ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Discipline-Specific Training Guide for Candidate Engineering Technicians in Metallurgical Engineering

R-05-MET-PN

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DEFINITIONS

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, 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 co-ordinated activities required

(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 who have 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.

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 at the prescribed level though work performed by the applicant 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 both a high-level and an outcome-by-outcome understanding of the competency standards that form an essential basis for this discipline-specific guide.

This 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).

2. AUDIENCE

This guide is directed towards Candidates and their supervisors and mentors in the discipline of Metallurgical Engineering. The guide is intended to support a programme of training and experience, incorporating good practice elements.

This guide applies to persons who have

- completed the educational requirements by obtaining an accredited NDip (National Diploma Engineering), Dip (Eng Tech), Adv. Cert Engineering type qualification, or by obtaining a Dublin Accord Recognised qualification, or through evaluation/assessment;
- registered as a Candidate Engineering Technician; and
- 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 COMMITMENT AND UNDERTAKING (C&U)

All applicants for registration must present the same evidence of competence and be assessed against the same standards, irrespective of the developmental path followed.

Application for registration as a Professional Engineering Technician is permitted without being registered as a Candidate Engineering Technician or without training under a C&U. However, mentorship and adequate supervision are key factors in effective development to the level required for registration. A C&U indicates that the company is committed to mentorship and supervision.

If the trainee’s employer has no 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 should be consulted for assistance in locating an external mentor. A mentor should be in place at all stages of the development process.

This guide is 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 been through a mentorship programme are advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their application for registration.

The guide may be applied in the case of a person moving at a later stage into a candidacy programme that is at a level below that required for registration (see Section 7.4 of this document).

Applicants who do not hold an NDip Engineering may apply under an alternative route and complete the additional form (C18). This alternative route considers number of years’ experience, the well-defined engineering activities undertaken during this period and experience at the responsible level.
4. ORGANISING FRAMEWORK FOR OCCUPATIONS (OFO)

4.1 Metallurgical Engineering

Metallurgists normally work within the metal and mineral industry and are involved in mining and production in concentrators and metal recovery operations, in smelters, metal refineries, foundries and Research and Development laboratories. Metallurgists use their knowledge of chemistry, physics and mineralogy, and their knowledge of underlying process fundamentals and process engineering to control and improve processes that separate, concentrate and recover minerals and their valuable metals from natural ores. Three career paths are available to the Metallurgist, Mineral Processing Engineering, Extraction Engineering and Physical Engineering.

4.2 Extractive Metallurgical Engineering

Extractive Metallurgical Engineering is the extraction of metals from their natural mineral deposits or intermediate compounds by chemical or physical processes, including wet or hydrometallurgical processes, high temperatures or pyrometallurgical processes and electro-metallurgical processes. Such processes may result in crude metal products that can be subjected to further processing called metallurgy or physical metallurgy and includes processes such as alloying, casting in foundry, rolling and extrusion. For example, copper, uranium vanadium and other metals produced by solvent extraction using a hydrometallurgical process.

Typical tasks that an Extractive Metallurgical Engineering Technician may undertake include the following:

- Assist in conducting research and developing methods for extracting metals from their ores
- Advise on the application of such methods
- Plan, design, develop and implement well-defined process projects
- Operate and optimise process plants or commercial-scale processes

Practising Extractive Metallurgical Engineering Technicians generally concentrate on one or more of the following fields:

- Metallurgy / Mineral Processing Researcher / Lecturer
- Extractive Metallurgy
- Metallurgy / Mineral Processing / Consulting Engineering Technician
- Pyrometallurgy
• Hydrometallurgy
• Electrometallurgy

4.3 Mineral Processing Engineering
Mineral Processing Engineering involves the process in which valuable minerals are separated from worthless material or other valuable minerals by inducing them to gather in and on the surface of a froth layer using processes such as flotation, jigging, milling, scrubbing, magnetic separation, Dense Medium Separation (DMS) and Heavy Medium Separation (HMS). The process of froth flotation entails crushing and grinding the ore to a fine size. This fine grinding separates the individual mineral particles from the waste rock and other mineral particles. Valuable minerals such as gold, silver, copper, lead, zinc, molybdenum, iron, potash, phosphate and even sand for glass are often processed by froth flotation.

4.4. Metallurgical and Materials Engineering
Metallurgical and Materials Engineering Technicians are involved in research, analysis, design, production, characterisation, failure analysis and the application of materials such as metals for engineering applications based on an understanding of the properties of matter and engineering requirements.

Typical tasks that a Metallurgical and Materials Engineering Technician may undertake include:
• assisting in the development and control of processes used for casting, alloying, heat treating or welding of metals, alloys and other materials to produce commercial metal products or to develop new alloys, materials and processes;
• advising on such processes;
• evaluating and specifying materials for engineering applications;
• conducting quality control and failure analyses;
• assisting during the investigation of properties of metals and alloys and the development of new alloys;
• advising on and supervising technical aspects of metal and alloy manufacture, processing and use; and
• participating during residual life evaluations and predictions and failure analyses and prescribing remedial actions to avoid material failures.
Practising *Metallurgical and Materials Engineering Technicians* generally concentrate on one or more of the following areas:

- Metallurgy / Mineral Processing Researcher / Lecturer
- Physical Metallurgy Technician
- Materials Engineering Technician
- Welding Engineering Technician
- Corrosion Engineering Technician
- Quality Assurance Engineering Technician
- Metallurgy / Mineral Processing Consulting Engineering Technician (Technician works on a variety of processes, plants and ores in areas of Research and Development or Project Management)
- Mineral Process Engineering Technician (Technician works in all stages or ore processing)

Metallurgical Engineering Technicians work at the well-defined level, assisting and supporting the Metallurgical Engineering Technologist or Metallurgical Engineer.

