ENSURING THE EXPERTISE TO GROW SOUTH AFRICA

Discipline Specific Training Guide for Registration as a Professional Engineer in Computer Engineering

R-05-COMP-PE

REVISION No. 0: 13 April 2021

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ECSA

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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 that is based on the natural sciences and uses mathematical formulation where necessary, which extends knowledge and develops models and methods to support its application, to solve problems and to provide the knowledge base for engineering specialisations.

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 requires analysis, synthesis, analysis of impacts, checking of regulatory conformance and judgement in decisions.

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

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

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

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

Outcome: A statement of the performance that a person must demonstrate to be judged competent at the *professional* level.

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

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

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

BACKGROUND

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

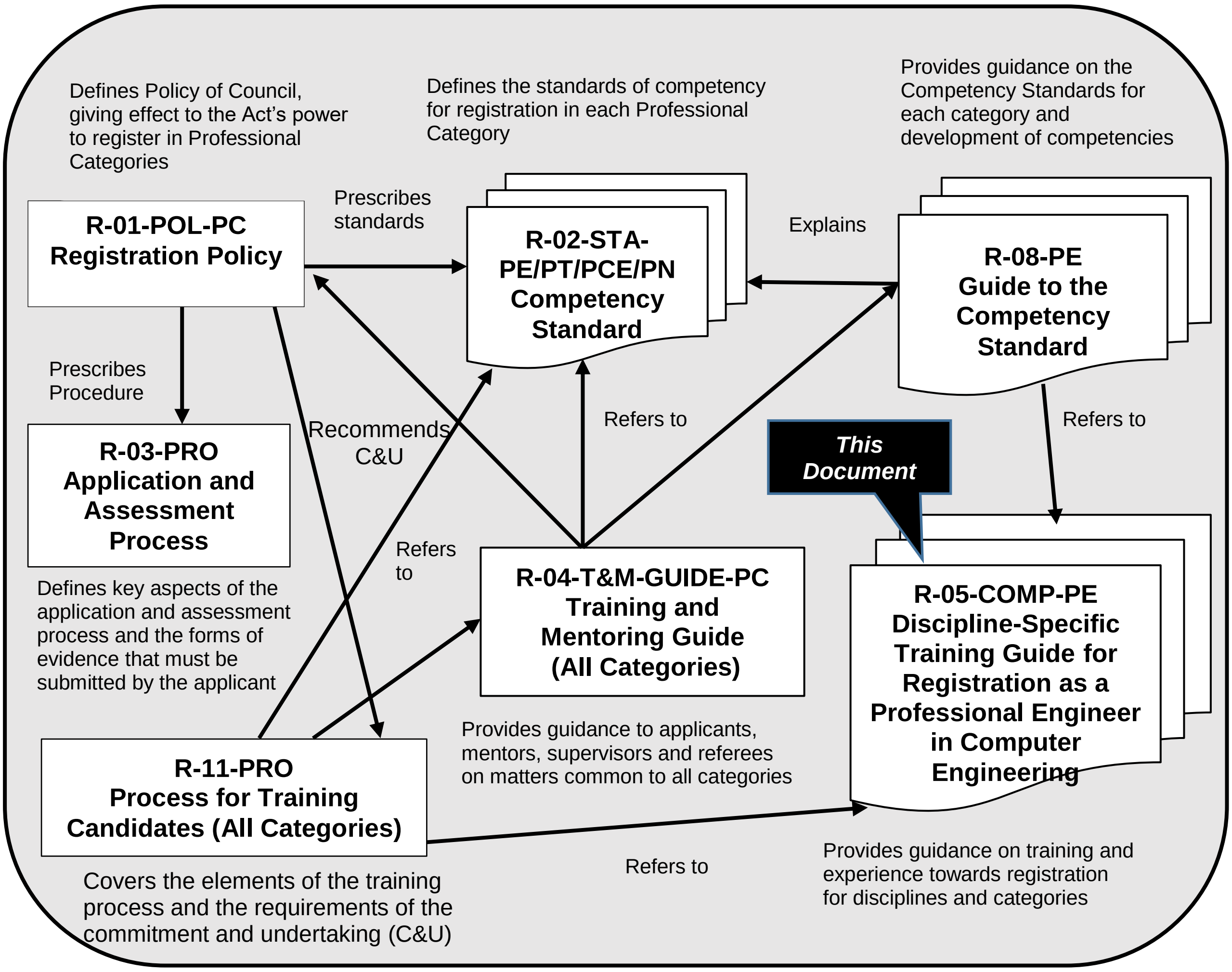

Figure 1: Documents defining the ECSA Registration System

1. PURPOSE OF THIS DOCUMENT

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

The document **R-02-STA-PE/PT/PCE/PN** supplements the generic Training and Mentoring Guide (document **R-04-T&M-GUIDE-PC**) and the Guide to the Competency Standards for Professional Engineers (document **R-08-PE**).

In document **R-04-T&M-GUIDE-PC**, attention is drawn to the following sections:

- Duration of training and period 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 document **R-08-PE** provides a high-level, outcome-by-outcome understanding of the competency standards that form an essential basis for this Discipline-Specific Training Guide (DSTG).

This guide and the documents **R-04-T&M-GUIDE-PC** and **R-08-PE** are subordinate to the Policy on Registration (document **R-01-POL-PC**), the Competency Standard (document **R-02-STA-PE/PT/PCE/PN**) and the application process definition (document **R-03-PRO**).

2. AUDIENCE

The DSTG is directed towards candidates and their supervisors and mentors in the discipline of Computer Engineering, which comprises bio-engineering, computer engineering, control engineering, electronic engineering, power engineering, software engineering, information engineering, telecommunications engineering and others. The guide is intended to support a programme of training and experience through incorporating elements of good practice.

The guide applies to persons who have:

