TABLE OF CONTENTS

DEFINITIONS ............................................................................................................................ 3

BACKGROUND ............................................................................................................................ 5

1. PURPOSE OF THIS DOCUMENT ............................................................................................ 5

2. AUDIENCE ............................................................................................................................... 6

3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER
   COMMITMENT AND UNDERTAKING ...................................................................................... 7

4. ORGANISING FRAMEWORK FOR OCCUPATIONS ................................................................. 8

5. NATURE AND ORGANISATION OF THE INDUSTRY ............................................................. 9

6. DEVELOPING COMPETENCY: (DOCUMENT R-08-PN) ...................................................... 10

   6.1 Engineering lifecycle considerations .................................................................................. 10

   6.2 Functions performed .......................................................................................................... 11

   6.3 Contextual knowledge ....................................................................................................... 14

   6.4 Industry-related statutory requirements ............................................................................ 15

   6.5 Recommended formal learning activities .......................................................................... 16

7. PROGRAMME STRUCTURE AND SEQUENCING ................................................................ 17

   7.1 Best practice ...................................................................................................................... 17

   7.2 Considerations for special cases ........................................................................................ 18

   7.3 Moving into or changing candidacy training programmes ................................................ 18

REVISION HISTORY .................................................................................................................. 20

Appendix A: Training elements ................................................................................................. 21
DEFINITIONS

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

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

**Ill-posed problem:** Problems for which the requirements are not fully defined or may be defined erroneously by the requesting party

**Integrated performance:** An overall satisfactory outcome of an activity requires several outcomes to be satisfactorily attained. For example, a design will require 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 required co-ordinated activities are as follows:

(i) to direct and control everything that is constructed or results from construction or manufacturing operations;

(ii) to operate engineering works safely and in the manner intended;

(iii) to 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;

(iv) to direct and control the engineering processes, systems, commissioning, operation and decommissioning of equipment; and

(v) to maintain engineering works or equipment in a state in which it can perform its required function.

**Over-determined problem:** A problem for which the requirements are defined in excessive detail, making the required solution impossible to attain in all of its aspects
Outcome: A statement of the performance that a person must demonstrate in order to be judged competent at the professional level

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 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 the performance of an engineering activity
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.

![Diagram showing the documents that comprise the ECSA system for registration in professional categories.]

Figure 1: Documents defining the ECSA Registration System

1. PURPOSE OF THIS DOCUMENT

All persons applying for registration as a Professional Engineering Technician are expected to demonstrate the competencies specified in document R-02-PN through work performed at the prescribed level of responsibility, irrespective of the trainee’s discipline.

This document supplements the generic Training and Mentoring Guide (document R-04-P) and the Guide to the Competency Standards for Professional Engineering Technicians (document
In document R-04-P, attention is drawn to the following sections:

- 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

The second document (document R-08-PN) provides a high-level, outcome-by-outcome understanding of the competency standards that form an essential basis for this Discipline Specific Training Guide (DSTG).

This guide and the documents R-04-P and R-08-PN are subordinate to the Policy on Registration (document R-01-POL), the Competency Standard (document R-02-PN) and the application process definition (document R-03-PRO).

2. AUDIENCE

This DSTG is directed towards Candidate Engineering Technicians and their supervisors and mentors in the discipline of Civil Engineering. The guide is intended to support a programme of training and experience through incorporating good practice elements.

This guide applies to persons who have:

- completed the education requirements by obtaining an accredited Dip. (Engineering), Dip. (Eng Tech) or Adv. Cert. (Engineering) type qualification, by obtaining a Dublin Accord recognised qualification, or through evaluation/assessment;
- registered as a Candidate Engineering Technician; or
- embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) programme with a mentor guiding the professional development process at each stage.

A C&U programme indicates that the company is committed to mentorship and supervision.
The guide may also be applied in the case of a person moving into a candidacy programme at a later stage that is at a level below that required for registration (document R-04-P).

3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER COMMITMENT AND UNDERTAKING

Irrespective of the development path followed, all applicants for registration must present the same evidence of competence and be assessed against the same standards. Application for registration as a Professional Engineering Technician is permitted without being registered as a Candidate Engineering Technician and without training under a C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration.

If the employer of the trainee does not offer C&U, the trainee should establish the level of mentorship and supervision that the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The Voluntary Association for the discipline may be consulted for assistance in locating an external mentor. A mentor should keep abreast of all stages of the development process.

This guide is written for the recent graduate who is training and gaining experience towards registration. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development.

Applicants who do not hold a benchmark qualification with reference to document E-17-PRO may apply under an alternative route and complete the additional form (Educational Development Report) by considering the number of years of experience, the well-defined engineering activities undertaken during this period and experience at the responsible level.

