ENSURING THE EXPERTISE TO GROW
SOUTH AFRICA

Discipline-specific Training Guide for Candidate Engineering Technologist in Industrial Engineering

R-05-IND-PT

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DEFINITIONS

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

**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.

**Mentor:** A person willing to spend his/her time and expertise to guide the development of another person.
Outcome: At the professional level, it means a statement of the performance that a person must demonstrate in order to be judged competent.

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.

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

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 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.

Sydney Accord: An ECSA agreement for the international recognition of Engineering Technologists qualifications and competencies.

Voluntary Associations Voluntary Associations recognised by the ECSA Council in terms of section 36(1) of the Engineering Profession Act, 46 of 2000.
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
SAIIE     The Southern African Institute for Industrial and Systems Engineering
TER       Training and Experience Report
TES       Training and Experience Summary
VA        Voluntary Association
BACKGROUND

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

![Diagram](image)

Figure 1: Document defining the ECSA registration system

1. PURPOSE OF THE DOCUMENT

This guideline is aimed at providing information about the requirements for registration as a Professional Engineering Technologist with ECSA. All persons applying for registration as Professional Engineering Technologists are expected to demonstrate the competencies specified in document **R-02-PT** at the prescribed level, irrespective of the sub-discipline.
specific within electrical engineering, through work performed by the applicant at the prescribed level of responsibility.

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

In document R-04-P, attention should be 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.

Document R-08-PT provides a high-level, outcome-by-outcome understanding of the competency standards that form an essential basis for this Discipline-Specific Training Guide (DSTG). This guide and documents R-04-P and R-08-PT are subordinate to the Policy on Registration, document R-01-POL, the Competency Standard, document R-02-PT, and the application process definition, document R-03-PRO.

2. AUDIENCE

This DSTG is directed at Candidates and their supervisors and mentors in the discipline of Industrial Engineering and Systems 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 Technologist 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 BTech (Engineering) or BEng Tech type qualification, or a Sydney-Accord recognised qualification or through evaluation / assessment;
- registered as a Candidate Engineering Technologist; and/or,
• 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, irrespective of the development path followed. Application for registration as a Professional Engineering Technologist is permitted without being registered as a Candidate Engineering Technologist or without training under a C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration. The 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 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 should be consulted for assistance in locating an external mentor. A mentor should be in pace at all stages of the development process.

This guide is written for the recent graduate who is training and gaining experience toward registration. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development. Any 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. The guide may be applied in the case of a person moving into a candidacy programme at a later stage that is at a level below that required for registration (see section 7.5 of this document).
4. ORGANISING FRAMEWORK FOR OCCUPATIONS

4.1 OFO Definition

The Organising Framework for Occupations (OFO) 2012, offers a similar, though simplified definition of our profession: An Industrial Technologist investigates and reviews the utilisation of personnel, facilities, equipment and materials, current operational processes and established practices, to recommend improvement in the efficiency of operations in a variety of commercial, industrial and production environments.

4.2 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 Technologist
- Automation and Control Engineering Technologist
- Clinical Engineering Technologist
- Enterprise Resource Management Engineering Technologist
- Fabrication Engineering Technologist
- Industrial Efficiency Engineering Technologist
- Industrial Machinery Engineering Technologist
- Manufacturing Logistics Engineering Technologist
- Manufacturing Technology Engineering Technologist
- Operations Research Engineering Technologist
- Plant Engineering Technologist
- Process Design Engineering Technologist
- Process Engineering Technologist
- Production Engineering Technologist
- Quality Management Engineering Technologist
- Robotics and Production Automation Engineering Technologist
- Safety Engineering Technologist
- Supply Chain Management Engineering Technologist
- Value Engineering Technologist.
4.3 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:

4.3.1 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;
- 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.

4.3.2 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.

4.3.3 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.
4.3.4 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.

Industrial Engineering is not limited to any of the four dimensions mentioned in the areas of specialisation. It is therefore no surprise that a growing number of industries benefit from an Industrial Engineering skill set. The list of such industries includes, but is not limited to:

- 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.