- completed the tertiary educational requirements in Computer Engineering:
    - by obtaining an accredited B.Eng.-type qualification from a recognised tertiary university in South Africa

    - by acquiring an ECSA-accredited qualification or a Washington Accord recognised qualification, or through evaluation
- registered with the ECSA as a Candidate Engineer, and/or
- embarked on a process of acceptable training through a registered Commitment and Undertaking (C&U) programme that is under the supervision of an assigned mentor guiding the professional development process at each stage.

3. PERSONS NOT REGISTERED AS A CANDIDATE AND/OR NOT TRAINED UNDER C&U

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

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

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

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

4. ORGANISING FRAMEWORK FOR OCCUPATIONS

Computer Engineering (Organising Framework for Occupations (OFO) 215102)

Computer Engineers form a collective group of engineers who design, advise, plan, direct, implement, test, maintain and conduct research on computer hardware and software for computer-based systems in electronic, electrical, telecommunications, information technology and other allied fields. Computer Engineers use computer science and electronic engineering knowledge to develop system software and hardware for control, management, performance aiding, monitoring of computing systems, products, components and processes.

Computer Engineers' functions include research, planning, design, development, construction, operation and maintenance of software and firmware for software computing systems, hardware computing systems, embedded microcontrollers, operating systems, data security systems, imaging systems, robotic systems, information technology systems and artificial intelligence systems, among others.

Specialised areas in which Computer Engineers may practice include:

- Computer Engineering (hardware and software)
- Electronic Engineering
- Telecommunication Engineering
- Software Engineering
- Computer Hardware Design Engineering
- Network Engineering
- Data Security Engineering
- Embedded Systems Engineering
- Machine Learning Engineering.

4.1 Computer Engineering (hardware & software)

Computer Engineers conduct research and advise on the design and direct the construction/implementation, maintenance and repair of computer-based systems, software and equipment. Computer Engineers study and advise on the technological aspects of computer- based systems, software, products and processes. Computer Engineers perform system analyses on computer-based systems and software and specify the systems required. Computer Engineers plan, design and monitor computer-based systems, software, networks and associated communication equipment.