5. NATURE AND ORGANISATION OF THE INDUSTRY

5.1 Investigation and problem analysis

- Well-defined investigation and problem analysis involves demonstration of theoretical and practical knowledge to solve problems, using well-proven analytical techniques and tools together with recognised codes and standards.
- Well-defined investigation and problem analysis involves identification of problems/hazards and practical analysis of the cause(s) of process problems in a systematic manner using applicable models and frameworks/tools.
- Well-defined investigation and problem analysis involves the well-defined use of practical data interpretation methodologies, literature surveys, data analyses and root cause analysis tools to identify or to analyse problems.
- Materials Engineering Technicians must demonstrate practical involvement in the investigation of the properties of metals, ceramics, polymers and other materials in addition to the development and assessment of their commercial and engineering applications.
- Materials Engineering Technicians must prepare reports on metallurgical operations and project plans.
• Metallurgical and Mineral Process Engineering Technicians are involved in
  o well-defined practical metallurgical problem-solving with the application of modified or
    additional unit processes; and
  o management of process data collection and analysis.

5.2 Location of training in overall engineering lifecycle and functions performed
The areas in which Metallurgical Engineering Technicians work follow the conventional stages of
the project lifecycle.

5.2.1 Engineering lifecycle considerations
Since the Metallurgical Engineering industry encompasses a wide field of activities ranging from
extractive metallurgy to physical metallurgy, it is not realistic to expect all training programmes to
cover the same fields. However, it is recognised that a Metallurgical Engineering Technician is
usually employed in an organisation operating in one or more of the following fields:

• Research and Development: Assisting in the development of new production from extraction
  metallurgy or solving existing problems using laboratory or industry scale pilot plants
  o Participate in Research and Development studies to improve existing processes or to
    apply existing or possible processes to new ores or concentrates
  o Study and practical application of the fundamentals of metallurgical processes to both
    aid control and improve physical and economic operation
• Metallurgical Plant Operation and Optimisation
• Project Management planning for specification, design and commissioning of metallurgical
  plants / components
• Metallurgy and Mineral Processing Consulting (Project Management Planning)

The Candidate Engineering Technician should have sound training in at least one of the above
mentioned fields. The levels of experience to which the Candidate Engineering Technician must be
exposed in order to gain well defined engineering experience are listed below.

Research, Development, Technology Transfer and Consulting include the following sub-disciplines:
• Mineral Processing
• Hydrometallurgy
Graduate Metallurgical Engineering Technicians employed in Research and Development should gain experience in as many of the following facets as possible:

- A clear understanding of the well-defined problem / opportunity to be investigated by conducting a critical analysis of the literature and other relevant information and assembling the documentation on the subject in an organised manner
- Motivation, planning and design of the well-defined research project and its associated equipment and/or plant
- Well-defined theoretical or paper investigations and laboratory-scale investigations
- Well-defined investigations on a pilot plant scale and/or industrial plant scale
- Interpretation of results and assurance that results are meaningful and have been correctly obtained in accordance with well-defined scientific principles
- Data processing and analysis
- Practical involvement in studies of technical and economic feasibility
- Compilation of the results into a written report and presentation of verbal reports
- Participation in technology transfer to ensure that the maximum benefit is obtained from the research and the development effort
- Investigation by Metallurgy and Mineral Process Engineering Technicians into why and how metals and minerals behave the way they do or are the way they are and determination of the economic issues regarding how to extract metals and minerals from ore
- Practical assistance of the Materials Engineering Technician during the study of the structure and properties of metals and other materials in addition to assistance during the investigation of the methods for shaping and fabricating materials and the study methods for joining materials, improving existing materials and evaluating new materials
- Assistance of the Hydrometallurgy Engineering Technician during the study of the nature and properties of different metals and materials and the removal of insoluble and toxic materials from metal using water-based solutions to find a purer form of ore
- Assistance of the Extractive Metallurgical Engineering Technician during the research, develop, control with advice on processes used in extracting metals from their ores and the washing, crushing and grading of ore or refining metals
- Involvement of the Minerals Process Engineering Technician in all stages of the processing of raw materials. The Candidate Engineering Technician assists during the process to transform low value impure minerals, recycled materials and by-products of other processing operations into commercially valuable products. The main sources of these raw materials are low grade minerals, by-products of other processing operations and recycled materials.