4.4 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 following:

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

Considering the dynamic nature of the profession, the diverse range of industries which Industrial Engineering Technologists could find them 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 Technologist Candidacy Phase.

Instead of predetermined paths, a set of guiding principles is proposed, whereby Candidates 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:
  - 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.

6. DEVELOPING COMPETENCY: DOCUMENT R-08-PT

This section elaborates on the discipline-independent competency standards outlined in document R-08-PT and highlights specific competencies across the respective 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 Technologists 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.

6.1 Contextual knowledge

For all successful solutions and interventions, the applicant needs to consider the context in which they exist. The integrative nature of Industrial and Systems Engineering specialised knowledge and 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
6.2 Functions performed

Candidates/applicants must demonstrate that during their training period, they have mastered the competencies defined in document R-08-PT 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.

It is useful to measure the progression of candidates' competency by using the degree of responsibility, as shown in Table 1 below. The degree of responsibility shows the gradual increase in responsibility to which Candidate Technologists are exposed during their professional training. The aim is to get the applicant or candidate at Responsibility Level E prior registering for professional registration.

Table 1: Degree of responsibility

<table>
<thead>
<tr>
<th>Level</th>
<th>Nature of Work</th>
<th>Level of Responsibility</th>
<th>Level of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Being Exposed</td>
<td>The candidate undergoes induction, observes processes, work of competent practitioners.</td>
<td>There is no responsibility, except to pay attention.</td>
<td>Mentor explains challenges and forms a solution.</td>
</tr>
<tr>
<td>B: Assisting</td>
<td>The candidate performs specific processes, under close supervision.</td>
<td>Limited responsibility for work output.</td>
<td>Supervisor/Mentor coaches, offers feedback.</td>
</tr>
<tr>
<td>C: Participating</td>
<td>The candidate performs specific processes as directed with limited supervision.</td>
<td>Full responsibility for supervised work.</td>
<td>Supervisor progressively reduces support, but monitors outputs.</td>
</tr>
</tbody>
</table>
### Discipline-Specific Training Guideline for Candidate Engineering Technologist in Industrial Engineering

<table>
<thead>
<tr>
<th>Subject: Discipline-specific Training Guideline for Candidate Engineering Technologist in Industrial Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compiler: MB Mtshali</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Degree of Responsibility</th>
<th>Candidate's Role</th>
<th>Applicant's Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>D: Contributing</td>
<td>The candidate performs specific work with detailed approval of work outputs.</td>
<td>Full responsibility to supervisor for quality of work.</td>
</tr>
<tr>
<td>E: Performing</td>
<td>The candidate works in team without supervision; recommends work outputs; responsible but not accountable.</td>
<td>Level of responsibility to supervisor is appropriated to a registered person.</td>
</tr>
</tbody>
</table>

Appendix A has been developed against the Degree of Responsibility scale. Activities should be selected to ensure the Candidate reaches the required level of competency and responsibility. It is therefore expected that the Candidate or the applicant should ensure that each outcome meets the responsibility level as indicated in **Appendix A** for application as a Professional Engineering Technologist.

### 6.3 Statutory and Regulatory Requirements

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

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 rules and the Code of Conduct of the ECSA;
- Occupational Health and Safety Act, 85 of 1993, as amended by Act 181 of 1993 (OHS Act);
- Machinery and Works Regulations;
- Labour Relations Act, 66 of 1995;
• 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 that may also be pertinent to a Candidate’s work environment.

6.4 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. Formal learning activities for Candidate Technologists include postgraduate programmes in Industrial and Systems Engineering and related fields such as Supply Chain Management and 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 Technologists 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:
• Systems engineering
• Project management
• Business strategy techniques and development
• Change and transformation management
• Maintenance management
• Strategic sourcing
• Standards development and specifications
• Engineering finance
• Risk analysis and quality systems
• Occupational health and safety
• Discipline specific courses quality systems
• Maintenance engineering
• Technical and business report writing
• Planning methods
• Environment impacts management.

