from a responsible authority on matters outside your area of competence.</p> <p>10.3 Academic knowledge of at least B Eng, BTech N Dip, level combined with past experience used in formulating decisions.<sup>1</sup></p>	<p>broadly defined activities.</p> <p>10.2 The <b>Engineer, Technologist and Technician</b> does not operate on tasks at a higher level than, complex, broadly defined, well defined and consults professionals at engineer level if elements of the project to be done are beyond his/her education and experience, e.g., power system stability.</p> <p>10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction and corrective action, if necessary, forms an important element. The calculations, for example fault levels, load calculations, losses, etc. are done to ensure that the correct material and components are utilised.</p>
<b>Range Statement:</b> Responsibility must be discharged for significant parts of one or more <b>complex, broadly defined and well-defined</b> engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
<b>Note 1:</b> <i>Demonstrating responsibility is under supervision of a competent engineering practitioner but is expected to perform as if he/she is in a responsible position.</i>	
<b>Group E: Initial Professional Development (IPD)</b>	<b>Explanation and Responsibility Level</b>
<b>Outcome 11:</b> Undertake independent learning activities sufficient to maintain and extend his or her competence.	<b>Responsibility level D</b>
<b>Assessment criteria:</b> Self-development managed typically: 11.1 Strategy independently adopted to enhance professional development evident. 11.2 Awareness of philosophy of employer regarding professional development evident.	<p>11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a programme drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated.</p> <p>11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and being in charge of experiential development towards <b>Engineer, Technologist and Technician</b> engineering.</p>
<b>Range Statement:</b> Professional development involves: a) planning own professional development strategy b) selecting appropriate professional development activities c) recording professional development strategy and activities,	a) In most places of work training is seldom organised by a training department. It is up to the <b>Engineer, Technologist and Technician</b> to manage his/her own experiential development. <b>Engineer, Technologist and Technician</b> frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely.

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while displaying independent learning ability.	<ul style="list-style-type: none"> <li>b) Preference must be given to engineering development rather than developing soft skills.</li> <li>c) Developing a learning culture in the workplace environment of the <b>Engineer, Technologist and Technician</b> is vital to his/her success</li> </ul>
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## APPENDIX B: TRAINING ELEMENTS SCOPE

<b>1.1</b>	<b><i>Induction programme (typically 1–5 days)</i></b>
1.1.1	Organisation structure
1.1.2	Organisation policies
1.1.3	Organisation Code of Conduct
1.1.4	Organisation safety regulations
1.1.5	Organisation regulations
<b>1.2</b>	<b><i>Exposure to engineering principles and processes (Typically, 6 to 12 months) and cover how things are: (Responsibility level A, B, C)</i></b>
<b><i>Experience in the following but not necessarily all:</i></b>	
1.2.1	Laboratory and testing
1.2.2	Project management
1.2.3	Process design and optimisation
1.2.4	Plant or system operations and maintenance, construction, commissioning and decommissioning eg for food processing
1.2.5	Mechanical testing of materials
1.2.6	Non-destructive testing of materials
<b>2</b>	<b><i>Design or develop solution</i></b>
<b>2.1</b>	<b><i>Experience in design and application of design knowledge (typically 12–18 months). Focus is on planning, design, and application (Responsibility Levels C–D)</i></b>
<b><i>Experience in the following but not necessarily all:</i></b>	
2.1.1	Analysis of systems including modelling eg system for environmental control for farm buildings
2.1.2	Manufacturing / Production e.g., of farm machinery
2.1.3	Process optimisation and design eg for food processing
2.1.4	Plant or system operations and maintenance, construction, commissioning and decommissioning e.g., irrigation system
2.1.5	Component/product design e.g., for farm machinery
2.1.6	Structural design e.g., farm buildings
2.1.7	Mechanical testing of materials
2.1.8	Research and investigation
2.1.9	Preparation of specifications and associated documentation
2.1.10	Preparation of contract documents and associated documentation
2.1.11	Development of standards
2.1.12	Application of quality systems
2.1.13	Problem investigation & failure investigations

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<b>3</b>	<b>Engineering tasks</b>
<b>3.1</b>	<b><i>Experience in the execution of engineering tasks (remainder of training period). Focus should be on projects and project management (Responsibility Level )</i></b>
<b><i>Experience in the following but not necessarily all:</i></b>	
3.1.1.	Design or development of solution
3.1.2	Manufacture
3.1.3	Construction
3.1.4	Installation
3.1.5	Commissioning
3.1.6	Maintenance
3.1.7	Modifications
<b>3.2</b>	<b><i>Organising for implementation of 3.1 (Responsibility Level E)</i></b>
3.2.1	Manage resources
3.2.2	Optimisation of resources and processes
<b>3.3</b>	<b><i>Controlling for implementation or operation of 3.1 (Responsibility Level E)</i></b>
3.3.1	Monitor progress and delivery
3.3.2	Monitor quality
<b>3.4</b>	<b><i>Completion of 3.1 (Responsibility Level E)</i></b>
3.4.1	Commissioning completion
3.4.2	Documentation completion
3.4.3	Documentation handover
<b>3.5</b>	<b><i>Maintenance and repair of 3.1 (Responsibility Level E)</i></b>
3.5.1	Plan and schedule maintenance
3.5.2	Monitor quality
3.5.3	Oversee maintenance and repair e.g., of farm machinery
<b>4</b>	<b>Risk and impact mitigation</b>
<b>4.1</b>	<b><i>Impact and risk assessments (Responsibility Level E)</i></b>
4.1.1	Risk assessments
<b>4.2</b>	<b><i>Regulatory compliance (Responsibility Level E)</i></b>
4.2.1	Health and safety
4.2.2	Codes and standards
4.2.3	Legal and regulatory
<b>5</b>	<b>Managing engineering activities</b>
<b>5.1</b>	<b><i>Self-management (Responsibility Levels C–D)</i></b>
5.1.1	Manages own activities
5.1.2	Communicates effectively
<b>5.2</b>	<b><i>Team environment (Responsibility Levels C–D)</i></b>
5.2.1	Participates in and contributes to team planning activities

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5.2.2	Manages people
<b>5.3</b>	<b><i>Professional communication and relationships (networking)</i></b> <b>(Responsibility Levels C–D)</b>
5.3.1	Establishes and maintains professional and business relationships
5.3.2	Communicates effectively
<b>5.4</b>	<b><i>Exercising judgement and taking responsibility</i></b> (Responsibility Level E)
5.4.1	Ethical practices
5.4.2	Code of Conduct
5.4.3	Exercises sound judgement in the course of engineering activities
5.4.4	Is responsible for decision-making in some or all engineering activities
<b>5.5</b>	<b><i>Competency development</i></b> (Responsibility Level D)
5.5.1	Plans own development programme
5.5.2	Constructs initial professional development record

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