5.2.2 Process optimisation, plant and equipment design

The Metallurgical Engineering Technician must participate in Process optimisation, plant and equipment design:

- Adhere to the principles of well-defined Metallurgical Engineering practice, including the critical study of well-defined work methods and the development of more effective techniques for recognising real and significant problems and how to solve them
- Assist during process optimisation by providing a solution to the identified problem; this may be through improving the operating parameters of the system/equipment by modification or installation of new equipment or systems
- Practically assist during equipment sizing and the selection and application of instrumentation
- Practically assist during the design of plants or equipment by considering the aspects of reliability, maintainability, usability, supportability, reducibility, disposability and affordability
- Ensure optimisation and control of the well-defined process to improve performance
- Practically perform cost and economic analysis for minimising cost and maximising throughput and/or efficiency of the plant operation or process
- Practically assist during the design of the mineral processing and extractive metallurgical plant
- Practically assist during the process of Design and Development
- Practically assist during the equipment and process optimisation by improving operating parameters, sizing and selection of appropriate equipment
- Practically assist technologists and engineers during the improvement/development of new processes and materials in addition to methods and equipment for extraction, filtration and distillation
- Design plants and specify equipment/processes and layouts
- Test the quality of the process and product

Metallurgical Engineering Technicians apply theory to well-defined engineering work in support of
work done or developed by technologists and engineers. This means that the Candidate
Engineering Technician practically supports the Metallurgical Engineering Technologist and the
Metallurgical Engineer during the understanding, interpretation and development (design) of the
solution and seeks their approval.

5.2.3 Risk management and impact mitigation
The Metallurgical Engineering Technician must participate in risk management and impact mitigation:

- Assist Metallurgists in coordinating the analysis of samples taken from metallurgical process
  streams to ensure safe and economic operation and acquire advice as operations personnel
  on the process changes required to obtain desired products, processes and quality control
- Improve environmental performance of metallurgical operations and ensure all environmental
  standards are met
- Undertake risk assessments during plant operation and projects
- Ensure the OHS Act and other standards are followed

5.2.4 Project management
Project management comprises a number of phases and stages that must be followed to solve
industrial problems. Companies use different project lifecycles that include project development
(involves design specifications, concept design, basic design and detailed design); procurement
management; contract management; plant construction; commissioning and handover; and
decommissioning.

Application of the supporting project management process to solve the scientific problem may
include the following:

- Integrated Project Controls: Includes cost control, estimating resources, capital and operating
  and/or lifecycle costs, planning and scheduling and project risk management
- Stakeholder Management: Liaisons with a wide variety of people on the job such as
  operators, maintenance and engineering staff, geologists, mining engineers and supporting
  specialists in process control, computing, technology provision and research
- Assistance during design, development, construction, commissioning and handover
  regarding metal and mineral processing and pilot and industry equipment and plants
- Project Time management or planning
• Management of project change and project risk

5.2.5 Project development

The Metallurgical Engineering Technician participates and assists in project development:
• Integrated Project Controls: Include cost control, estimating resources, capital and operating and/or lifecycle costs, planning and scheduling and project risk management
• Stakeholder Management: Responsibility for communication and overall control of the engineering team; interfacing with client/legal entities
• Project Resource Management
• Management of project change and project risk
• Project management tasks during all the project development phases including idea, problem analysis, definition need, conceptual design, and basic and detailed engineering. Research and feasibility studies are undertaken to identify, select and develop the preferred solution.
• Laboratory, pilot or full-scale plant work primarily aimed at obtaining engineering data for the specification and design of well defined, new metallurgical plants or the improvement of existing plants
• Sound financial business concepts, ranging from budgeting to feasibility studies
• Plant Design: Preparation of well-defined flow sheets and material and energy balances; appreciation of the operation of a drawing office and an engineering purchasing office; checking of working drawings for suitability with regard to the particular well-defined metallurgical operation, specification and design; selection of equipment and service requirements; consideration of the design with regard to materials used, economics, instrumentation, quality control, logistics, safety, acceptable operation conditions, spillage management and the effect on the environment
• Assistance of the Pyrometallurgical Engineering Technician during the design and development of high temperature heat based processes and equipment to concentrate, extract and obtain pure metals and ore through various extractive processes such as refining, fusing and smelting metals
• Assistance with compiling and procuring contracts management documents
• Consideration of National Treasury rules
5.2.6 Plant Construction, commissioning and handover

The Metallurgical Engineering Technician participates and assists during the following project management processes at the well-defined level:

- Plant construction: Site establishment and site management, assembling of plant equipment in accordance with drawings and installation designs
- Preparation of operating, start up, shutdown and emergency procedures
- Plant commissioning: Measurement and analysis of actual performance data versus design parameters; responsibility for performance of the plant; optimisation of plant performance; review of all safety standards; operability of the plant; sound labour relations and practices; and managerial aspects
- Plant handover: Includes ‘as-built’ documentation, construction, planning and execution of punch-out and handover

5.2.7 Plant decommissioning

The Metallurgical Engineering Technician:

- Assists during the decommissioning involving disassembling of equipment. This can be a process undertaken from one pilot plant to another depending on exploration period and requirements from the mineral processing or mining plant.
- Assists during the evaluation, design and analysis of the new site requirements for optimum performance
- Participates during the compilation of decommissioning strategy. Safety procedures are followed by understanding the chemical and physical characteristics of the equipment or plant
- Participates in the compilation of procedures for plant decommissioning and consolidation for shutdown or closure
- Ensures regulatory and statutory application and the implementation of the authorisation process

5.2.8 Product / Manufacturing

The Metallurgical Engineering Technician

- Application of physical and chemical methods to concentrate valuable minerals from their ores. Methods can involve magnetic, electrostatic, gravity and flotation processes
- Application of a combination of processes involving hydrometallurgy, electrometallurgy and
5.2.9 Plant operation and maintenance