Examples of courses that offer generalist or soft skills are as follows:

• Negotiation and influencing
• Industrial relations
• Stakeholders management
• Public speaking
• Conflict management
• Political savvy skills
• Professional writing
• Business law.

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

7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 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 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 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.

7.2 Activities undertaken under training

Table 2 below shows different activities that the Candidate or applicant undertakes during progression to different responsibility levels.

Table 2: Progression throughout the training period

<table>
<thead>
<tr>
<th>Level of Responsibility</th>
<th>Activities or duties to be undertaken by the candidate under training</th>
</tr>
</thead>
</table>
| A: Being Exposed        | • Understand the business environment and the dynamics that shape the business and industries it operates in.  
                           | • Understand the business model, its key conversion processes and critical outcomes.  
                           | • Understand the value added by Industrial Engineering Technologists and by other professions in the business. |
| B: Assisting            | • Develop insight and understanding of the different, broadly defined processes and systems in the transformation of inputs into goods and services.  
                           | • Develop an appreciation of the numerous resources at the disposal of the Industrial Engineer.  
                           | • Obtain experience in the day-to-day operations of the business to gain insight and understanding of the different broadly defined processes and systems in the transformation of inputs into goods and services, with specific emphasis on productivity and quality measurements. |
| C: Participating        | • Gain first-hand experience of a broad range of broadly defined industrial engineering activities; for example, process design and re-engineering, planning and control, work study, value engineering, materials and information management, people management skills, logistics, specialists’ inputs, tools and equipment and quality assurance.  
                           | • The problems and limitations of particular broadly defined philosophies, methods and techniques should be noted, with emphasis on cost / effort and relative benefit. |
| D: Contributing         | • Involvement in for example the planning of production, the control of quality and costs of process study and work study and good materials handling and workplace layout, activity-based costing, bench marking, business cases, process re-engineering, maintenance practice and procedures, project |
Level of Responsibility | Activities or duties to be undertaken by the candidate under training
--- | ---
management and system specification all working together in the economic use of people, materials and machines is of particular importance.
- Specific attention should also be given to human aspects concerning communication, interpersonal relationships and teamwork, training and cost analysis, budget control and profit accountability. These should proceed in parallel, applying broadly defined industrial engineering techniques and by utilising computers in problem solving.

E: Performing
- Assume increasing broadly defined technical responsibility and increasingly co-ordinate the work of others.
- Exposure to and development of skill in management areas such as in labour relations, management accounting, business law and general business management are important to develop a fully rounded industrial engineering technologist.
- Assignments that require broadly defined judgment to be made, even when full information is not available leading to a position of professional responsibility is of great value and should be pursued.

7.3 Realities

Generally, irrespective of the discipline, it is unlikely that the period of training will be less than three years, the minimum time ECSA requires post BTech (Eng) or BEng Tech degrees. Typically, it will be longer and would be determined among others by the availability of functions in the actual work situation.

7.4 Considerations for generalists, specialists, researchers and academics

Document R-08-PT 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.

7.5 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.
The Discipline-Specific Training Guide for:

Candidate Engineering Technologist in Industrial Engineering

Revision 2 dated 10 October 2019 and consisting 22 pages reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (RPS).

Business Unit Manager

Date

Executive: RPS

Date

This definitive version of this policy is available on our website.
APPENDIX A: Training elements

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

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

Broadly defined engineering work is usually characterised by the application of novel technology deviating from standard procedures, codes and systems, the deviation verified by research, modelling and/or substantiated design calculations.

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

### 1. Purpose

This standard defines the competence required for registration as a Professional Engineering Technologist. Definitions of terms having particular meaning within this standard is given in text in Appendix B.

### DSTGs

DSTGs give context to the purpose of the Competency Standards. Professional Engineering Technologists operate within the nine disciplines ECSA recognises. Each discipline can be further divided into sub-disciplines and finally into specific workplaces as given 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).

**NOTE:** The training period must be utilised to develop the competence of the trainee towards achieving the standards below at a Responsibility Level E, i.e., Performing. (Refer to 7.1 in the specific DSTG.)