Applicants who have not enjoyed mentorship are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their application for registration.
4. ORGANISING FRAMEWORK FOR OCCUPATIONS

Civil Engineering Technician (Organising Framework for Occupations (OFO) 311201)

A Civil Engineering Technician plans, designs, organises and oversees the construction and operation of Civil Engineering projects such as

- Structural systems: These include buildings, dams, bridges, roads, highways, runways, harbours and railways.
- Geotechnical systems: These include township services, earthworks, excavations, soil conservation and geotechnical processes.
- Transportation systems.
- Hydraulic engineering systems: These include water resources and supply, pipelines, canals, water treatment, storm water and drainage, sewerage systems, sanitation waste disposal and coastal engineering.

Typical tasks that a Civil Engineering Technician undertakes include

- assistance in conducting research and developing new or improved theories and methods related to Civil Engineering;
- advising on and designing well-defined infrastructure such as bridges, dams, harbours, roads, airports, railways, canals, pipelines, treatment works, waste-disposal and flood control systems and buildings for residential, commercial, industrial and other purposes;
- determining and specifying well defined construction methods, materials and quality standards and directing construction work;
- applying control systems to ensure safety and environmental protection and the efficient functioning of infrastructure;
- organising and directing the maintenance and repair of existing Civil Engineering infrastructure;
- analysing the behaviour of founding material when subjected to super-imposed loading;
- analysing the stability of structures and testing the behaviour and durability of materials used in their construction; and
- analysing earth-retaining structures.

Practising Civil Engineering Technicians generally concentrate on one or more of the following areas:
• Structural Engineering
• Geotechnical Engineering
• Water Engineering
• Transportation Engineering
• Environmental Engineering
• Construction Engineering including Site Supervision and Control

More specialised Civil Engineering Technicians may operate in fields such as Transportation and Urban Planning, Biosystems Engineering, Geographic Information Systems (GIS) and Land Use Management.

5. NATURE AND ORGANISATION OF THE INDUSTRY

Civil Engineering Technicians may be employed in either the private or the public sector.

In the private sector, the Civil Engineering Technician would typically be involved in consulting and contracting in supply and manufacturing organisations. Civil Engineering consultants are responsible for documentation and plan, design and supervise the construction of projects on behalf of their clients. Civil Engineering contractors are responsible for project implementation, and their activities include planning, construction and labour and resource management. Technicians working in supply and manufacturing companies are involved in production, supply and quality control and could be involved in research and development.

The public sector is responsible for service delivery and is usually the client. However, in some departments, design and construction are also carried out. Civil Engineering Technicians are required at all levels of the public sector, including national, provincial and local government departments, state-owned enterprises and public utilities. The public sector is largely involved in planning, specifying and overseeing the implementation of infrastructure projects in addition to engaging in operations and maintaining infrastructure. An extension of the public sector includes tertiary academic institutions and research organisations.

Depending on where the applicant is employed, there may be situations in which the in-house opportunities are not sufficiently diverse to develop all the required competencies that are noted...
in groups A and B of document R-02-PN. For example, the opportunities for developing problem solving competence (including design and development of solutions) and for managing engineering activities (including implementation and construction of solutions) may not be available to the applicant. In such cases, employers are encouraged to implement a secondment system.

It is fairly common practice that in situations in which organisations are not able to provide training in certain areas, secondments are arranged with other organisations so that candidates are able to develop all the competencies required for registration. These secondments are usually of a reciprocal nature so that both employers and their respective employees mutually benefit from each other. Secondments between consultants and contractors and between the public and the private sector should be made possible.

A generic scheme is presented for the outcomes that are applicable to all disciplines. Applicants must demonstrate competence in these outcomes during the various phases of a project or task:

- **Group A**: Solving problems based on well-defined engineering activities and contextual knowledge
- **Group B**: Managing engineering activities
- **Group C**: Impacts of the engineering activity
- **Group D**: Judgement, responsibility and ethical behaviour during an engineering activity
- **Group E**: Professional development after graduation

### 6. DEVELOPING COMPETENCY: (DOCUMENT R-08-PN)

#### 6.1 Engineering lifecycle considerations

A Civil Engineering Technician is involved in the activities that are associated with the asset lifecycle.
6.2 Functions performed

A conventional path to registration usually involves the candidate carrying out the functions described in Table 1 below. Generally, these functions relate to the section for ‘producing an asset’ but can also relate to the section that concerns ‘use of an asset’.

Regarding the section ‘producing an asset’, the functions are expanded from the conventional sequence of an engineering project to encompass conceive, design, implement and operate. Usually, the applicant will experience the functions in this order.

Regarding the section ‘use of an asset’ in which the work involves operations and maintenance, the candidate may experience the functions differently although the functions may be similar.

It is very useful to measure the progression of the candidate’s competency by making use of the scales concerning Degree of Responsibility, Problem Solving and Engineering Activity as
specified in the relevant documentation. Appendix A was developed against the Degree of Responsibility Scale. Activities should be selected to ensure that the applicant reaches the required level of competency and responsibility.