A Computer Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- conducting research and developing new or improved theories and methods relating to Computer Systems Engineering
- advising on and designing computer-based systems or components, systems equipment, software and distribution centres
- specifying production or installation methods, specifying materials, quality and safety standards and directing production and installation of computer-based products, software and systems
- supervising, controlling, developing and monitoring the operation and maintenance of computer-based systems, software, networks and equipment
- developing and implementing test procedures for computer-based systems, software, networks, programmes and equipment
- organising and directing the maintenance and repair of existing computer-based systems, programmes and equipment
- researching and advising on computer-based equipment and software
- planning and designing computer-based communication networks based on wired, fibre optic and wireless communication media and ultra-high-speed data networks
- performing system analyses together with designing and developing computer-based systems
- implementing these computer-based systems through appropriate choice of hardware and managing the development of the necessary software
- determining manufacturing methods for computer-based systems, networks and equipment.

Practising Computer Engineers may specialise as one or more of the following:

- Computer System Engineer
- Computer System Design Engineer
- Systems Engineer
- Software Engineer
- Systems Architect.

4.2 Electronic Engineering

Electronic Engineering is a subfield within the wider Electrical Engineering academic subject but denotes a broad engineering field that covers subfields such as analogue electronics, digital electronics, consumer electronics, embedded systems and power electronics. Electronics Engineering deals with the implementation of applications, principles and algorithms that are developed within many related fields, for example, solid-state physics, radio engineering, telecommunications, control systems, signal processing, systems engineering, computer engineering, instrumentation engineering, electric power control and robotics.

Electronic Engineers conduct research and advise on the design and direct the construction, maintenance and repair of electronic systems. Electronics Engineers study and advise on the technological aspects of electronic engineering materials, products and processes.

An Electronic Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- conducting research and developing new or improved theories and methods relating to Electronics Engineering
- advising on and designing electronic devices or components, circuits, semi-conductors and systems
- specifying production or installation methods, materials and quality standards and directing production or installation of electronic products and systems

- supervising, controlling, developing and monitoring the operation and maintenance of electronic equipment and systems
- establishing control standards and procedures to ensure efficient functioning and safety of electronic systems and equipment
- organising and directing the maintenance and repair of existing electronic systems and equipment
- designing electronic circuits and components for use in fields such as aerospace, guidance and propulsion control, acoustics or instruments and controls
- determining manufacturing methods for electronic systems and maintaining and repairing existing electronic systems and equipment
- researching and advising on radar, telemetry and remote-control systems, microwaves and other electronic equipment
- designing and developing signal processing algorithms and implementing these through appropriate choice of hardware and software
- developing apparatus and procedures to test electronic components, circuits and systems
- designing, specifying and implementing Control and Instrumentation of plants and processes
- designing, specifying, controlling and monitoring of equipment for fire detection and safety (safety integrity level – SIL rating) in plants and factories
- controlling robotics and processes of manufacturing plants
- increasing energy efficiency of photovoltaic (PV) cells.

Practising Electronics Engineers may specialise as one or more of the following:

- Communications Engineer (Army)
- Mechatronics Engineer
- Electronic Design Engineer
- Instrumentation Engineer
- Television Engineer
- Biomedical Engineer
- Clinical Engineer
- Aircraft Electronic Systems Engineer

- Electronic Warfare Engineer.

4.3 Telecommunications Engineering

Telecommunications Engineers conduct research and advise on the design and direct the construction, maintenance and repair of telecommunication systems and equipment. Telecommunications Engineers study and advise on the technological aspects of the materials products or processes relating to Telecommunications Engineering. Telecommunications Engineers plan, design and monitor telecommunication networks and associated broadcasting equipment.