### 2. Demonstration of competence

Competence must be demonstrated within broadly defined engineering activities, defined below, by integrated performance of the outcomes defined in section 3 at the level defined for each outcome. Required contexts and functions may be specified in the applicable DSTGs.

#### Level descriptor:

Broadly defined engineering activities (BDEAs) have several of the following characteristics:

a) Scope of practice area is linked to technologies used and changes by adoption of new technology into current practice

b) Practice area is located within a wider, complex context, requires teamwork, has interfaces with other parties and disciplines

Engineering activities can be divided into (approximately): 5% Complex (Professional Engineers) 5% Broadly Defined (Professional Engineering Technologists) 10% Well-defined (Professional Engineering Technicians) 15% Narrowly Well-defined (Registered Specified Categories) 20% Skilled Workman (Engineering Artisan) 55% Unskilled Workman (Artisan Assistants)

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

#### Level descriptor:

BDEA in the various disciplines are characterised by several or all of:

a) Scope of practice area does not cover the entire field of the discipline (exposure limited to the sub-discipline and specific workplace). Some technologies used are well established and adoption of new technologies needs investigation and evaluation.

b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for advice on complex activities and problems. Broadly defined activities in the sub-discipline needs interfacing with professional engineers, professional technicians, artisans, architects, financial staff, etc. as part of the team.

c) The bulk of the work involves familiar, defined range of resources, including people, money,
c) Involve the use of a variety resources, including people, money, equipment, materials, technologies

d) Require resolution of occasional problems arising from interactions between wide-ranging or conflicting technical, engineering or other issues

e) Are constrained by available technology, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws

f) Have significant risks and consequences in the practice area and in related areas.

**Activities** include but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; manufacture or construction; engineering operations; maintenance; project management; research; development and commercialisation.

equipment, materials, but new technologies are investigated and implemented.

d) Most of the impacts in the sub discipline are on wider issues, but some arise from conflicting technical and engineering issues that have to be addressed by the application of broadly defined non-standard engineering principles.

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 but are not limited to design; planning; investigation and problem resolution; improvement of materials, components, systems or processes; engineering operations; maintenance; project management. For Engineering Technologists, research, development and commercialisation happen more frequently in some disciplines but are seldom encountered in others.

3. Outcomes to be satisfied:

<table>
<thead>
<tr>
<th>Group A: Engineering Problem Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome 1</strong>: Define, investigate and analyse broadly defined engineering problems</td>
</tr>
</tbody>
</table>
| **Responsibility Level E** | Analysis of an engineering problem means the “separation into parts possibly with comment and judgement”. Broadly means “not minute or detailed” and “not kept within narrow limits”.

Broadly defined engineering problems have the following characteristics:

| a) Require coherent and detailed engineering knowledge, | a) Coherent and detailed engineering knowledge for Engineering Technologists means the problem encountered cannot be solved without the combination of all the relevant detail |

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underpinning the technology area; and one or more of:

b) Are ill-posed, under- or over-specified, require identification and interpretation into the technology area.

c) Encompass systems within complex engineering systems; belong to families of problems which are solved in well-accepted but innovative ways; and one or more of:

d) Can be solved by structured analysis techniques;

e) May be partially outside standards and codes;

f) Must provide justification to operate outside;

g) Require information from practice area and sources interfacing with practice area that is complex and incomplete;

h) Involve a variety of issues which may impose conflicting constraints: technical, engineering and interested or affected parties; and one or both of:

i) Require judgement in decision-making in practice area, considering interfaces to other areas;

j) have significant consequences which are important in practice area but may extend more widely.

<table>
<thead>
<tr>
<th>Assessment criteria:</th>
<th>A structured analysis of broadly defined problems typified by the following performances is expected:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Performed or contributed in defining engineering</td>
<td>To perform an engineering task an engineering technologist will typically receive an instruction from a senior person (customer) to do a specific task, and must:</td>
</tr>
</tbody>
</table>

To make very sure that the instruction is complete, clear and within his/her capability and that
problems leading to an agreed definition of the problems to be solved.
1.2 Performed or contributed in investigating engineering problems including collecting, organising and evaluating information.
1.3 Performed or contributed in analysis of engineering problems using conceptualisation, justified assumptions, limitations and evaluation of results.

the person who issued the instruction agrees with his/her interpretation.
1.2 The engineering problem and related information must be segregated from the bulk of the information, investigated and evaluated.
1.3 Ensure that the instruction and information to do the work is fully understood and complete, including engineering theory needed to understand the task and acceptance criteria, and to carry out and/or check calculations. If needed, supplementary information must be gathered, studied and understood. Concepts and assumptions must be justified by engineering theory and calculations, if applicable.