It should be noted that a candidate working at Responsibility Level E carries the responsibility appropriate to that of a registered person except that the candidate's supervisor is accountable for the candidate’s recommendations and decisions.

**TABLE 1: FUNCTIONS**

<table>
<thead>
<tr>
<th></th>
<th>ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Be exposed to, observe and understand a range of processes, materials and products that are relevant to your employer and typical clients</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>DEVELOPING AN ENGINEERING BRIEF</th>
</tr>
</thead>
</table>
| 2.1 | **Accurate identification and definition**  
Take an active part in researching, compiling and assessing basic data and background information and determining the meaning and purpose of an assignment. This will probably be in a supporting role.  
Record your involvement in a report to your mentor and demonstrate the process by which the assignment was finally and properly defined. |

<table>
<thead>
<tr>
<th></th>
<th>Systems approach</th>
</tr>
</thead>
</table>
| 2.2 | It is generally accepted that to ensure a holistic (all encompassing) solution to a problem, all relevant aspects must be considered.  
In reports to your mentor, record through your own experience how you were involved in adopting the wider approach in defining problems. |

<table>
<thead>
<tr>
<th></th>
<th>Standards and codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3</td>
<td>List the documents relating to National and International Standards, Codes of Practice and Environmental Requirements that you have used. In your reports to your mentor, discuss the relevance of these documents to your work.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>DESIGNING A SOLUTION</th>
</tr>
</thead>
</table>
| 3.1 | **Resolution of an engineering brief**  
This involves compiling all the relevant data that was acquired during the investigation period and producing a statement of the completed analytical work.  
**Finding alternative solutions**  
This involves the technical and financial evaluation of alternatives, for example, by assisting with a feasibility study covering aspects such as  
- Concepts and precedents |
3.2 **Present the solution to a problem**
This involves producing documentation for the solution, including diagrams, charts and/or detailed drawings using acceptable standards.
In a report to your mentor, present the example for discussion and approval.

3.3 **Choice of construction material in deciding on a solution**
Read the supplier’s instructions for use of patent materials. Read the SABS specifications on Civil Engineering materials (naturally occurring, processed, manufactured). List all references. Discuss the choice and the use of prescribed materials for a specific solution with your mentor.

4 **DOCUMENTATION**

4.1 **Purpose of documentation**
This involves acquiring an appreciation that technical specifications are an essential part of the solution to the problem. Select or write a specification and/or amend an existing specification for a particular item of work.
Discuss the specification used in your work with your mentor.

4.2 **Costing of solutions**
Cost solutions to problems by taking off quantities and carry out cost estimates.
Present examples to your mentor for discussion and comment.

4.3 **Safety**
State in a quarterly report which regulations apply and which safety criteria you have followed in the course of implementing solutions.

5 **IMPLEMENTATION**

5.1 **Know how all parties to a contract exercise their duties and responsibilities**
In a report to your mentor, demonstrate your knowledge of the duties and responsibilities of all parties involved in a contract. Discuss with your mentor the practical application of the various documents forming a particular contract.
5.2 Know the procedures for the issuing, receipt, registration and filing of work instructions, drawings and amendments
Gain practical experience of these procedures and demonstrate this experience in a report to your mentor.

5.3 Keep an accurate daily record of events and instructions
Keep an up-to-date and accurate daily diary for inspection by your mentor.

5.4 Read and co-ordinate drawings and/or implement work instructions
Be involved in the process on a day-to-day basis.
Demonstrate your competence by the quality of your work.

5.5 Participate in the dimensional control and accuracy of the work that you are implementing or controlling
Demonstrate your competence by the quality of your work, and discuss this process with your mentor.

5.6 Know the use, performance and cost of equipment, plant and/or labour resources
In a report to your mentor, present a list of all major items of which you have first-hand knowledge. Discuss your experience with your mentor.

5.7 Plan and programme sections of work and be involved in the monitoring and reporting of progress
Discuss the programme with your mentor.

5.8 Measure and record or independently check work done for payment purposes
Take part in this work in preparation of checking Interim Valuations and/or Final Accounts. Demonstrate your involvement to your mentor.

5.9 Take a critical approach towards safety matters in the implementation process and towards observance of safe working practices
Know your responsibilities regarding safety and be familiar with the legislation relating to your particular work. Appreciate good safety practices that are relevant to your work by referencing your company safety manual. Emphasise your involvement in safety matters in a report to your mentor.

