



ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Discipline-Specific Training Guide for Engineering Technicians in Industrial Engineering

R-05-IND-PN

REVISION No. 2: 10 October 2019





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DEFINITIONS

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

Dublin Accord: An ECSA agreement for the international recognition of Engineering Technicians qualifications and competencies.

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 and using mathematical formulation where necessary, that extends knowledge and develops models and methods to support its application, solve problems and provide the knowledge base for engineering specialisations.

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 coordinated activities required to:

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

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Mentor: A person willing to spend his/her time and expertise to guide the development of another person.

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

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.

R-01-POL: Registration Policy in Professional Categories.

R-02-PN: Competency standard for registration as professional technician.

R-03-PRO: Refers to application and assessment process for registration as candidates and professionals.

R-04-PN: Training and mentoring guide document.


R-08-PN: Guide to competency standard for registration as professional technician.

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

Specified Category: A category of registration for persons who must be licensed through the Engineering Profession Act or a combination of the Engineering Profession Act and external legislation as having specific engineering competencies at NQF 5 related to an identified need to protect the public safety, health and interest or the environment, in relation to an engineering activity.

Voluntary Associations: Voluntary Associations recognised by the ECSA Council in terms of section 36(1) of the Engineering Profession Act, 46 of 2000.

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ACRONYMS AND ABBREVIATIONS

AdvCert	Advanced Certificate
C&U	Commitment and Undertaking
Dip Eng Tech	Diploma in Engineering Technology
DSTG	Discipline-Specific Training Guideline
ECSA	Engineering Council of South Africa
NDip	National Diploma
OFO	The Organising Framework for Occupations (OFO)
SAIIE	The Southern African Institute for Industrial and Systems Engineering
TER	Training and Experience Report
TES	Training and Experience Summary
VA	Voluntary Association

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BACKGROUND

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

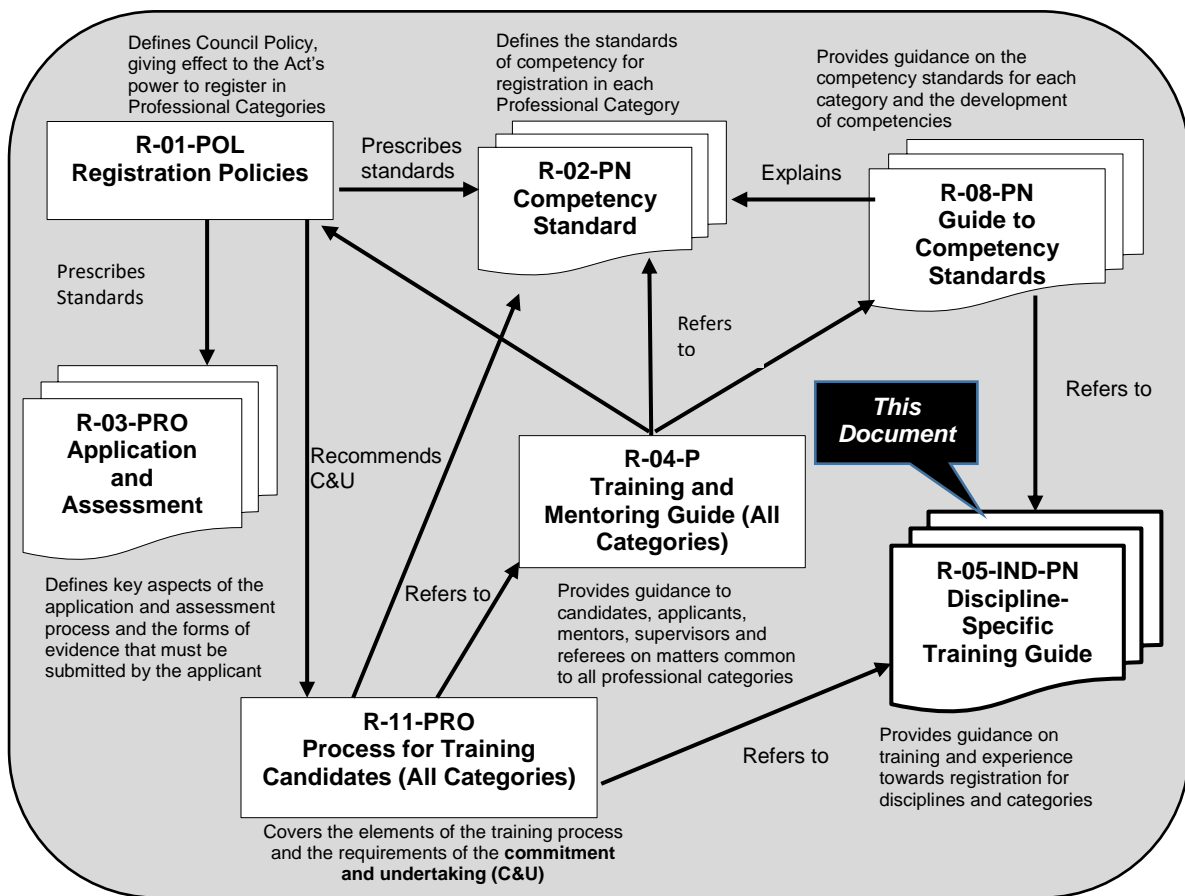



Figure 1: Document defining the ECSCA registration system

1. PURPOSE OF THIS DOCUMENT

The purpose of this document is to create a clear guide to the training of Candidate Technicians in Industrial Engineering who wish to register as professionals. All persons applying for registration as Professional Engineering Technician are expected to demonstrate the competencies specified in document **R-02-PN** at the prescribed level, irrespective of the trainee's discipline, through work performed by the applicant at the prescribed level of responsibility.