Range statement: The problem may be a design requirement, an applied Research and Development requirement or a problematic situation in an existing component, system or process. The problem is one amenable to solution by technologies known to the candidate. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.

Outcome 2: Design or develop solutions to broadly defined engineering problems.

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

Assessment criteria: This outcome is normally demonstrated after a problem analysis as defined in outcome 1. Working systematically to synthesise a solution to a broadly defined problem, typified by the following performances is expected:
2.1 Designed or developed solutions to broadly defined engineering problems.

After the task received is fully understood and interpreted, a solution to the problem posed can be developed (designed). To synthesise a solution is “the combination of separate parts, elements, substances, etc. into a whole or into a system” by:
2.1 The development (design) of more than one way to solve an engineering task or problem should always be done, including the costing and impact assessment for each alternative. All the alternatives must meet the requirements set out by the instruction received, and the theoretical calculations to support each alternative must be done and submitted as an
2.2 Systematically synthesised solutions and alternative solutions or approaches to the problem by analysing designs against requirements, including costs and impacts on outside parameters. (requirements).

2.3 Drawing up of detailed specification requirements and design documentation for implementation to the satisfaction of the client.

attachment.

2.2 The Engineering Technologist will in some cases not be able to support proposals with the complete theoretical calculation to substantiate every aspect and must in these cases refer his / her alternatives to an engineer for scrutiny and support. The alternatives and alternative recommended must be convincingly detailed to win customer support for the alternative recommended. Selection of alternatives might be based on tenders submitted with alternatives deviating from those specified.

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

Range statement: Solutions are those enabled by the technologies in the candidate’s practice area.

Applying theory to do broadly defined engineering work is mostly done in a way that has been used before, probably developed by engineers in the past, and documented in written procedures, specifications, drawings, models, examples, etc. Engineering Technologists must seek approval of any deviation from these established methods, but also initiate and/or participate in the development and revision of these norms.

Outcome 3: Comprehend and apply the knowledge embodied in widely accepted and applied engineering procedures, processes, systems or methodologies and those specific to the jurisdiction in which he/she practices.

Responsibility Level E

Comprehend means “to understand fully”. The jurisdiction in which an Engineering Technologist practices is given in Clause 4 of the specific DSTG.

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

3.1 Applied engineering principles, practices, technologies, including the application of BTech theory in the practice area.

3.2 Indicated working knowledge of areas of practice that Design work for Engineering Technologists is based on BTech theory and is mostly the utilisation and configuration of manufactured components and selected materials and associated novel technology. Engineering Technologists develop and apply codes and procedures in their design work. Investigation would be on broadly defined be incidents and condition monitoring, and operations mostly on developing and improving engineering systems and operations.

3.1 Calculations at BTech theoretical level confirming the correct application and utilisation of equipment, materials and systems listed in Clause 4 of the specific DSTG must be done on...
Subject: Discipline-specific Training Guideline for Candidate Engineering Technologist in Industrial Engineering

Compiler: MB Mtshali
Approving Officer: EL Nxumalo
Next Review Date: 10/10/2023

interact with practice area to underpin teamwork.

3.3 Applied related knowledge of finance, statutory, safety and management.

broadly defined activities.

3.2 The understanding of broadly defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge, as part of personal contribution within the engineering team.