6.3 Contextual knowledge

Applicants are expected to possess knowledge of the following topics:

- General appreciation of engineering procedures applicable to Civil Engineering
Read the information brochures provided by
- The South African Institution of Civil Engineering (SAICE)
- Consulting Engineers South Africa (CESA)
- The South African Forum of Civil Engineering Contractors (SAFCEC)

Discuss the procedures with your mentor at a quarterly interview.
- Relationships between organisations

Display a working knowledge of the roles of organisations and the interaction between organisations such as
- ECSA
- SAICE
- CESA
- SAFCEC
- The Building Industries Federation South Africa (BIFSA)
- The Construction Industry Development Board (CIDB)
- Knowledge of Conditions of Contract

Display a working knowledge of the Conditions of Contract used in Civil Engineering such as
- General Conditions of Contract (GCC) of the SAICE
- Conditions of Contract of the Fédération Internationale des Ingénieurs Conseils (FIDIC) (International Federation of Consulting Engineers)
- New engineering contract (NEC)
- Structure of the organisation in which the applicant is employed
- Study all available organisation charts
- Write a report on the management structure of your organisation/project team, defining your roles and responsibilities.

6.4 Industry-related statutory requirements

Applicants are expected to have a working knowledge of the following Acts:
- Engineering Profession Act, No. 46 of 2000, its rules and specifically, the Code of Conduct

Depending on their area of practice, applicants may need to have a working knowledge of the following Acts:

• National Building Regulations and Building Standards Act, No. 103 of 1977
• National Building Regulations and Building Standards Amendment Act, No. 49 of 1995
• Environment Conservation Act, No. 73 of 1989 as amended by the Environment Conservation Amendment Act, No. 52 of 1994
• Environment Conservation Amendment Act, No. 50 of 2003
• Water Services Act, No. 108 of 1997
• Water Services Amendment Act, No. 30 of 2004
• National Water Act, No. 36 of 1998 as amended by the National Water Amendment Act, No. 45 of 1999

Many Acts not listed in this document may be pertinent to the work functions of the applicant. Applicants are expected to have a basic knowledge of these Acts where applicable.

6.5 Recommended formal learning activities

Applicants may find the formal learning activities presented in the following list useful in developing their competencies. The list is by no means extensive.

• Discipline-specific courses relating to practice areas of Report Writing
• Project Management
• Conditions of Contract
• Standard Specifications
• Preparation of Specifications
• Negotiation Skills
• Engineering Finance
• Risk Analysis
• Quality Systems
• Occupational Health and Safety
7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best practice

Regardless of the discipline, it is generally unlikely that the period of training will be three years, which is the minimum time required by the ECSA. Typically, the period of training will be longer and is determined by the availability of functions in the actual work situation and other criteria.

There is no ideal training programme structure or unique sequencing that constitutes best practice. The training programme for each candidate depends on the available work opportunities assigned to the candidate by the employer at the time.

Best practice programmes are programmes that address the development of the competencies needed for candidates to be able to register as Professional Engineering Technicians successfully.

It is suggested that candidates work with their mentors to determine appropriate projects in order to gain exposure to elements of the asset lifecycle and to ensure that their designs are constructible and operable and are designed considering lifecycle costing and long-term sustainability. A regular reporting structure with suitable recording of evidence of achievement against the competency outcomes and levels of responsibility needs to be in place.

The training programme should be such that the candidate progresses through the levels of work capability described in document R-04-P so that by the end of the training period, the candidate exhibits a Level E Degree of Responsibility and is able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

The nature of work and the degrees of responsibility defined in document R-04-P are presented here.
A: Being Exposed
B: Assisting
C: Participating
D: Contributing
E: Performing

Undergoes induction; observes processes; works with competent practitioners
Performs specific processes under close supervision
Performs specific processes as directed with limited supervision
Performs specific work with detailed approval of work outputs
Works in team without supervision; recommends work outputs; responsible but not accountable

Responsible to supervisor
Limited responsibility for work output
Full responsibility for supervised work
Fully responsible to supervisor for immediate quality of work
Level of responsibility is equivalent to that of a registered person but supervisor is accountable for candidate’s decisions

Depending on the nature of the work undertaken by an employer, it may be possible to develop a training programme that provides opportunities for the candidate to undertake the work functions described in Section 5.2 of Table 1 of this document. In certain cases, an employer may only cover some of these functions. In such cases, the employer and the candidate should make appropriate arrangements as described in Section 4 of this document.

7.2 Considerations for special cases

Document R-08-P adequately describes what is expected of persons whose formative development has not followed a conventional path, for example, academics, researchers and specialists. Irrespective of the route followed, the overriding consideration is that the applicant must provide evidence of competence against the standard.

7.3 Moving into or changing candidacy training programmes

This guide assumes that the candidate enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the candidate is supervised and mentored by persons who meet the requirements stated in document R-04-P. 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:

- The candidate must complete the Training and Experience Summary (TES) and the Training and Experience Reports (TERs) for the previous programme or unstructured experience. In the latter case, it is important to reconstruct the experience as accurately as possible. The TERs must be signed off by the relevant supervisor.
- On entering the new programme, the mentor and supervisor should review the candidate's development while being mindful of past experience and the opportunities and requirements of the new programme. At minimum, the mentor and supervisor should plan the next phase of the candidate’s programme.
The Discipline-Specific Training Guide for:

Candidates Engineering Technician in Civil Engineering

Revision 2 dated 25 July 2019 and consisting of 20 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (RPS).