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This document supplements the generic *Training and Mentoring Guide R-04-P* and the *Guide to the Competency Standards for Professional Engineering Technicians*, document **R-08-PN**.

In document **R-04-P** attention is drawn to the following sections:

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

The document **R-08-P** 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 training guide and 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**. This guide further presents relevant information for all Candidate Engineering Technicians practising in the Industrial Engineering discipline.

2. AUDIENCE


This DSTG is directed to candidates and their supervisors and mentors in the discipline of Industrial Engineering. The guide is intended to support a programme of training and experience incorporating good practice elements. The guide applies to persons who wish to be registered as a professional engineering technician with ECSA. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development.

This guide applies to persons who have:

- completed the education requirements by obtaining an accredited National Dip (Engineering), Dip (Eng Tech), Adv Cert (Engineering) type qualification, or a Dublin-Accord Recognised qualification or through evaluation/assessment;
- registered as Candidate Engineering Technicians; and/or

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- embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) with a Mentor guiding the professional development process at each stage.

3. PERSONS NOT REGISTERED AS CANDIDATES OR NOT BEING TRAINED UNDER C&U

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 Technician and without training through a C&U candidacy programme. Mentorship and adequate supervision are, however, key factors in effective development to attain the level required for registration. If the employer of the applicant or candidate does not offer C&U, the applicant or candidate must establish the level of mentorship and supervision 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 (VA) for the discipline may be consulted for assistance in locating an external mentor. A mentor must 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 have not enjoyed mentorship are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their applications for registration.

4 ORGANISING FRAMEWORK FOR OCCUPATIONS

3.1 OFO Definition

The Organising Framework for Occupations (OFO) 2012, offers a similar, though simplified definition of our profession: An Industrial technician investigates and reviews the utilisation of personnel, facilities, equipment and materials, current operational processes and established

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practices, to recommend improvement in the efficiency of operations in a variety of commercial, industrial and production environments.

3.2 Specialisation

The OFO also offers the following alternative Titles and Specialisations, which give an indication of the various areas of specialisation, many of which are industry specific:

- Agri-Produce Process Engineering Technician
- Automation and Control Engineering Technician
- Clinical Engineering Technician
- Enterprise Resource Management Engineering Technician
- Fabrication Engineering Technician
- Industrial Efficiency Engineering Technician
- Industrial Machinery Engineering Technician
- Manufacturing Logistics Engineering Technician
- Manufacturing Technology Engineering Technician
- Operations Research Engineering Technician
- Plant Engineering Technician
- Process Design Engineering Technician.

3.3 Skills perspective

A further dimension of specialisation and sub disciplines is revealed when viewing the profession from a skills perspective. A skill is defined as the ability to carry out the tasks and duties of a given job.


The OFO considers skill specialisation in terms of four themes. Examples of specialised Industrial Engineering skills in each of the four themes are listed below:

3.3.1 The field of knowledge required

This could include the following:

- Knowledge of the area of specialisation and associated problem-solving methods, e.g. Value Engineering, Quality Assurance

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- Skills associated with phases in the life cycle of a business, programme, project, product or service, e.g. Asset and Maintenance Management,
- Project and Programme Management,
- Industry specific knowledge, in as far as it presents the context in which a problem needs to be understood and ultimately solved, e.g. Fast-Moving Consumer Goods, Warehousing & Transportation, Capital Investment.

3.3.2 The tools and machinery used

This could be interpreted to include the following:

- Manufacturing, processing and fabrication techniques
- Techniques and models, e.g. Operations Research
- Modelling tools, e.g. Simulation and Optimisation Tools
- System tools, e.g. Enterprise Resource Planning Systems
- Philosophies, e.g. Just in Time.

3.3.3 Materials worked on or with, which are typically closely related to Industry

This could include the following:


- Agri-produce and Agri-processing
- Petrochemical and processing industries
- Steel and other metals, and Beneficiation
- Smelters, Metal Works
- Precision Manufacturing,
- Steel Fabrication.

3.3.4 The kinds of goods and service produced

This could include the following:

- Manufacturing, processing, assembly, fabrication, construction and engineering contracting
- Complex systems
- Service industries
- Professional and Management Consulting services.