A Telecommunications Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- conducting research and developing new or improved theories and methods relating to Telecommunications Engineering
- advising on and designing telecommunication devices or components, systems, equipment and distribution centres
- specifying production or installation methods, materials, quality and safety standards and directing production or installation of telecommunication products and systems
- supervising, controlling, developing and monitoring the operation and maintenance of telecommunication systems, networks and equipment
- determining the manufacturing methods for telecommunication systems and maintaining and repairing existing telecommunication systems, networks and equipment
- organising and directing the maintenance and repair of existing telecommunication systems, networks and equipment
- planning and designing communication networks based on wired, fibre-optic and wireless communication media
- designing and developing signal processing algorithms and implementing these through appropriate choice of hardware and software
- designing telecommunication networks and radio and television distribution systems, including both cable transmission and over-the-air broadcasting.

Practising Telecommunications Engineers may specialise as one or more of the following:

- Broadcast Engineer
- Digital Signal Processing Engineer
- Communications Engineer
- Fibre Optics Engineer
- Radio Frequency Design Engineer
- Radar Engineer
- Radio Engineer
- Radio and Telecommunications Engineer
- Mobile Radio Engineer
- Satellite Transmission Engineer
- Processing and Communications Systems Engineer
- Consulting Communications Engineer
- Specialist Telecommunications (ICT) Engineer
- Consulting Telecommunications Engineer
- Network Planning Engineer
- Microwave Engineer.

4.4 Software Engineering

Software Engineers conduct research and advise on the design and direct the construction, maintenance and repair of software and software systems. Software Engineers study and advise on the technological aspects of software. Software Engineers perform system analyses on software and specify the system requirements. Software Engineers plan, design and monitor software and associated software infrastructure.

A Software Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- conducting research and developing new or improved theories and methods related to Software Engineering
- advising on and design of software systems

- specifying aspects of production or installation methods and quality standards, and directing production or installation work of software and developing and monitoring aspects of the operation and maintenance of computer software and systems
- implementing and improving control standards and procedures to ensure efficient functioning and software
- organising and directing maintenance and repair of existing software
- designing software and software systems
- determining maintenance and repair procedures of existing software and software systems
- performing research and advising on radar, telemetry and remote-control systems, microwaves and other electronic equipment
- developing procedures to test software and software components.

Practising Software Engineers may specialise as one or more of the following:

- Software Design Engineer
- Front-end Software Engineer
- Back-end Software Engineer
- Mobile Software Engineer
- Systems Engineer
- Solutions Architect.

4.5 Computer Hardware Design Engineering

Computer Hardware Design Engineers research, design, develop, implement and test computer systems and components such as processors, circuit boards, computer memory and storage systems, network equipment and graphics acceleration equipment like GPUs. They are also involved in the designing of computers integrated into consumer devices like home appliances, cars and medical devices, to name a few. As technology evolves, these engineers are at the forefront of computer hardware development with the chief aim of improving performance and efficiency to realise the next generation of computer equipment.

A Computer Hardware Design Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- designing, developing and implementing computer hardware
- conducting research and developing new or improved theories and methods related to Computer Hardware Design Engineering
- advising on and design of computer hardware and computer systems
- specifying aspects of production or installation methods and quality standards, and directing production and deployment of computer hardware
- implementing and improving control standards and procedures to ensure efficient functioning of computer systems
- organising and directing maintenance and repair of existing systems
- determining maintenance and repair procedures of existing hardware systems
- developing procedures to test newly developed computer hardware.

Practising Computer Hardware Design Engineers may specialise as one or more of the following:

- Computer Systems Design Engineer
- Integrated Circuit Design Engineer
- Microelectronic Engineer.

4.6 Network Engineering

Network Engineers, also called Network Architects, are responsible for designing, planning, implementing, optimising, maintaining, monitoring and managing computer networks. These networks can be as small as company networks, but usually span across large areas (LANs, WANs and GANs). Network Engineers have comprehensive knowledge of network protocols and services such as TCP/IP, DNS, DHCP and firewalls, and are trained to configure switches, routers and wireless access points. They are able to administrate computer networks and related computing environments including systems software, applications software, hardware, and configurations. They are also able to perform disaster recovery operations and to ensure the protection of data from malicious attacks. They have a strong understanding of network infrastructure and network hardware. They also have superior fault-finding skills of network functions such as security, servers and routing.