Business Unit Manager

Date: 13/09/2019

Executive: RPS

Date: 16/09/2019

This definitive version of the policy is available on our website
Appendix A: Training elements

Synopsis: Candidate Engineering Technicians should achieve specific competencies at the prescribed level during their development towards professional registration and at the same time, should accept 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 the engineering career:

1. Confirm understanding of instructions received and clarify if necessary.
2. Use theoretical training to develop possible solutions, thereafter selecting the best and presenting to the recipient.
3. Apply theoretical knowledge to justify decisions taken and processes used.
4. Understand one’s 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 the high standards of ethical conduct and the ECSA’s Code of Conduct.
9. Display sound judgement by considering all factors together with their interrelationships and consequences and their evaluation when all evidence is not available.
10. Accept responsibility for own work by using theory to support decisions, by seeking advice when uncertain and by evaluating shortcomings.
11. Become conversant with your employer’s training and development programme and develop your own lifelong development programme within this framework.

Well-defined engineering work is usually restricted to applying standard procedures, codes and systems (i.e. work that was done before).

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing
### Competency Standards for Registration as a Professional Engineering Technician

<table>
<thead>
<tr>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline specific training guides (DSTGs) give context to the purpose of the Competency Standards. Professional Engineering Technicians operate within the nine disciplines recognised by the ECSA. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given in this DSTG. Discipline-specific training guides are used to facilitate experiential development towards ECSA registration and to assist in compiling the required portfolio of evidence (specifically the Engineering Report in the application form).</td>
</tr>
<tr>
<td>NOTE: The training period must be utilised to develop the competence of the trainee towards achieving the standards that are presented below at Responsibility Level E (i.e. Performing) (Refer to 7.1 of the specific DSTG).</td>
</tr>
</tbody>
</table>

### 1. Purpose

This standard defines the competence required for registration as a Professional Engineering Technician. Definitions of terms having particular meaning within this standard are given in the main text.
### 2. Demonstration of Competence

Competence must be demonstrated within well-defined engineering activities (defined below) by integrated performance of the outcomes defined in Section 3 at the level defined for each outcome. Required contexts and functions may be specified in the applicable DSTG.

**Level Descriptor: Well-defined engineering activities (WDEAs)** have several of the following characteristics:

- **(a)** Scope of practice area is defined by techniques applied; change is by adopting new techniques into current practice.
- **(b)** Practice area is located within a wider, complex context, with well-defined working relationships with other parties and disciplines.
- **(c)** Work involves a familiar, defined range of resources, including people, money, equipment, materials and technologies.
- **(d)** Activities require resolution of interactions manifested between specific technical factors with limited impact on wider issues.
- **(e)** Activities are constrained by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, and applicable laws.
- **(f)** Activities have risks and consequences that are locally important but are generally not far reaching.

**Activities** include 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.

Engineering activities can be divided into (approximately):

- 5% Complex (Professional Engineers)
- 5% Broadly Defined (Professional Engineering Technologists)
- 10% Well-Defined (Professional Engineering Technicians)
- 15% Narrowly Well-Defined (Registered Specified Categories)
- 20% Skilled Workman (Engineering Artisan)
- 55% Unskilled Workman (Artisan Assistants)

The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.

**Level Descriptor: WDEAs** in the various disciplines are characterised by several or all of the following:

- **(a)** Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Techniques applied are largely well established and change by adopting new techniques into current practice is the exception.
- **(b)** Practice area varies substantially with unlimited location possibilities, resulting in the additional responsibility of identifying the need for complex and/or broadly defined advice to be included in the well-defined working relationships with other parties and disciplines.
- **(c)** The bulk of the work involves a familiar, defined range of resources, including people, money, equipment, materials and technologies.
- **(d)** Most of the impacts in the sub-discipline are on wider issues, and although occurring frequently, are well-defined and can be resolved by following established procedures.
- **(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).
- **(f)** Even locally important minor risks can have far-reaching consequences.

**Activities** include design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; and project management. For Engineering Technicians, research, development and commercialisation happen frequently in some disciplines and are seldom encountered in others.

### 3. Outcomes to be satisfied

#### Group A: Engineering Problem-Solving

<table>
<thead>
<tr>
<th>Outcome 1: Define, investigate and analyse well-defined engineering problems</th>
<th>Responsibility Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of an engineering problem means the ‘separation into parts, possibly with comment and judgement’.</td>
<td></td>
</tr>
</tbody>
</table>
Well-defined engineering problems have the following characteristics:

(a) can be solved mainly by practical engineering knowledge, underpinned by related theory;
(b) are discrete, focused tasks within engineering systems;
(c) are routine, frequently encountered, may be unfamiliar but in a familiar context;
(d) can be solved in standardised or prescribed ways;
(e) are encompassed by standards, codes and documented procedures; authorisation required to work outside limits;
(f) information is concrete and largely complete but requires checking and possible supplementation;
(g) involve several issues (but few of these impose conflicting constraints) and a limited range of interested and affected parties; and one or more of:
(i) require practical judgement in the practice area in the evaluation of solutions and consideration of interfaces to other role players; and
(j) have consequences that are locally important but not far reaching (wider impacts are dealt with by others).