3.3 The ability to manage the resources within legal and financial constraints must be evident.

Range statement: Applicable knowledge includes:

a) Technological knowledge that is well-established and applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example, established properties of local materials. Emerging technologies are adopted from formulations of others.

b) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork.

c) Jurisdictional knowledge includes legal and regulatory requirements as well as locally relevant codes of practice. As required for practice area, a selection of: law of contract, health and safety, environmental, intellectual property, contract administration, quality management, risk management, maintenance management, regulation, project and construction management.

a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of systems, materials, components and projected customer requirements and expectations. New ideas, materials, components and systems must be investigated, evaluated and applied, accompanied by complex theoretical motivation.

b) In spite of having a working knowledge of interacting disciplines, Engineering Technologists take responsibility for the multidisciplinary team of specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings, Electrical Engineers on communication equipment, etc.

c) Jurisdictional in this instance means “having the authority”, and Engineering Technologists must be aware of and decide on the relevant requirements applicable to each specific project that he/she is responsible for. They are usually appointed as the “responsible person” for specific projects in terms of the OHS Act.
### Group B: Managing Engineering Activities.

#### Outcome 4: Manage part or all of one or more broadly defined engineering activities.

**Assessment criteria:** The candidate is expected to display personal and work process management abilities:

- **4.1** Managed self, people, work priorities, processes and resources in broadly defined engineering work.
- **4.2** Role in planning, organising, leading and controlling broadly defined engineering activities evident.
- **4.3** Knowledge of conditions and operation of contractors and the ability to establish and maintain professional and business relationships evident.

**Responsibility Level D**

Manage means "control".

In engineering operations Engineering Technologists will typically be given the responsibility to carry out projects.

- **4.1** Resources are usually subdivided based on availability and controlled by a work breakdown structure and scheduling to meet deadlines. Quality, safety and environment management are important aspects.
- **4.2** The basic elements of managements must be applied to broadly defined engineering work.
- **4.3** Depending on the project, Engineering Technologists can be the team leader, a team member, or can supervise appointed contractors. To achieve this, maintenance of relationships is important and must be demonstrated.

#### Outcome 5: Communicate clearly with others in the course of his/her broadly defined engineering activities.

**Assessment criteria:** Demonstrates effective communication by:

- **5.1** Ability to write clear, concise, effective technical, legal and editorially correct reports shown.
- **5.2** Ability to issue clear instructions to stakeholders using appropriate language and communication skills evident.
- **5.3** Oral presentations made using structure, style, language, visual aids and supporting documents appropriate to the audience and purpose.

**Responsibility Level C**

- **5.1** Refer to Range Statement for Outcome 4 and 5 below.
- **5.2** Refer to Range Statement for Outcome 4 and 5 below.
- **5.3** Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor.
Range statement for Outcomes 4 and 5: Management and communication in well-defined engineering involves:

a) Planning broadly defined activities
b) Organising broadly defined activities
c) Leading broadly defined activities
d) Controlling broadly defined activities.

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

a) Planning means “the arrangement for doing or using something, considered in advance”.
b) Organising means “put into working order, arrange in a system, make preparations for”.
c) Leading means to “guide the actions and opinions of, influence, persuade”.
d) Controlling means the “means of regulating, restraining, keeping in order, check”.

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<table>
<thead>
<tr>
<th>Group C: Impacts of Engineering Activity</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome 6:</strong> Recognise the foreseeable social, cultural and environmental effects of broadly defined engineering activities generally.</td>
<td><strong>Responsibility Level B</strong></td>
</tr>
<tr>
<td><strong>Assessment criteria:</strong> This outcome is normally displayed in the course of analysis and solution of problems. The candidate typically shows:</td>
<td>Social means “people living in communities; of relations between persons and communities”. Cultural means “all the arts, beliefs, social institutions, etc. characteristic of a community”. Environmental means “surroundings, circumstances, influences”.</td>
</tr>
<tr>
<td>6.1 Ability to identify interested and affected parties and their expectations in regard to interactions between technical, social, cultural and environmental considerations shown.</td>
<td>6.1 Engineering impacts heavily on the environment, e.g. servitudes, expropriation of land, excavation of trenches with associated inconvenience, borrow pits, dust and obstruction, street and other crossings, power dips and interruptions, visual and noise pollution, malfunctions, oil and other leaks, electrocution of human beings, detrimental effect on animals and wild life, dangerous rotating and other machines, demolishing of structures, etc.</td>
</tr>
<tr>
<td>6.2 Measures taken to mitigate the negative effects of engineering activities evident.</td>
<td>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, compensation paid, etc.</td>
</tr>
</tbody>
</table>
Outcome 7: Meet all legal and regulatory requirements and protect the health and safety of persons in the course of his/her broadly defined engineering activities.