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It is evident from the above that Industrial Engineering is not limited to these four dimensions of specialisation. It is therefore no surprise that a growing number of industries are benefiting from an Industrial Engineering skill set. The list of such industries includes but is not limited to the following:


- Primary industries and their downstream beneficiation industries, including mining, fisheries, forestry and agriculture
- Manufacturing industries, ranging from highly specialised capital and goods manufactured on order, to mass produced and fast-moving consumer goods
- Chemical, petrochemical, agriculture, food, cosmetics and other processing industries
- Construction and engineering contracting
- Logistics and transport
- Medical and health industries
- Services industries, including banking, insurance and the various spheres of government
- Engineering consulting
- Information and Communication Technology, including business management systems, artificial intelligence, virtual reality, simulation and other decision support mechanisms.

3.4 Problem solving methods

Industrial Engineering also continues to evolve in its response to the typical optimisation challenges of industries. As knowledge and technology evolves, Industrial Engineering has embraced as sub-disciplines many problem-solving techniques, methodologies, approaches and even philosophies. Some examples include:

- The Lean and Just in Time philosophies and associated techniques typically applied in manufacturing and construction supply chains
- Supply Chain Management and its associated disciplines in the areas of procurement, inventory and materials management, warehouse and logistics management, manufacturing management, production and process control, and sales and distribution management
- Methodologies and techniques associated with the planning and control of primary conversion processes and the associated accounting practices
- Re-engineering of primary and support processes

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- Total Quality Management, Six Sigma and other approaches to Quality Assurance and Management
- Theory of Constraints and associated techniques
- Simulation and stochastic processes, statistical analysis, operations research and other associated quantitative problem-solving techniques
- Maintenance Management, including Total Preventative Maintenance
- Systems design and systems engineering, including systems support over its entire life cycle
- System dynamics, policy planning and process design
- Cost and value engineering
- Facilities design and management
- Project management
- Engineering economics.

4. NATURE AND ORGANISATION OF THE INDUSTRY

Considering the dynamic nature of the profession, the diverse range of industries that Industrial Engineering Technicians could find themselves in and the diverse range of sub-disciplines and specialised skills characterising the profession, it is evident that it is virtually impossible to define a set of predetermined training paths for the Industrial Engineering Technician Candidacy Phase.


Instead of predetermined paths, a set of guiding principles is proposed whereby Candidates should shape the course of their own Candidacy Phase.

The list of guiding principles

- To be involved with the solution of at least one broadly defined problem through its entire life cycle, starting with problem definition, continuing to evaluation and selection of proposed solutions, solution design, as well as its implementation and post implementation support.
- To seek a fair balance between width of exposure and depth of specialisation, and not to compromise the one for the other.
- To actively seek diversity across broadly defined assignments, in terms of:

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- the types of underlying complexity of problems exposed to
- the management and leadership style of business leaders, managers and mentors exposed to
- teams involved with, as well as teamwork and individual work.
- To seek a level of continuity across at least one area of specialisation, e.g. industry, discipline or problem-solving technique.


5. DEVELOPING COMPETENCY: DOCUMENT R-08-PN

This section elaborates on the discipline-independent competency standards outlined in document **R-08-PN** and highlights specific competencies across the areas most relevant to Industrial and Systems Engineering. All applicants for registration are required to demonstrate insight and ability to use and interface various engineered and innovative solutions with practical problems experienced in their work environments. In addition, applicants must develop the skills required to demonstrate the advanced use of industrial engineering knowledge in optimising the efficiency of operations or the constructability of projects.

Candidate Engineering Technicians must obtain experience in solving a variety of problems in their work environment. The solutions to these problems should also involve the use of fundamental and advanced engineering knowledge obtained at university. The problems that require a scientific and engineering approach to their solutions may be encountered in any engineering work environment that consists of integrated engineering systems, equipment, machinery and infrastructure.

From early in their training years, Candidates must actively seek opportunities to obtain experience in the area of simulating solutions to real-life engineering problems encountered in the workplace. In applying technical and scientific knowledge gained through academic training, the applicant must also demonstrate the financial and economic benefits of engineered solutions at a sufficiently advanced level. In addition, applicants must show evidence of adequate training in these functions/skills through project work carried out in the analysis of broadly defined problems and the synthesis of solutions

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5.1 Contextual knowledge

For all successful solutions and interventions, applicants need to consider the context in which they exist. The integrative nature of Industrial and Systems Engineering, specialised knowledge, variety of skills and the requirement of satisfying multiple objectives simultaneously place added emphasis on the understanding and considerations of context. Contextual knowledge includes, but is not limited to the following:


- Organisation vision, mission, aspirations, objectives and core strategy
- Business model
- Industry dynamics
- Risk, compliance and governance framework
- Legal and regulatory framework
- Cultural and social value systems
- Political and economic context
- Historic context
- Stakeholder and role player expectations, limitations and aspirations
- Behaviour, mind-set, skills and capabilities context
- Physical environment
- Support context.

Successful professionals have developed the art and skill to discern which contexts are most important to the situation at hand and make an effort to understand the opportunities, limitations and rules of engagement associated with the particular environment and context they find themselves in.