Assessment Criteria: A structured analysis of well-defined problems typified by the following performances is expected:

1.1 State how you interpreted the work instruction received, checking with your client or supervisor that your interpretation is correct.

1.2 Describe how you analysed, obtained and evaluated further clarifying information and indicate if the instruction was revised as a result.

To perform an engineering task, an Engineering Technician will typically receive an instruction from a senior person (customer) to perform task and must

1.1 ensure that the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation; and

1.2 ensure that the instruction and information to do the work is complete and fully understood and includes the engineering theory needed to understand the task and to carry out and/or check the calculations and the acceptance criteria. If needed, supplementary information must be gathered, studied and understood.

Range Statement: The problem may be part of a larger engineering activity or may stand alone. The design problem is amenable to solution by established techniques that are practised regularly by the candidate. This outcome is concerned with the understanding of a problem. Outcome 2 is concerned with the solution.

Please refer to Section 4 of the specific DSTG.
### Discipline-specific Training Guideline for Candidate Engineering Technicians in Civil Engineering

**Outcome 1:**
Design or develop solutions to well-defined engineering problems.

<table>
<thead>
<tr>
<th>Responsibility levels C and D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design means ‘drawing or outline from which something can be made’.</td>
</tr>
<tr>
<td>Develop means ‘come or bring into a state in which it is active or visible’.</td>
</tr>
</tbody>
</table>

**Assessment Criteria:**
This outcome is normally demonstrated after the problem analysis defined in Outcome 1. Working systematically to synthesise the solution to a well-defined problem typified by the following performances is expected:

- **2.1** Describe how you designed or developed and analysed alternative approaches to do the work. Impacts checked. Calculations attached.
- **2.2** State your final solution to perform the work, with the client or your supervisor in agreement.

After the task received is fully understood and interpreted, a solution to the problem posed can be developed (designed).

- **The synthesis of a solution is ‘the combination of separate parts, elements, substances, etc. into a whole or into a system’ by the following:**
- **2.1** The development (design) of more than one way to solve an engineering task or problem should always be done and include 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.
- **2.2** In some cases, the Engineering Technician will not be able to support proposals with a complete theoretical calculation to substantiate every aspect and must, in these cases, refer his/her alternatives to an Engineer or Technologist for scrutiny and support. The alternatives and the recommended alternative must be convincingly detailed to win customer support for the alternative that is recommended. The selection of alternatives may be based on tenders submitted with alternatives deviating from those specified.

**Range Statement:**
The solution is amenable to established methods, techniques or procedures within the candidate’s practice area.

Applying theory to well-defined engineering work is done in a way that has been used before. The process was probably developed by Engineers or Technologists in the past and is documented in written procedures, specifications, drawings, models, examples, etc. Engineering Technicians must seek approval for any deviation from these established methods.

**Outcome 3:** Comprehend and apply knowledge embodied in established engineering practices and knowledge specific to the jurisdiction in which he/she practises.

<table>
<thead>
<tr>
<th>Responsibility Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehend means ‘to understand fully’. The jurisdiction in which an Engineering Technician practises is given in Section 4 of the specific DSTG.</td>
</tr>
</tbody>
</table>

**Assessment Criteria:**
This outcome is normally demonstrated in the course of the design, investigation or operations.

- **3.1** State which NDip-level engineering standard procedures and systems you used to execute the work, and how NDip-level theory was applied to understand and/or verify these procedures;
- **3.2** Provide your own NDip-level theoretical calculations and/or reasoning on why the application of this theory is considered correct (actual examples required).

Design work for Engineering Technicians mainly involves utilising and configuring manufactured components and repetitive design work, using an existing design as an example. Engineering Technicians apply existing codes and procedures in their design work. Investigation is on well-defined incidents, with condition monitoring and operations mainly on controlling, maintaining and improving engineering systems and operations.

- **3.1** The understanding of well-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge. Specific procedures and techniques applied to do the work accompanied by the underpinning theory must be provided.
- **3.2** Calculations confirming the correct application and utilisation of equipment listed in Clause 4 of the specific DSTG must be done on practical well-defined activities. Reference must be made to standards and procedures used and how they were derived from NDip theory.
Range Statement: Applicable knowledge includes the following:

(a) Technical knowledge that is applicable to the practice area irrespective of location and is supplemented by locally relevant knowledge, for example, established properties of local materials.

(b) A working knowledge of interacting disciplines and codified knowledge in related areas – financial, statutory, safety, management.

(c) Jurisdictional knowledge includes legal and regulatory requirements and prescribed codes of practice.

(a) The specific location of the 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 and must include a comprehensive study of materials, components and projected customer requirements and expectations.