<table>
<thead>
<tr>
<th>Responsibility Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 The OHS Act is supplemented by a variety of parliamentary Acts, regulations, local authority by-laws, standards and codes of practice. Places of work might have standard procedures, instructions, drawings and operation and maintenance manuals available. These documents, depending on the situation (emergency, breakdown, etc.) are consulted before work is commenced and during the activity.</td>
</tr>
<tr>
<td>7.2 It is essential to attend a Risk Management (assessment) course, and to investigate and study the materials, components and systems used in the workplace. The Engineering Technologist seeks advice from knowledgeable and experienced specialists if the slightest doubt exist that safety and sustainability cannot be guaranteed.</td>
</tr>
</tbody>
</table>

Assessment criteria:

7.1 Identified applicable legal and regulatory requirements including health and safety requirements for the engineering activity.

7.2 Circumstances stated where applicant assisted in or demonstrated awareness of the selection of safe and sustainable materials, components and systems and have identified risk and applied risk management strategies.

Range statement for Outcomes 6 and 7: Impacts and regulatory requirements include:

a) Requirements include both explicit regulated factors and those that arise in the course of particular work.

b) Impacts considered extend over the lifecycle of the project and include the consequences of the technologies applied.

c) Effects to be considered include direct and indirect, immediate and long-term related to the technology used.

d) Safe and sustainable materials, components and systems.

a) The impacts will vary substantially with the location of the task, e.g. the impact of laying a cable or pipe in the main street of town is entirely different to construction in a rural area. The methods, techniques or procedures differ accordingly and may be complex. It is identified and studied by the Engineering Technologist 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 Technologist is responsible to see that this is done, and if not, establishes which regulations apply, and ensures they are adhered to. Usually the people working on site are strictly controlled w.r.t. health and safety, but the Engineering Technologist checks that this is done, but may authorise unavoidable deviation after setting conditions for such deviations. Projects are mostly carried out where contact with the public cannot be avoided, and safety measures like barricading and warning signs must be used and maintained.
e) Regulatory requirements are explicit for the context in general.

b) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings and moving parts on machinery. The Engineering Technologist needs to identify, analyse and manage any long-term risks and develop strategies to solve these by using alternative technologies.

d) The safe and sustainable materials, components and systems must be selected and prescribed by the Engineering Technologists or other professional specialists must be consulted. It is the responsibility of the Engineering Technologist to use his/her knowledge and experience to confirm that prescriptions by others are correct and safe.

e) Application of regulations associated with the particular aspects of the project must be carefully identified and controlled by the Engineering Technologist.

<table>
<thead>
<tr>
<th>Outcome 8: Conduct engineering activities ethically.</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Responsibility Level E</strong></td>
<td>Ethically means “science of morals; moral soundness”.</td>
</tr>
<tr>
<td></td>
<td>Moral means “moral habits; standards of behaviour; principles of right and wrong”.</td>
</tr>
</tbody>
</table>