One of the most effective ways in which the Candidate Engineering Technician can gain experience is to become a member of a team responsible for the commissioning of a new or modified plant. However, routine operation of existing plants will be considered as sufficient training provided as many of the following facets as possible are covered and emphasis is placed on those that are particularly relevant to the operation:

- Measurement and analysis of performance plant or equipment data
- Undertaking of material and energy balances
- Process plant operation, especially with direct and increasing responsibility for certain sections of the plant
- Quality control in respect of measurement and specifications
- Plant records and operating costs
- Process control and management
- Safety and acceptance of the principle that the Engineering Technician may not pose a threat to life and limb through negligence
- Interrelationships between engineering personnel and management, between the members of the engineering team and especially between production and maintenance
- Consideration of the impact that the operation may have on the environment
- Application of economic analysis of production processes to effect optimal performance
- Management of the technical aspects of metallurgical operations using tools such as on-line process monitoring, sampling, chemical analysis, data analysis and process modelling
- Management and supervision of production staff in metallurgical operations
- Application of chemical, metallurgical and process engineering fundamentals to production processes
- Fault finding in plant equipment and application of corrective action to ensure safe operation:
  - Pyrometallurgists control temperature adjustments and change mixtures and other variables in operations such as blast furnaces and steel melting furnaces to obtain materials such as pig iron and steel of specified metallurgical characteristics and qualities.
- Assurance that appropriate safety, health and environmental (SHE) management systems and practices are implemented within the department/organisation
• Assurance that plant availability, use and operability throughput and recovery targets are being met
• Assurance that all plant operations are running efficiently against industry best practices and appropriate standards by updating, recording, archiving and analysing all plant related data
• Assurance that appropriate metallurgical input is provided for business plans and forecasts (e.g. monthly, quarterly and annual forecasts)
• Assurance that cost and cash flow targets are met
• Assurance that appropriate policies and procedures or work instructions align with design bases. These include policies and procedures applicable to Main Processing Plant; Final Recovery; Slimes Dam and Tailings Dump; Return Water Dam and Plant Water Supply; and maintenance bases / system / equipment lifecycle plans

6. DEVELOPING COMPETENCY: DOCUMENT R-08-PN

6.1 Contextual knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The Voluntary Associations applicable to the Metallurgical Engineering Technician and their functions and services to members provide a broad range of contextual knowledge for the Candidate Engineering Technician through the full career path of the registered Engineering Technician.

The profession identifies specific contextual activities that are considered essential in the development of competence of the Metallurgical Engineering Technician. These include the applicable basic analytical, process and fabrication activities and the competencies required of the engineer, technician and artisan. Exposure to practice in these areas is identified in each programme within the employer environment.

The Professional Engineering Technician Registration Committee of the ECSA carries out the review of the Candidate’s portfolio of evidence at the completion of the training period.

Chemical Engineering Technicians may also find themselves gaining experience from diverse industries such as mining and metallurgy. Chemical metallurgy uses chemical processing at high temperatures or in solution to convert minerals from inorganic compounds to useful metals and other materials.
6.2 Functions performed

The functions that are required to a greater or lesser extent in all the areas of employment and in which all Metallurgical Engineering Technicians need to be proficient are listed below. The parallels with the well-defined generic competence elements required by the Competency Standard (document R-02-PN) should be clear.

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

- Group A: Knowledge based problem solving (this should be a strong focus)
- Group B: Management and communication
- Group C: Identifying and mitigating the impacts of engineering activity
- Group D: Judgement and responsibility
- Group E: Independent learning

It is very useful to measure the progression of the Candidate’s competency by making use of the scales regarding 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 Candidate reaches the required level of competency and responsibility.

It should be noted that the 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.

The nature of work and the degrees of responsibility defined in document R-04-P are presented here and in Appendix A.
A: Being Exposed | B: Assisting | C: Participating | D: Contributing | E: Performing
---|---|---|---|---
Undergoes induction; observes processes and work of competent practitioners | Performs specific processes under close supervision | Performs specific processes as directed with limited supervision | Performs specific work with detailed approval of work outputs | Works in team without supervision; recommends work outputs; responsible but not accountable
Responsible to supervisor | Limited responsibility for work output | Full responsibility for supervised work | Full responsibility to supervisor for immediate quality of work | Level of responsibility to supervisor is equivalent to that of a registered person; supervisor is accountable for applicant’s decisions

6.3 Statutory and regulatory requirements
The Candidate Engineering Technician should be aware of the requirements for safety appointments in terms of the Occupational Health and Safety Act for plant managers.