(b) Despite having a working knowledge of interacting disciplines, Engineering Technicians must appreciate the importance of working with specialists such as Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings, Electrical Engineers on communication equipment, etc. The codified knowledge in the related areas means working to and understanding the requirements set by specialists in the areas mentioned.

(c) Jurisdictional in this instance means ‘having the authority’. Engineering Technicians must adhere to the terms and conditions associated with each task that is undertaken. The Engineering Technician may even be appointed as the ‘responsible person’ for specific duties in terms of the OHS Act.
### Group B: Managing Engineering Activities

<table>
<thead>
<tr>
<th>Outcome 4: Manage part or all of one or more well-defined engineering activities</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
</table>
| **Assessment Criteria:** The display of personal and work process management abilities is expected:  
   4.1 State how you managed yourself, priorities, processes and resources in performing the work (e.g. bar chart).  
   4.2 Describe your role and contribution in the work team. | Responsibility Level D  
Manage means ‘control’.  
In engineering operations and projects, Engineering Technicians will typically be given the responsibility to carry out specific tasks and/or to complete projects.  
4.1 Resources are usually subdivided based on availability and are controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environmental management are important aspects.  
4.2 Depending on the task, the Engineering Technician can be the team leader, a team member or can supervise appointed contractors. |

<table>
<thead>
<tr>
<th>Outcome 5: Clear communication with others in the course of his/her well-defined engineering activities</th>
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</table>
| **Assessment Criteria:** Demonstration of effective communication  
   5.1 State how you presented your point of view and compiled reports after completion of the work.  
   5.2 State how you compiled and issued instructions to entities working on the same task. | Responsibility Level C  
5.1 Refer to Range Statements for outcomes 4 and 5. Presentation of point of view mainly occurs in meetings and discussions with the immediate supervisor.  
5.2 Refer to Range Statements for outcomes 4 and 5. |

| Range Statement for outcomes 4 and 5: Management and communication in well-defined engineering involves:  
(a) Planning well-defined activities  
(b) Organising well-defined activities  
(c) Leading well-defined activities  
(d) Controlling well-defined activities |  
Communication relates to the technical aspects and wider impacts of professional work. The audiences include peers, other disciplines, clients and stakeholders. Appropriate modes of communication must be selected.  
The Engineering Technician is expected to perform the communication functions reliably and repeatedly. |

(a) Planning means ‘the arrangement for doing or using something, considered in advance’.  
(b) Organising means ‘put into working order; arrange in a system; make preparations for’.  
(c) Leading means to ‘guide the actions and opinions of; influence; persuade’.  
(d) Controlling means the ‘means of regulating, restraining, keeping in order; checking’.  
Engineering Technicians write or participate in writing 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; report back 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 back on cost control; etc.
<table>
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<tr>
<th>Group C: Impacts of Engineering Activity</th>
<th>Explanation and Responsibility Level</th>
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</table>
| **Outcome 6:** Recognise the general foreseeable social, cultural and environmental effects of well-defined engineering activities | **Responsibility Level B**  
Social means relating to ‘people living in communities; relationships between persons and communities’. Cultural means ‘all the arts, beliefs, social institutions, etc. that are characteristic of a community’. Environmental means ‘surroundings, circumstances, influences’. |

**Assessment Criteria:** This outcome is normally displayed in the course of the analysis and solution of problems:  
6.1 Describe the social, cultural and environmental impact of the engineering activity.  
6.2 State how you communicated mitigating measures to affected parties and acquired stakeholder engagement.

<table>
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<tr>
<th><strong>Outcome 7:</strong> Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her well-defined engineering activities</th>
<th><strong>Responsibility Level E</strong></th>
</tr>
</thead>
</table>

**Assessment Criteria:**  
7.1 List the major laws and regulations applicable to the particular activity and how health and safety matters were handled.  
7.2 State how you obtained advice in doing risk management for the work and elaborate on the risk management system applied.

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 may have standard procedures, instructions, drawings and operation and maintenance manuals available. Depending on the situation (emergency, breakdown, etc.), these documents are consulted before the work commences and during the activity.  
It is advisable to attend a Risk Management (Assessment) course and to investigate and study the materials, components and systems used in the workplace. The Engineering Technician must seek advice from knowledgeable and experienced specialists if the slightest doubt exists that safety and sustainability cannot be guaranteed.
Range Statement for outcomes 6 and 7: Impacts and regulatory requirements include the following:

(a) Impacts to be considered are generally those identified within the established methods, techniques or procedures used in the practice area.

(b) Regulatory requirements are prescribed.

(c) Prescribed risk management strategies are applied.

(d) Effects to be considered and methods used are defined.

(e) Safe and sustainable materials, components and systems are prescribed.