5.2 Functions performed

Candidates/applicants must demonstrate that during their training period, they have mastered the competencies defined in document **R-08-PN** to a satisfactory level. From the reports submitted as part of the application for registration (i.e. Training and Experience Reports [TERs] and the Engineering Report [ER]), candidates should demonstrate that the 11 Outcomes have been met.

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It is useful to measure the progression of Candidates' competency by making use of the degree of responsibility shown on Table 1 below. The degree of responsibility shows the gradual increase in responsibility to which Candidate Technicians are exposed to during their professional training. The aim is to get the Applicant/Candidate at Responsibility Level E prior registering for professional registration.


Table 1: Degree of responsibility

Level	Nature of work	Responsibility	Level of support
A: Being Exposed	The candidate/applicant undergoes induction, observes processes and work of competent practitioners.	No responsibility, except to pay attention.	Mentor explains challenges and forms of solution.
B: Assisting	The candidate/applicant performs specific processes, under close supervision.	Limited responsibility for work output.	Supervisor/Mentor coaches, offer feedback.
C: Participating	The candidate/applicant performs specific processes as directed with limited supervision.	Full responsibility for supervised work.	Supervisor progressively reduces support but monitors outputs.
D: Contributing	The candidate/applicant performs specific work with detailed approval of work outputs.	Full responsibility to supervisor for quality of work.	Applicant/candidate articulates own reasoning and compares it with those of supervisor.
E: Performing	The candidate/applicant works in team without supervision; recommends work outputs; responsible but not accountable.	Level of responsibility to supervisor is appropriated to a registered person.	Applicant/candidate takes on problem solving without support; at most limited guidance.

Appendix A has been developed against the Degree of Responsibility scale. Activities should be selected to ensure that the Candidate reaches the required level of competency and responsibility.

It should be noted that for an applicant to be registered as Professional Engineering Technician, each outcome should meet the responsibility level indicated in **Appendix A**.

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5.3 Statutory and regulatory requirements

There is no direct public liability associated with the typical activities of Industrial Technicians outlined in the sections above. The legislation listed in document **R-08-PN** also applies to Industrial Technicians. However, this list does not include all the industry-specific legislation and regulations that form part of the contextual knowledge required of Industrial Technicians.

Candidates or applicants are expected to have a working knowledge of the following regulations and acts and how they affect their working environment:


- Engineering Profession Act, 46 of 2000, including the ECSA rules and the Code of Conduct;
- Occupational Health and Safety Act, 85 of 1993, as amended by Act 181 of 1993 (OHS Act);
- Building Regulations – National Building Regulations and Building Standards Act, 103 of 1977, as amended by Act 49 of 1995;
- Machinery and Works Regulations;
- Labour Relations Act, 66 of 1995;
- Environment Conservation Act, 73 of 1989, as amended by Act 52 of 1994 and Act 50 of 2003;
- National Environmental Management Act, 107 of 1998;
- Industry Specific Work Instructions – Mine Health and Safety Act, 29 of 1996;
- The Public Financial Management Act, 1 of 1999;
- Public Service Act, 103 of 1994;
- Public Service Regulations, 2001, as amended.

Candidates or applicants are expected to have basic knowledge of any other regulations, Acts and by-laws not listed above which may also be pertinent to a Candidate's work environment.

5.4 Recommended formal learning activities

As part of the documentation required in the application for registration, the Candidate needs to provide evidence of initial professional development (IPD) by supplying a list of structured learning activities for continued education that were completed during the training period.

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Formal learning activities for Candidate Technicians include postgraduate programmes in Industrial and Systems Engineering and related fields such as Supply Chain Management, Project Management and Technology Management, which are offered by universities with accredited engineering degree programmes.


The Southern African Institute for Industrial and Systems Engineering (SAIIE) offers an annual conference and specialist group meetings through which Candidate Technicians may pursue continuous professional development (CPD). The institute also provides a listing of possible CPD activities for which CPD points are awarded. The following list of formal learning activities is by no means extensive and is purely a sample of some useful courses.

Examples of courses that offer specialist skills:

- Project management
- Standard specifications
- Preparation of specifications
- Negotiation skills
- Engineering finance
- Risk analysis quality systems
- Occupational health and safety
- Discipline specific courses quality systems
- Maintenance engineering
- Environment impacts management
- Technical and business report writing
- Planning methods
- System engineering
- Industrial relations
- Change and transformation management.

The learning activities listed above are normally augmented by in-house training in the workplace.

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6. PROGRAMME STRUCTURE AND SEQUENCING

6.1 Best practice

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. It is suggested that Candidates/Applicants work with their mentors to determine appropriate projects in order to gain exposure to elements of the asset life cycle. 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 the Candidate progresses through the levels of work capability described in document of **R-04-P** to ensure that by the end of the training period, the Candidate exhibits Responsibility Level E and is able to perform individually and as a team member at the level of problem-solving and engineering activity required for registration.