- SANS Codes for Specification for Piping Design / Material (ANSI) (see www.sabs.co.za)
- Minerals and Energy Acts (e.g. Mineral and Petroleum Act, No. 28 of 2002)
- Project and Construction Management Professions Act, No. 48 of 2000
- National Environmental Management Act, No. 107 of 1998 (Various measures relating to pollution of a water resource; Waterworks process controller)
- National Water Act, No. 54 of 1956 (Determination of persons permitted to design dams)
- Nuclear Energy Act, No. 46 of 1999
- National Water Act, No. 36 of 1998
- Occupational Health and Safety Act, No. 85 of 1993 (OHS Act) and Regulations: Driven Machinery Regulations; Pressurised Equipment Regulations
- ISO 9001: 2015
6.4 Desirable formal learning activities

Attendance of relevant technical courses and conferences is recommended. Formal safety training should be mandatory. The Candidate Engineering Technician should register with the relevant volunteer associations to access lists of training courses / conferences / seminars and other relevant information (e.g. SAIMM, PMI, PMISA, CESA, SACPCMP). The following is a list of sample training / courses:

- Problem solving and analysis tools (e.g. brain storming, gap analysis, FMEA, Pareto Analysis, root cause analysis, problem tree analysis, trade-off tools)
- Risk assessment and analysis techniques
- Project management techniques and tools, including conditions of contract management, finance and economics, quality systems, stakeholder management and Project Management (planning, scheduling and project controls), tools and software (e.g. Ms Project, Primavera, Project Risk Analysis tools, Earn Value Management [EVM] and other SAP Tools)
- Modelling and Simulation tools (e.g. for pumps, DMS) from original equipment manufacturer (OEM) or own development as part of competency gained
- Occupation Health and Safety, including the OHS Act and ‘safety in design’
- Formally registered Continuing Professional Development (CPD) courses in Metallurgical Engineering and associated disciplines
- Value Engineering and other Value Improvement Practices (VIPs)
- Preparation of engineering design specifications
- Environmental aspects of projects and plant operations
- Waste management and treatment process
- Professional skills such as report writing, presentations, facilitation and negotiation
7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best practice

Best practice is a developmental process that assists applicants in becoming registered Professional Engineering Technicians. Best practice comprises the process used for the continuous development of the Candidate. A number of courses (technical and management) must be attended in order to gain Initial Professional Development (IPD) at the level required for registration. On-the-job learning at the organisation in which the Candidate is employed. Refer to the Southern African Institute of Minerals and Metals industry (SAIMM) for some best practice ideas. Applicants may register with these bodies to gain access to courses, articles and relevant information for their development. Such registration may also present opportunities to meet with experts during seminars.

It is suggested that Candidates work with their mentors to determine appropriate projects for gaining exposure to elements of the asset lifecycle and to ensure that their designs are constructible, 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 level 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 can perform as an individual and as a team member at the level of problem-solving and well-defined engineering activity required for registration, exhibiting a Degree of Responsibility Level E.

7.2 Realities

There is no ideal training programme structure or unique sequencing that constitutes best practice. The training programme for each Candidate will depend on the work opportunities available at the
time for the employer to assign to the Candidate. For ECSA registration in the fields in which the Candidates are employed, applicants must ensure that they undertake tasks that provide experience in the three generic engineering competence elements of problem investigation and analysis; problem solution; and execution/implementation. It should be possible by judicious selection of work task opportunities with the same employer to gain experience in all three elements. Candidate Engineering Technicians are advised that although three years is the minimum required period of experience following graduation, in practice, Metallurgical Engineering Technicians seldom meet the experience requirements in three years, and then only if they have followed a structured training programme. Applicants are advised to gain at least five years of experience before applying.

7.3 Considerations for generalists, specialists, researchers and academics
To be able to become a Professional Engineering Technician, the lecturer/researcher must become involved in the application of engineering knowledge by way of applied research and consulting work under the supervision of a Professional Engineering Technologist or Engineer.

For generalists and specialists, provided the applicant's specialist knowledge is at least at the level of a BTech degree and provided the applicant has demonstrated the ability to identify engineering problems at a professional level and to produce well-defined solutions that can be satisfactorily implemented, a degree of trade-off may be acceptable in assessing the experience. Where an applicant's experience is judged to be in a narrow specialist field, a minimum of five years' experience after obtaining the NDip Engineering will be required, but each application will be considered on merit.

Applicants who studied Chemical Engineering may find themselves in a metallurgical environment and can undertake mineral processing duties.

Candidates working towards becoming Professional Engineering Technicians while in the academic environment need to acquire the following well-defined engineering activities.

Teaching / Lecturing / Facilitation
- Reading in applicable fields of knowledge
- Curriculum development
• Selection and development of teaching materials
• Compilation of lecture notes
• Compilation of examination papers
• Demonstration of application of theory in practice
• Service as supervisor for student projects

Research or further studying
• Literature surveys
• Obtaining higher qualifications
• Advancement of the current state-of-the-art technology
• Theoretical research / development of analytical techniques
• Practical/experimental research
• Participation in international collaborative research

Laboratory experimental activities
• Experimentation
• Design and building of laboratories
• Experimental equipment design / construction
• Experiment design
• Development of new manufacturing techniques
• Development of non-destructive testing techniques
• Vibration testing
• Material/structural testing

Conferences / Symposia / Seminars
• Publishing papers (peer-reviewed journals and international conferences)
• Public speaking

Consulting:
• Consulting to industry in solving real problems encountered in engineering practice
• Design of products /structures / systems / components
Multi-disciplinary exposure
Interphase management between various disciplines needs to be formalised. Details of signed-off interface documents between different disciplines are essential.