<table>
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<tr>
<th>Group D: Exercise judgement, take responsibility and act ethically</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome 8:</strong> Conduct engineering activities ethically</td>
<td><strong>Responsibility Level E</strong></td>
</tr>
<tr>
<td>Ethically means ‘science of morals; moral soundness’.</td>
<td>Systematic means ‘methodical; based on a system’.</td>
</tr>
<tr>
<td>Morally means ‘moral habits; standards of behaviour; principles of right and wrong’.</td>
<td>8.1 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 and misrepresentation of facts.</td>
</tr>
<tr>
<td><strong>Assessment Criteria:</strong> Sensitivity to ethical issues and the adoption of a systematic approach to resolving such issues are expected:</td>
<td>8.2 The ECSA Code of Conduct (as per ECSA’s website) is known and adhered to. Applicable examples are given.</td>
</tr>
<tr>
<td>8.1 Statement how you identified the ethical issues and the affected parties and their interests and indicate the actions you took when a problem arose.</td>
<td></td>
</tr>
<tr>
<td>8.2 Confirm that you are conversant and in compliance with ECSA’s Code of Conduct and why this is important in your work.</td>
<td></td>
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</table>

**Outcome 9:** Exercise sound judgement in the course of well-defined engineering activities

**Responsibility Level E**

Judgement means ‘good sense; ability to judge’.

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### Assessment Criteria: Judgement is displayed by the following performance:

| 9.1 | The extent of a project or task given to a junior Engineering Technician is characterised by the limited number of factors and their resulting interdependence. The Engineering Technician will seek advice if educational and/or experiential limitations are exceeded. Examples of the main engineering factors applied must be given. |
| 9.2 | Taking risky decisions will lead to equipment failure, excessive installation and maintenance costs, damage to persons and property, etc. Give examples. |

### Range Statement for outcomes 8 and 9: Judgement in decision-making involves

- Accounting for limited risk factors, some of which may be ill-defined;
- Accounting for consequences in the immediate work context; or
- Accounting for an identified set of interested and affected parties with defined needs.

### Outcome 10:

**Be responsible for making decisions on part or all of one or more well-defined engineering activities**

<table>
<thead>
<tr>
<th>Responsibility Level E</th>
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<tbody>
<tr>
<td>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'.</td>
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</table>

### Assessment Criteria: Responsibility is displayed by the following performance:

| 10.1 | The calculations (e.g. fault levels, load calculations, losses) are done to ensure that the correct material and components are utilised. |
| 10.2 | The Engineering Technician does not operate on tasks at a higher level than well-defined and consults professionals at Engineer and/or Technologist level if elements of the tasks to be done are beyond his/her education and experience (e.g. power system stability). |
| 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 form important elements. |

### Range Statement: Responsibility must be discharged for significant parts of one or more well-defined engineering activities.

The responsibility is mainly allocated within a team environment, with an increasing designation as experience is gathered.

### Note 1: Demonstration of responsibility is under the supervision of a competent Engineering Practitioner but the Engineering Technician is expected to perform as if he/she were in a responsible position.
**Group E: Initial Professional Development (IPD)**

<table>
<thead>
<tr>
<th>Outcome 11: Undertake independent learning activities sufficient to maintain and extend his/her competence</th>
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<tbody>
<tr>
<td><strong>Assessment Criteria:</strong> Management of self-development:</td>
</tr>
<tr>
<td>11.1 Provide the strategy that you adopted independently to enhance professional development (IPD report).</td>
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<tr>
<td>11.2 Be aware of the philosophy of your employer in regard to professional development.</td>
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<tr>
<td><strong>Range Statement:</strong> Professional development involves the following:</td>
</tr>
<tr>
<td>(a) Taking ownership of own professional development</td>
</tr>
<tr>
<td>(b) Planning own professional development strategy</td>
</tr>
<tr>
<td>(c) Selecting appropriate professional development activities</td>
</tr>
<tr>
<td>(d) Recording professional development strategy and activities while displaying independent learning ability</td>
</tr>
<tr>
<td><strong>Explanation and Responsibility Level</strong></td>
</tr>
<tr>
<td>11.1 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.</td>
</tr>
<tr>
<td>11.2 Record keeping must not be left to the employer or any other persons. The trainee must manage his/her own training independently, taking the initiative and being in charge of his/her experiential development towards Professional Engineering Technician level. Knowledge of the employer’s policy and procedures on training is essential.</td>
</tr>
<tr>
<td>(a) This is your professional development; it is not the development of the organisation for which you working.</td>
</tr>
<tr>
<td>(b) In most places of work, training is seldom organised by a training department. The Engineering Technician must manage his/her own experiential development. Engineering Technicians frequently find themselves at a standstill and are left doing repetitive work. If development is not self-driven, success is unlikely.</td>
</tr>
<tr>
<td>(c) Preference must be given to engineering development rather than the development of soft skills.</td>
</tr>
<tr>
<td>(d) Developing a learning culture in the workplace environment of the Engineering Technician is vital to his/her success. Information is readily available, and most senior personnel in the workplace are willing to mentor if approached.</td>
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