6.2 Realities


Generally, irrespective of the discipline, it is unlikely that the period of training will be less than three years for Candidates with a Dip (Engineering), Dip (Eng Tech), or four years for candidates with an Adv Cert (Engineering), the minimum time ECSA requires. In most cases, it will be longer and would be determined among others by the availability of functions in the actual work situation.

Each Candidate will effectively undertake a unique programme where the various activities carried out at the discipline specific level are then linked to the generic competency requirements of **R-08-PN**.

6.3 Considerations for generalists, specialists, researchers and academics

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

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6.4 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 apply for registration. It also assumes that the Candidate is supervised and mentored by persons who meet the requirements in document **R-04-P**. In 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 be completed:

- The Candidate must complete the training and experience summary (TES) and 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 a new programme, the mentor and supervisor should review the Candidate's development in the light of the past experience and opportunities and the requirements of the new programme and plan at least the next phase of the Candidate's programme.

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The Discipline-Specific Training Guide (DSTG) for
Candidate Engineering Technician in Industrial Engineering

Revision 2 dated 10 October 2019 and consisting 20 pages reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (RPS).

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 Business Unit Manager

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 Date


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 Executive: RPS

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 Date

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 QM-TEM-001 Rev 0 – ECSA Policy/Procedure

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APPENDIX A: Training elements

Synopsis: Candidate Technicians should achieve specific competencies at the prescribed level during their development towards professional registration and at the same time should accept 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 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 to the ECSA 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 employer's training and development programme and develop 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

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Competency Standards for Registration as a Professional Engineering Technician	Explanation and Responsibility Level
<p>1. Purpose</p> <p>This standard defines the competence required for registration as a Professional Engineering Technician. Definitions of terms having particular meaning within this standard are presented in Appendix B.</p>	<p>DSTGs give context to the purpose of the Competency Standards. Professional Technicians operate within the nine disciplines ECSA recognises. Each discipline can be further divided into sub-disciplines and finally, into specific workplaces as demonstrated in Clause 4 of the specific DSTG. 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).</p> <p>NOTE: The training period must be used to develop the competence of the trainee towards achieving the standards presented below at a Responsibility Level E (i.e. Performing). Refer to Section 7.1 of the specific DSTG.</p>
<p>2. Demonstration of competence</p> <p>Competence must be demonstrated within well-defined engineering activities (defined below) by the 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.</p> <p>Level descriptor: Well-defined engineering activities (WDEAs) have several of the following characteristics:</p> <p>a) Scope of practice area is defined by techniques applied; change is by adopting new techniques into current practice.</p> <p>b) Practice area is located within a wider, complex context, with well-defined working relationships with other parties and disciplines.</p> <p>c) Work involves a familiar, defined range of resources,</p>	<p>Engineering activities can be approximately divided into:</p> <ul style="list-style-type: none"> • 5% Complex (Professional Engineers) • 5% Broadly Defined (Professional Technologists) • 10% Well-Defined (Professional Technicians) • 15% Narrowly Well-Defined (Registered Specified Categories) • 20% Skilled Workman (Engineering Artisan) • 55% Unskilled Workman (Artisan Assistant). <p>The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.</p> <p>Level descriptor: WDEAs 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). Techniques applied are largely well-established and change by adopting new techniques into current practice is the</p>

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<p>including people, money, equipment, materials and technologies.</p> <p>d) Activities require resolution of interactions manifested between specific technical factors with limited impact on wider issues.</p> <p>e) Activities are constrained by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, and applicable laws.</p> <p>f) Activities have risks and consequences that are locally important but generally not far reaching</p> <p>Activities include design; planning; investigation and problem resolution; improvement of materials, components, systems and processes; manufacture and construction; engineering operations; maintenance; project management; research; development; and commercialisation.</p>	<p>exception.</p> <p>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.</p> <p>c) The bulk of the work involves a familiar, defined range of resources that includes people, money, equipment, materials and technologies.</p> <p>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.</p> <p>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).</p> <p>f) Even locally important minor risks can have far-reaching consequences.</p> <p>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 more frequently in some disciplines and are seldom encountered in others.</p>
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3. Outcomes to be satisfied	Explanation and Responsibility Level
Group A: Engineering Problem-Solving	
Outcome 1: Define, investigate and analyse well-defined engineering problems.	Responsibility Level E Analysis of an engineering problem means the “separation into parts, possibly with comment and judgement”.
<p>Well-defined engineering problems have the following characteristics:</p> <p>a) can be solved mainly by practical engineering knowledge underpinned by related theory; <i>and one or more of:</i></p> <p>b) are largely defined but may require clarification;</p> <p>c) are discrete, focused tasks within engineering systems;</p> <p>d) are routine, frequently encountered, may be unfamiliar but in a familiar context; <i>and one or more of:</i></p> <p>e) can be solved by standardised or prescribed ways;</p> <p>f) are encompassed by standards, codes and documented procedures; authorisation required to work outside limits;</p> <p>g) information is concrete and largely complete but requires checking and possible supplementation;</p> <p>h) involve several issues (few of these impose conflicting constraints) and a limited range of</p>	<p>a) A practical problem for Engineering Technicians means the problem encountered cannot be solved by artisans because theoretical calculations and engineering decisions are necessary to substantiate the solution proposed.</p> <p>b) Further investigation to identify the nature of the problem is seldom necessary.</p> <p>c) The problem is discrete, meaning it is individually distinct and easily recognised as part of the larger engineering task, project or operation.</p> <p>d) It is recognised that the problem occurred in the past or the possibility exists that it may have happened before; it definitely and possibly occurred in the past therefore it is not a new problem.</p> <p>e) The problem does not require the development of a new solution (determine how the problem was previously solved).</p> <p>f) Encompassed means encircled: The standards, codes and documented procedures must be obtained to solve the problem, and authorisation from the Engineer or Technologist in charge must be obtained to waive the stipulations.</p> <p>g) The responsibility lies with the Engineering Technician to check that the information received regarding the problem encountered is correct and is added to as necessary to ensure the correct and complete execution of the work.</p> <p>h) The problem handled by the Engineering Technician must be limited to well-known matters and preferably requires standardised solutions without possible complications.</p>