A Network Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- conducting research and developing new or improved theories and methods related to Network Engineering
- design, planning and deploying computer networks of any size and on any scale using appropriate technologies, protocols and equipment
- specifying aspects of production or installation methods, and quality standards and directing production or installation work and monitoring aspects of the operation and maintenance of computer networks
- implementing and improving control standards and procedures to ensure efficient functioning of computer networks
- determining, organising and directing procedures for maintenance, repair and upgrading of existing computer networks
- developing procedures to test and troubleshoot computer networks.

Practising Network Engineers may specialise as one or more of the following:

- Network Security Engineer
- Systems Engineer.

4.7 Data Security Engineering

Data Security Engineers conduct research and advise on the design and direct the implementation, maintenance and repair of data security and software systems. Data Security Engineers study and advise on the technological aspects of data security. Data Security Engineers generate and implement secure network solutions that deliver security against cyber-attacks, hackers and so on. They continuously invigilate systems and networks to ensure functionality and try to prevent cyber-crimes.

A Data Security Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- designing, implementing, administering and improving all the security networks as well as systems to safeguard an organisation's complete data
- administering the appraisal of security obligations of an organisation and determine best practices and standards
- conducting research and developing new or improved theories and methods related to Data Security Engineering
- advising on and designing well-defined data security systems
- specifying aspects of production or installation methods and quality standards, and directing well-defined production or installation work of software and developing and monitoring aspects of the operation and maintenance of data security computer software and systems
- implementing and improving control standards and procedures to ensure efficient functioning of data security systems
- organising and directing maintenance and repair of existing software
- designing data security software and software systems
- determining maintenance and repair procedures of existing data security software and software systems
- developing procedures to test data security software and software components
- investigating, responding and collaborating on any security breach within networks and systems
- conducting numerous tests on system vulnerability to evaluate stability as well as troubleshooting of incidents
- managing all communication between departments to ensure functionality.

Practising Data Security Engineers may specialise as one or more of the following:

- Network Engineer
- Data Security Engineer
- Web Security Engineer
- Cyber Security engineer.

4.8 Embedded Systems Engineering

An embedded system is a subsystem of a larger system that contains hardware and software. These computing systems usually contain a number of chips and integrated circuits (ICs) that are programmed to perform a predefined function. An Embedded Systems Engineer is responsible for the research, design, development, production, testing and deployment of embedded systems. They study and advise on the technological aspects of embedded systems to generate and implement solutions that deliver the functionality of embedded software systems. They continuously invigilate systems and networks to ensure optimum functionality.

An Embedded Systems Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- designing, implementing, administering and improving embedded systems
- managing embedded systems in terms of hardware and software
- administering the appraisal of embedded systems in an organisation and determining best practices and standards
- conducting research and developing new or improved theories and methods related to embedded systems
- advising on and designing embedded systems
- specifying aspects of production or installation methods and quality standards, and directing production or installation work of software and developing and monitoring aspects of the operation and maintenance of embedded computer software and hardware systems
- implementing and improving control standards and procedures to ensure efficient functioning of embedded systems
- organising and directing maintenance and repair of existing systems
- determining maintenance and repair procedures of existing embedded systems
- developing procedures to test embedded hardware and software systems.

Practising embedded systems engineers may specialise as one or more of the following:

- Embedded Software Engineer

- Electronic Design Engineer
- Computer Systems Engineer.

4.9 Machine Learning Engineering

Machine Learning is an integral division of Artificial Intelligence (AI). It focuses on the development of algorithms that can autonomously learn from data, identify patterns and apply knowledge towards making decisions. It requires a proficient integration of programming languages, statistics, signal processing techniques, applied mathematics, neural network architectures, cloud applications and artificial intelligence, among other skills. Machine Learning Engineers have to be scientifically knowledgeable on the algorithms and statistical models that computer systems use towards effectively and independently executing a targeted task.