Orientation requirements
- Introduction to company safety regulations
- Company code of conduct
- Company staff code and regulations
- Typical functions and activities in company
- Hands on experience and orientation in each of the major company divisions

7.4 Moving into or between 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 indicated 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.
- On entering the new programme, the mentor and supervisor should review the Candidate’s development, taking into consideration past experience, opportunities and the requirements of the new programme and planning at least the next phase of the Candidate’s programme.
REVISION HISTORY

<table>
<thead>
<tr>
<th>Revision Number</th>
<th>Revision Date</th>
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<tr>
<td>Rev 1</td>
<td>30 January 2018</td>
<td>Reviewed and checked</td>
<td>Z Zwane, J Cato</td>
</tr>
<tr>
<td>Rev 2</td>
<td>23 May 2019</td>
<td>Approval</td>
<td>RPSC</td>
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Discipline-specific Training Guideline for:

Candidate Engineering Technicians in Metallurgical Engineering

Revision 2 dated 23 May 2019 and consisting of 26 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (RPS).

[Signature]  
Business Unit Manager  
24/07/2019  
Date

[Signature]  
Executive: RPS  
26/07/2019  
Date

This definitive version of this policy is available on our website.
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:

- Confirm understanding of instructions received and clarify if necessary
- Use theoretical training to develop possible solutions, thereafter selecting the best and presenting to the recipient
- Apply theoretical knowledge to justify decisions taken and processes used
- Understand role in the work team and plan and schedule work accordingly
- Issue complete and clear instructions and report comprehensively on work progress
- Be sensitive about the impact of the engineering activity and take action to mitigate this impact
- Consider and adhere to legislation applicable to the task and the associated risk identification and management
- Adhere strictly to high ethical behavioural standards and to the ECSA Code of Conduct
- Display sound judgement by considering all factors, their interrelationships, consequences and evaluation when all evidence is not available
- Accept responsibility for own work by using theory to support decisions, seeking advice when uncertain and evaluating shortcomings
- 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
## Competency Standards for Registration as a Professional Engineering Technician

<table>
<thead>
<tr>
<th>1. Purpose</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td>Discipline-Specific Training Guides (DSTGs) give context to the purpose of the Competency Standards. Professional 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 demonstrated in Clause 4 of the specific DSTG. Discipline-Specific Training Guides 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). 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.</td>
</tr>
</tbody>
</table>
2. Demonstration of Competence

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.

**Level Descriptor: Well-defined engineering activities (WDEA) 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 and construction; engineering operations; maintenance; project management; research; development; and commercialisation.

Engineering activities can be approximately divided into:

- 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)

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

**Level Descriptor: WDEA 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 that includes 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 more frequently in some disciplines and are seldom encountered in others.

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**CONTROLLED DISCLOSURE**

When downloaded for the ECSA Document Management System, this document is uncontrolled and the responsibility rests with the user to ensure that it is in line with the authorised version on the database. If the ‘original’ stamp in red does not appear on each page, this document is uncontrolled.
3. Outcomes to be satisfied

Group A: Engineering Problem-Solving

Outcome 1: Define, investigate and analyse well-defined engineering problems

<table>
<thead>
<tr>
<th>Explanation and Responsibility Level</th>
<th>Responsibility Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-defined engineering problems have the following characteristics:</td>
<td>Analysis of an engineering problem means the ‘separation into parts, possibly with comment and judgement’.</td>
</tr>
<tr>
<td>(a) can be solved mainly by practical engineering knowledge underpinned by related theory; and one or more of:</td>
<td>(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.</td>
</tr>
<tr>
<td>(b) are largely defined but may require clarification;</td>
<td>(b) Further investigation to identify the nature of the problem is seldom necessary.</td>
</tr>
<tr>
<td>(c) are discrete, focused tasks within engineering systems;</td>
<td>(c) The problem is discrete, meaning it is individually distinct and easily recognised as part of the larger engineering task, project or operation.</td>
</tr>
<tr>
<td>(d) are routine, frequently encountered, may be unfamiliar but in a familiar context; and one or more of:</td>
<td>(d) It is recognised that the problem occurred in the past or the possibility exists that it may have happened before; it is definitely not a new problem.</td>
</tr>
<tr>
<td>(e) can be solved by standardised or prescribed ways;</td>
<td>(e) The problem does not require the development of a new solution (determine how the problem was previously solved).</td>
</tr>
<tr>
<td>(f) are encompassed by standards, codes and documented procedures; authorisation required to work outside limits;</td>
<td>(f) 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.</td>
</tr>
<tr>
<td>(g) information is concrete and largely complete but requires checking and possible supplementation;</td>
<td>(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.</td>
</tr>
<tr>
<td>(h) involve several issues (few of these impose conflicting constraints) and a limited range of interested and affected parties; and one or both of:</td>
<td>(h) The problem handled by the Engineering Technician must be limited to well-known matters and preferably requires standardised solutions without possible complications.</td>
</tr>
<tr>
<td>(i) require practical judgement in the practice area in the evaluation of solutions and consideration of interfaces to other role players; and</td>
<td>(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.</td>
</tr>
<tr>
<td>(j) have consequences that are locally important but not far reaching (wider impacts are dealt with by others).</td>
<td>(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.</td>
</tr>
</tbody>
</table>

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 the 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, 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.
### 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.

### Outcome 2:
Design or develop solutions to well-defined engineering problems

**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.

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 – client or supervisor in agreement.

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

**Assessment Criteria:** This outcome is normally demonstrated in the course of 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).