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<p>interested and affected parties; <i>and one or both of:</i></p> <p>i) require practical judgement in the practice area in the evaluation of solutions and consideration of interfaces to other role players; and</p> <p>j) have consequences that are locally important but not far reaching (wider impacts are dealt with by others).</p>	<p>i) Practical solutions to problems include knowledge of the skills displayed by Practical Specialists and Engineering Artisans without sacrificing theoretical engineering principles and/or taking shortcuts to satisfy the parties involved.</p> <p>j) Engineering Technicians must realise that their actions may appear to be of local importance only but may develop into problems for which support from Engineers and Technologists may be needed to deal with the consequences.</p>
<p>Assessment criteria: A structured analysis of well-defined problems typified by the following performances is expected.</p> <p>1.1 State how <u>you</u> interpreted the work instruction received, checking with your client or supervisor that your interpretation is correct.</p> <p>1.2 Describe how <u>you</u> analysed, obtained and evaluated further clarifying information and indicate if the instruction was revised as a result.</p>	<p>1.1 To perform an engineering task, an Engineering Technician will typically receive an instruction from a senior person (customer) to perform the task and must 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.</p> <p>1.2 To ensure that the instruction and information to do the work is complete and fully understood, including 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.</p>
<p>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. Outcome 1 is concerned with the understanding of a problem; Outcome 2 is concerned with the solution.</p>	<p>Please refer to Clause 4 of the specific DSTG.</p>
<p>Outcome 2: Design or develop solutions to well-defined engineering problems.</p>	<p>Responsibility Levels C and D</p> <p>Design means “drawing or outline from which something can be made”.</p>

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	Develop means “come or bring into a state in which it is active or visible”.
<p>Assessment criteria: This outcome is normally demonstrated after the problem analysis defined in Outcome 1. Working systematically to synthesise a solution to a well-defined problem typified by the following performances is expected.</p> <p>2.1 Describe how <u>you</u> designed or developed and analysed alternative approaches to do the work. Impacts checked. Calculations attached.</p> <p>2.2 State <u>your</u> final solution to perform the work – client or supervisor in agreement.</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 means “to combine separate parts, elements, substances, etc. into a whole or into a system”.</p> <p>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 <u>the theoretical calculations to support each alternative must be done and submitted as an attachment.</u></p> <p>2.2 In some cases, the Engineering Technician will not be able to support proposals with the complete theoretical calculation substantiating 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 recommended alternative. Selection of alternatives may be based on tenders submitted with alternatives deviating from those specified.</p>
<p>Range statement: The solution is amenable to established methods, techniques and procedures within the candidate’s practice area.</p>	<p>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 documented in written procedures, specifications, drawings, models, examples, etc. Engineering Technicians must seek approval for any deviation from these established methods.</p>
<p>Outcome 3: Comprehend and apply knowledge embodied in established engineering practices and knowledge specific to the jurisdiction in which he/she practises.</p>	<p>Responsibility Level E</p> <p>Comprehend means to understand fully. The jurisdiction in which an Engineering Technician practises is given in Clause 4 of the specific DSTG.</p>

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<p>Assessment criteria: This outcome is normally demonstrated in the course of design, investigation or operations.</p> <p>3.1 State which NDip-level <u>engineering standard procedures and systems you used</u> to execute the work and how NDip-level theory was applied to understand and/or verify these procedures.</p> <p>3.2 Provide <u>your own</u> NDip-level theoretical calculations and/or reasoning on why the application of this theory is considered correct (actual examples required).</p>	<p>Design work for Engineering Technicians mainly involves utilising and configuring manufactured components. The design work is repetitive and uses an existing design as an example. Engineering Technicians apply existing codes and procedures in their design work. Investigation is on well-defined incidents. Condition monitoring and operations mainly involve controlling, maintaining and improving engineering systems and operations.</p> <p>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 given.</p> <p>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 these were derived from NDip theory.</p>
<p>Range statement: Applicable knowledge includes the following:</p> <p>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.</p> <p>b) A working knowledge of interacting disciplines and codified knowledge in related areas: financial, statutory, safety, management.</p> <p>c) Jurisdictional knowledge regarding legal and regulatory requirements and prescribed codes of practice.</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 and must include a comprehensive study of materials, components and projected customer requirements and expectations.</p> <p>b) Regardless of 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 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 the areas mentioned.</p> <p>c) Jurisdictional in this instance means “having the authority”, and Engineering Technicians must adhere to the terms and conditions associated with each task undertaken. The Engineering Technician may be appointed as the “responsible person” for specific duties</p>