**Assessment criteria:** Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by:

8.1 Conversance and operation in compliance with ECSA’s Rules of Conduct for registered persons confirmed.

8.2 How ethical problems and affected parties were identified and the best solution to resolve the problem selected.

8.1 ECSA’s Code of Conduct, as per ECSA’s website, is known and adhered to.

8.2 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc.
<table>
<thead>
<tr>
<th>Outcome 9: Exercise sound judgement in the course of broadly defined engineering activities</th>
<th>Responsibility Level E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment criteria</strong>: Judgement is displayed by the following performance:</td>
<td>Judgement means &quot;good sense: ability to judge&quot;.</td>
</tr>
<tr>
<td>9.1 Judgement exercised in arriving at a conclusion within the application of technologies and their interrelationship to other disciplines and technologies.</td>
<td>9.1 The extent of a project given to a junior Engineering Technologist is characterised by the several broadly defined and a few well-defined factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded.</td>
</tr>
<tr>
<td>9.2 Factors taken into consideration given, bearing in mind risk, consequences in technology application and affected parties.</td>
<td>9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, etc. Evaluation includes engineering calculations to substantiate decisions taken and assumptions made.</td>
</tr>
<tr>
<td><strong>Range statement for Outcomes 8 and 9: Judgement in decision making involves:</strong></td>
<td>In Engineering, about 5% of engineering activities can be classified as broadly defined where the Engineering Technologist uses standard procedures, codes of practice, specifications, etc, but develops variations and completely unique standards when needed. Judgement must be displayed to identify any activity falling inside the broadly defined range, as defined above:</td>
</tr>
<tr>
<td>a) taking several risk factors into account;</td>
<td>a) Getting the work done in spite of numerous risk factors needs good judgement and substantiated decision-making.</td>
</tr>
<tr>
<td>b) significant consequences in technology application and related contexts; or</td>
<td>b) Consequences are part of the project, e.g. extra cost due to unforeseen conditions, incompetent contractors, long-term environmental damage, etc.</td>
</tr>
<tr>
<td>c) ranges of interested and affected parties with widely varying needs.</td>
<td>c) Interested and affected parties with defined needs that may be in conflict, e.g. need for a service irrespective of environmental damage, local traditions and preferences, etc. needs sound management and judgement.</td>
</tr>
</tbody>
</table>
Outcome 10: Be responsible for making decisions on part or all of all of one or more broadly defined engineering activities.

Responsibility Level E

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

Assessment criteria: Responsibility is displayed by the following performance:

10.1 Engineering, social, environment and sustainable development taken into consideration in discharging responsibilities for significant parts of one or more activities.

10.2 Advice sought from a responsible authority on matters outside your area of competence.

10.3 Academic knowledge of at least BTech level combined with past experience used in formulating decisions.

Range statement: Responsibility must be discharged for significant parts of one or more broadly defined engineering activities.

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

Note 1: Demonstrating responsibility would be under supervision of a competent engineering practitioner but is expected to perform as if he/she is in a responsible position.
<table>
<thead>
<tr>
<th>Group E: Initial Professional Development (IPD)</th>
<th>Explanation and Responsibility Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome 11:</strong> Undertake independent learning activities sufficient to maintain and extend his or her competence.</td>
<td><strong>Responsibility Level D</strong></td>
</tr>
<tr>
<td><strong>Assessment criteria:</strong> Self-development managed typically:</td>
<td>11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a programme drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated.</td>
</tr>
<tr>
<td>11.1 Strategy independently adopted to enhance professional development evident.</td>
<td>11.2 Record keeping must not be left to the employer or anybody else. The trainee must manage his/her own training independently, taking initiative and being in charge of experiential development towards Professional Engineering Technologist level.</td>
</tr>
<tr>
<td>11.2 Awareness of philosophy of employer in regard to professional development evident.</td>
<td></td>
</tr>
<tr>
<td><strong>Range statement:</strong> Professional development involves:</td>
<td>a) In most places of work training is seldom organised by some training department. It is up to the Engineering Technologist to manage his/her own experiential development. Engineering Technologists frequently end up in a ‘dead-end street’ being left behind doing repetitive work. If self-development is not self-driven, success is unlikely.</td>
</tr>
<tr>
<td>a) planning own professional development strategy;</td>
<td>b) Preference must be given to <strong>engineering</strong> development rather than developing soft skills.</td>
</tr>
<tr>
<td>b) selecting appropriate professional development activities;</td>
<td>c) Developing a learning culture in the workplace environment of the Engineering Technologist is vital to his / her success. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.</td>
</tr>
<tr>
<td>c) recording professional development strategy and activities, while displaying independent learning ability.</td>
<td></td>
</tr>
</tbody>
</table>