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**Responsibility Levels C and D**

Design means ‘drawing or outline from which something can be made’.
Devlop means ‘come or bring into a state in which it is active or visible’.

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

**Responsibility Level E**

Comprehend means to understand fully. The jurisdiction in which an Engineering Technician practises is given in Clause 4 of the specific DSTG.

**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.

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.

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.
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 regarding legal and regulatory requirements and prescribed codes of practice

(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.

(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.

(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 in terms of the OHS Act.

Group B: Managing Engineering Activities

<table>
<thead>
<tr>
<th>Outcome 4:</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
</table>
| Manage part or all of one or more well-defined engineering activities | Responsibility Level D  
Manage means ‘control’.  
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 carrying out the work (e.g. bar chart).  
4.2 Describe your role and contribution in the work team. |
| Outcome 5: | Communicate clearly with others in the course of his/her well-defined engineering activities |
| Communicate clearly with others in the course of his/her well-defined engineering activities | Responsibility Level C  
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.  
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.  
5.2 Refer to the Range Statement for outcomes 4 and 5. |
### Range Statement for outcomes 4 and 5: Management and communication in well-defined engineering involves the following:

- **Planning** well-defined activities
- **Organising** well-defined activities
- **Leading** well-defined activities
- **Controlling** well-defined activities

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.

- **Planning** means ‘the arrangement for doing or using something; considering in advance’.
- **Organising** means ‘putting into working order; arranging in a system; making preparations for’.
- **Leading** means ‘guiding the actions and opinions of; influencing; persuading’.
- **Controlling** means the ‘regulating, restraining, keeping in order; checking’.

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.

### Group C: Impacts of Engineering Activity

#### Outcome 6: Recognise the general foreseeable social, cultural and environmental effects of well-defined engineering activities

<table>
<thead>
<tr>
<th>Assessment Criteria</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
</table>
| **Social** | Responsibility Level B
Social means ‘relating to people living in communities; relations between persons and communities’. |
| **Cultural** | 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). |
| **Environmental** | 6.2 Mitigating measures taken may include environmental impact studies, environmental impact management, community involvement and communication, barricading and warning signs, temporary crossings, alternative supplies (ring feeders and bypass roads), press releases and compensation paid. |

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.
### 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

#### 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 you obtained advice in carrying out risk management for the work and elaborate on the risk management system applied. |

#### Responsibility Level E

| 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.
- **(e)** Safe and sustainable materials, components and systems are prescribed.
- **(f)** Persons whose health and safety are to be protected are both inside and outside the workplace.

- **(a)** The impacts will vary substantially with the location of the task (e.g. the impact of laying a cable or pipe in the main street of a town will be entirely different to the impact of construction in a rural area). The methods, techniques and procedures will 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 that this is done. Tasks and projects are mainly carried out where contact with the public cannot be avoided, and safety measures such as barricading and warning signs must be used and maintained.
- **(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.
- **(d)** Effects associated with risk management are mostly well known if not obvious, and methods used to address these risks are clearly defined.
- **(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.
- **(f)** Staff working on the task or project as well as persons affected by the engineering work being carried out.
<table>
<thead>
<tr>
<th>Group D: Exercise judgement, take responsibility and act ethically</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome 8: Conduct engineering activities ethically</td>
<td>Responsibility Level E</td>
</tr>
</tbody>
</table>
| Assessment Criteria: Sensitivity to ethical issues and the adoption of a systematic approach to resolving such issues are expected.  
  8.1 State how you identified the ethical issues in addition to the affected parties and their interests and indicate the actions you took when a problem arose.  
  8.2 Confirm that you are conversant and in compliance with the ECSA Code of Conduct and why this Code of Conduct is important in your work.                                      | Systematic means 'methodical; based on a system'.  
  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.  
  8.2 The ECSA Code of Conduct as per the ECSA website is known and adhered to. Applicable examples given. |
| Outcome 9: Exercise sound judgement in the course of well-defined engineering activities | Responsibility Level E              |
| Assessment Criteria: Judgement is displayed by the following performance:  
  9.1 State the factors applicable to the work and their interrelationship and indicate how you applied the most important factors.  
  9.2 Describe how you foresaw work consequences and evaluated situations in the absence of full evidence.                                     | 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 Making risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Give examples. |
| Range Statement for outcomes 8 and 9: Judgement in decision-making involves  
  (a) accounting for limited risk factors, some of which may be ill-defined; or  
  (b) accounting for consequences that are in the immediate work contexts; or  
  (c) accounting for an identified set of interested and affected parties with defined needs. | 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):  
  (a) Advice is sought when risk factors exceed his/her capability.  
  (b) Consequences outside the immediate work contexts (e.g. long-term) are not normally handled.  
  (c) Interested and affected parties with defined needs outside the well-defined parameters are taken into account. |
**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 you used NDip theoretical calculations to justify decisions taken in carrying out the engineering work. Attach actual calculations.
10.2 State how you sought responsible advice on any matter falling outside your own education and experience.
10.3 Describe how you took responsibility for your own work and evaluated any shortcomings in your output.