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	in terms of the OHS Act.
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Group B: Managing Engineering Activities	Explanation and Responsibility Level
<p>Outcome 4: Manage part or all of one or more well-defined engineering activities</p> <p>Assessment criteria: The display of personal and work process management abilities is expected:</p> <p>4.1 State how <u>you</u> managed yourself, priorities, processes and resources in carrying out the work (e.g. bar chart).</p> <p>4.2 Describe <u>your</u> role and contribution in the work team.</p>	<p>Responsibility Level D</p> <p>Manage means “control”.</p> <p>In engineering operations and projects, Engineering Technicians will typically be given the responsibility to carry out specific tasks and/or complete projects.</p> <p>4.1 Resources are usually subdivided based on availability and are controlled by a work-breakdown structure and schedule to meet deadlines. Quality, safety and environmental management are important aspects.</p> <p>4.2 Depending on the task, the Engineering Technician can be the team leader or a team member and can supervise appointed contractors.</p>
<p>Outcome 5: Communicate clearly with others in the course of his/her well-defined engineering activities.</p> <p>Assessment criteria: Demonstration of effective communication.</p> <p>5.1 State how <u>you</u> presented your point of view and compiled reports after completion of the work.</p> <p>5.2 State how <u>you</u> compiled and issued instructions to entities working on the same task.</p>	<p>Responsibility Level C</p> <p>5.1 Refer to the Range Statement for outcomes 4 and 5. Presentation of point of view mainly occurs in meetings and discussions with immediate supervisor.</p> <p>5.2 Refer to the Range Statement for outcomes 4 and 5.</p>
<p>Range Statement for outcomes 4 and 5: Management and communication in well-defined engineering involves the following:</p> <p>a) Planning well-defined activities.</p>	<p>a) Planning means “the arrangement for doing or using something; considering in advance”.</p> <p>b) Organising means “putting into working order; arranging in a system; making</p>

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<p>b) Organising well-defined activities. c) Leading well-defined activities. d) Controlling well-defined activities.</p> <p>Communication relates to technical aspects and the wider impacts of professional work. Audience includes 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.</p>	<p>preparations for”.</p> <p>c) Leading means “guiding the actions and opinions of; influencing; persuading”.</p> <p>d) Controlling means the “regulating, restraining, keeping in order; checking”.</p> <p>Engineering Technicians write or participate in writing specifications for the purchase of materials and/or for 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.</p>
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Group C: Impacts of Engineering Activity	Explanation and Responsibility Level
<p>Outcome 6: Recognise the general foreseeable social, cultural and environmental effects of well-defined engineering activities</p>	<p>Responsibility Level B</p> <p>Social means “relating to people living in communities; relations between persons and communities”. Cultural means “all the arts, beliefs, social institutions, etc. that are characteristic of a community”. Environmental means “surroundings, circumstances, influences”.</p>
<p>Assessment criteria: This outcome is normally displayed in the course of the analysis and solution of problems.</p> <p>6.1 Describe the social, cultural and environmental impact of the engineering activity.</p> <p>6.2 State how <u>you</u> communicated mitigating measures to affected parties and acquired stakeholder</p>	<p>6.1 Engineering significantly affects 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 wild life, dangerous rotating and other machines, and demolition of structures).</p> <p>6.2 Mitigating measures taken may include environmental impact studies, environmental</p>

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engagement.	impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases and compensation paid.
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Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her well-defined engineering activities.	Responsibility Level E
Assessment criteria: 7.1 List the major laws and regulations applicable to this particular activity and indicate how health and safety matters were handled. 7.2 State how <u>you</u> obtained advice in carrying out 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 commencing the work and during the activity. 7.2 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 seeks 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 and 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.	a) The impacts vary substantially with the location of the task (e.g. the impact of laying a cable or pipe in the main street of a town will be entirely different to the impact of construction in a rural area). The methods, techniques and procedures differ accordingly and are identified and studied by the Engineering Technician 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 Engineering Technician is responsible for ensuring that this is done, and if not, for establishing which regulations apply and ensuring adherence. Usually, the people working on site are strictly controlled w.r.t. health and safety, but the Engineering Technician checks this is done. Tasks and projects are mainly carried out where contact