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

**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.

**Outcome 11:** Undertake independent learning activities sufficient to maintain and extend his/her competence

**Responsibility Level D**

**Assessment Criteria:** Self-development is displayed by the following performance:

11.1 Provide the strategy that you independently adopted to enhance professional development (IPD report)
11.2 Be aware of the philosophy of the employer in regard to professional development

**Explanation and Responsibility Level**

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.
11.2 Record-keeping must 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.
Range Statement: Professional development involves the following:

| (a) | Taking ownership of own professional development |
| (b) | Planning own professional development strategy |
| (c) | Selecting appropriate professional development activities |
| (d) | Recording professional development strategy and activities while displaying independent learning ability |

(a) This is your professional development, not the development of the organisation for which you are working.
(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.
(c) Preference must be given to engineering development rather than developing soft skills.
(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.
## APPENDIX B: SCOPE OF TRAINING ELEMENTS

<table>
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<th>Tasks</th>
<th>Contexts</th>
<th>Work Experience and Scope</th>
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</thead>
<tbody>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Training Induction Programme</td>
<td>(Typically 1–5 days)</td>
<td></td>
</tr>
<tr>
<td>1.1.1</td>
<td>Company structure</td>
<td></td>
</tr>
<tr>
<td>1.1.2</td>
<td>Company policies</td>
<td></td>
</tr>
<tr>
<td>1.1.3</td>
<td>Company Code of Conduct</td>
<td></td>
</tr>
<tr>
<td>1.1.4</td>
<td>Company safety regulations</td>
<td></td>
</tr>
<tr>
<td>1.1.5</td>
<td>Company staff code</td>
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<td>1.1.6</td>
<td>Company regulations</td>
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<td>1.2 Exposure to engineering principles and processes</td>
<td>(Typically 6–12 months); covers how things are (Experience in one or more of these but not all)</td>
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<tr>
<td>1.2.1 (Responsibility levels A, B, C)</td>
<td>Manufacturing / Production</td>
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<td>1.2.2</td>
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<td>1.2.3</td>
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<td>1.2.4</td>
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<td>1.2.5</td>
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<td>1.2.6</td>
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<td>1.2.7</td>
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<td>1.2.8</td>
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<td>Process Safety</td>
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<td>Problem Investigation</td>
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<td>Experience in design and application of design knowledge</td>
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<td>(Responsibility levels C and D)</td>
<td>Analysis of data and systems</td>
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<td>1.3.3</td>
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<td>Preparation of specifications and associated documentation</td>
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<td>System modelling and integration</td>
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<td>System and software designs</td>
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<td>1.3.6</td>
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<td>Component / Product designs</td>
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<td>1.3.7</td>
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<td>Preparation of contract documents and associated documentation</td>
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<td>1.3.8</td>
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<td>Preparation of project management documents</td>
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<td>1.3.9</td>
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<td>Configuration and Documentation Management (Quality Management Systems)</td>
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<td>Experience in the execution of engineering tasks</td>
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<td>1.4.4</td>
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<td>Construction and Installation</td>
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| 1.4.5 | Project Management |
| 1.4.6 | Commissioning |
| 1.4.7 | Plant Operations and Maintenance |
| 1.4.8 | Modifications |
| 1.4.9 | Decommissioning |
| 1.4.10 | Process Safety |
| 1.4.11 | Research and Development |

**2** Solving problems based on engineering and contextual knowledge

| 2.1 | Conceptualisation of well-defined engineering problems |
| 2.1.1 | Receive brief |
| 2.1.2 | Interpret client’s requirements |
| 2.1.3 | Gather information required for problem analysis |
| 2.1.4 | Participate in developing preliminary solutions |
| 2.2 | Design or development processes for well-defined engineering problems |
| 2.2.1 | Identify and analyse alternative approaches for design / solution / development processes |
| 2.2.2 | Develop documentation for implementing well-defined engineering solutions |

**3** Implementing projects or operating engineering systems or processes

| 3.1 | Planning processes for Implementation or Operations |
| 3.1.1 | Develop business and stakeholder relationships |
# 3.1.2
Determine scope and generate plan

## 3.2
Organising processes for Implementation or Operations

### 3.2.1
Manage resources

### 3.2.2
Optimise resources and processes

## 3.3
Controlling processes for Implementation or Operations

### 3.3.1
Monitor progress and delivery

### 3.3.2
Monitor quality

## 3.4
Close-out processes for Implementation or Operations

### 3.4.1
Commission processes

### 3.4.2
Develop operational documentation

### 3.4.3
Handover processes

## 3.5
Maintenance and repair processes

### 3.5.1
Plan and schedule for maintenance

### 3.5.2
Monitor quality

### 3.5.3
Oversee repairs and/or implement remedial processes

# 4 Risk and Impact Mitigation

## 4.1
Impact and risk assessments

### 4.1.1
Impact assessments

### 4.1.2
Risk assessments

---

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<td>Managing Engineering Activities</td>
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<td>Team Environment</td>
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<td>5.2.1</td>
<td>Participate in and contribute to team planning activities</td>
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<td>Manage people</td>
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<td>5.4</td>
<td>Exercising judgement and taking responsibility</td>
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<td>5.4.1</td>
<td>Practise ethically</td>
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<td>5.4.2</td>
<td>Exercise sound judgement in the course of well-defined engineering activities</td>
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<td>Be responsible for decision-making on part or all of well-defined engineering activities</td>
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<td>Competency development</td>
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<td><strong>Approving Officer:</strong> E Nxumalo</td>
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