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<p>e) Safe and sustainable materials, components and systems are prescribed.</p> <p>f) Persons whose health and safety are to be protected are both inside and outside the workplace.</p>	<p>with the public cannot be avoided, and safety measures such as barricading and warning signs must be used and maintained.</p> <p>c) Risks are mainly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. Risk-management strategies are usually implemented by more senior staff but are understood and applied by the Engineering Technician.</p> <p>d) Effects associated with risk management are mostly well-known if not obvious, and methods used to address these risks are clearly defined.</p> <p>e) Usually, the components and systems and the safe and sustainable materials are prescribed by Engineers, Technologists or other professional specialists. It is the responsibility of the Engineering Technician to use his/her knowledge and experience to check and interpret what is prescribed and to report if any dispute exists.</p> <p>f) Health and safety of the staff working on the task or project as well as persons affected by the engineering work should be considered.</p>
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Group D: Exercise judgement, take responsibility and act ethically	Explanation and Responsibility Level
<p>Outcome 8: Conduct engineering activities ethically.</p>	<p>Responsibility Level E Ethics means “science of morals; moral soundness”. Moral means “moral habits; standards of behaviour; principles of right and wrong”.</p>
<p>Assessment criteria: Sensitivity to ethical issues and the adoption of a systematic approach to resolving such issues are expected.</p> <p>8.1 State how <u>you</u> identified the ethical issues in addition to the affected parties and their interests and indicate the actions you took when a problem</p>	<p>Systematic means “methodical; based on a system”.</p> <p>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.</p>

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<p>arose.</p> <p>8.2 Confirm that <u>you</u> are conversant and in compliance with the ECSA Code of Conduct and why this Code of Conduct is important in <u>your</u> work.</p>	<p>8.2 The ECSA Code of Conduct as per the ECSA website is known and adhered to. Applicable examples given.</p>
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Outcome 9: Exercise sound judgement in the course of well-defined engineering activities	Responsibility Level E Judgement means “good sense; ability to judge”.
<p>Assessment criteria: Judgement is displayed by the following performance:</p> <p>9.1 State the factors applicable to the work and their interrelationship and indicate how <u>you</u> applied the most important factors.</p> <p>9.2 Describe how <u>you</u> foresaw work consequences and evaluated situations in the absence of full evidence.</p>	<p>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.</p> <p>9.2 Making risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Give examples.</p>
<p>Range statement for outcomes 8 and 9: Judgement in decision-making involves:</p> <p>a) accounting for limited risk factors, some of which may be ill-defined;</p> <p>b) accounting for consequences that are in the immediate work contexts; or</p> <p>c) accounting for an identified set of interested and affected parties with defined needs.</p>	<p>In engineering, approximately 10% of the activities can be classified as well-defined and for these, the Engineering Technician uses standard procedures, codes of practice, specifications, etc. Judgement must be displayed to identify any activity that falls outside the well-defined range (defined above):</p> <p>a) Advice is sought when risk factors exceed his/her capability.</p> <p>b) Consequences outside the immediate work contexts (e.g. long-term) are not normally handled.</p> <p>c) Interested and affected parties with defined needs outside the well-defined parameters are taken into account.</p>

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Outcome 10: Be responsible for making decisions on part or all of one or more well-defined engineering activities	Responsibility Level E Responsible means “legally or morally liable for carrying out a duty; caring for something or somebody while being in a position where one may be blamed for loss, failure, etc.”
Assessment criteria: Responsibility is displayed by the following performance: 10.1 Show how <u>you</u> used NDip theoretical calculations to justify decisions taken in carrying out the engineering work. Attach actual calculations. 10.2 State how <u>you</u> sought responsible advice on any matter falling outside <u>your</u> own education and experience. 10.3 Describe how <u>you</u> took responsibility for <u>your</u> own work and evaluated any shortcomings in <u>your</u> output.	10.1 The calculations (e.g. fault levels, load calculations, losses) are done to ensure that the correct material and components are used). 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 The Engineering Technician engages in 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 with corrective action taken, if necessary, forms an important element.
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 and 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 is in a responsible position.	

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Group E: Initial Professional Development (IPD)	Explanation and Responsibility Level
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his/her competence	Responsibility Level D
<p>Assessment criteria: Self-development is displayed by the following performance:</p> <p>11.1 Provide the strategy that <u>you</u> independently adopted to enhance professional development (IPD report).</p> <p>11.2 Be aware of the philosophy of the employer in regard to professional development.</p>	<p>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 the employer if costs are involved) and options that are open to expand knowledge into additional fields are investigated.</p> <p>11.2 Record-keeping may not be left to the employer or any other person. 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.</p>
<p>Range statement: Professional development involves the following:</p> <p>a) Taking ownership of own professional development.</p> <p>b) Planning own professional development strategy.</p> <p>c) Selecting appropriate professional development activities.</p> <p>d) Recording professional development strategy and activities while displaying independent learning ability.</p>	<p>a) This is your professional development, not the development of the organisation for which you are working.</p> <p>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 self-development is not self-driven, success is unlikely.</p> <p>c) Preference must be given to <u>engineering</u> development rather than developing soft skills.</p> <p>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.</p>

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