A Machine Learning Engineer may undertake tasks to solve **complex** engineering problems, which may include:

- designing, implementing, administering and improving machine learning systems
- managing machine learning in terms of software
- administering the appraisal of machine learning systems and determining best practices and standards
- conducting research and developing new or improved theories and methods related to machine learning systems
- advising on and design of machine learning systems
- specifying aspects of production or installation methods and quality standards, and directing production or installation work of machine learning software and developing and monitoring aspects of the operation and maintenance of machine learning software systems
- implementing and improving control standards and procedures to ensure efficient functioning of machine learning systems
- organising and directing updating of existing machine learning systems
- developing procedures to test machine learning systems.

Practising Machine Learning Engineers may specialise as one or more of the following:

- Robotics Engineer
- Computer Vision Engineer
- Data Engineer.

5. NATURE AND ORGANISATION OF THE INDUSTRY

5.1 Investigation

Computer Engineers may be employed in either the private or the public sector.

In the private sector, Computer Engineers are typically involved in consulting and contracting or they are employed by manufacturers of equipment or suppliers of services for the engineering sectors. Engineering consultants are concerned with planning, designing, documenting and supervising the construction of projects on behalf of clients. Engineering contractors are responsible for project implementation and their activities include planning, construction and labour and resource management. Computer Engineers working in supply or manufacturing companies are primarily involved in production, supply and quality control but could also be involved in research and development.

The public sector is responsible for service delivery although in some departments, design and construction is also carried out. Computer Engineers are required at all levels of the public sector, including national, provincial and local government level, state-owned enterprises and public utilities. The public sector is largely engaged in planning, specifying and overseeing the implementation, operation and maintenance of computer infrastructure. Extensions of the public sector include tertiary academic institutions and research organisations.

There may be employment situations where the in-house opportunities are insufficiently diverse to develop all the competencies required for the groups noted in the document **R-02-STA-PE/PT/PCE/PN**. For example, opportunities to develop problem-solving competence (designing and developing solutions) and to manage engineering activities (constructing and implementing solutions) may not be available to the Candidate. In such cases, employers are encouraged to establish a secondment system.

It is fairly common practice that should an organisation be unable to provide training in certain areas, secondments are arranged with other organisations so that Candidates are able to develop all the competencies required for registration. These secondments are usually of a reciprocal nature and as a result, both employers and the respective employees mutually benefit. Secondments between consultants and contractors and between the public and private sectors should be made possible.

5.2 Location of training in overall engineering life cycle and functions performed

The area in which Computer Engineers work generally follows the conventional stages of the life cycle of the project, product or process. These stages are as follows:

- Research and development of processes, new products or systems or advancement of solutions to system problems or system obsolescence.
- System or product design to establish a new system or product, solve system or product problems, achieve a particular desired result or select equipment for a particular purpose.
- Operation, maintenance and support of the system, network or product.
- Project Engineering to install, test and commission the necessary equipment or system to achieve the desired result.
- Decommissioning of the system or network.

Candidates are not expected to change their places of employment to work in all the areas listed above. Candidates, however, must ensure that in the area in which they are employed, tasks are undertaken that provide experience in all the generic engineering competencies of problem-solving, implementation and operation, risk and impact mitigation and management of engineering activities.

A schema is presented In the Appendix below that indicates the functions in which a Candidate should be competent when carrying out the various phases of a project:

- solving problems based on engineering and contextual knowledge

- implementing and operating engineering projects, systems, products and processes
- mitigating risk and impact
- managing engineering activities.

Three levels of description are provided. In regard to the third level, the description is largely independent of the discipline. Discipline specifics may be included as fourth and fifth levels as required. These specifics would include the types of evidence of performance that would be appropriate at each line and record-keeping of the evidence.

5.3 Process Design

Process Design, the process followed during the life cycle of a project, must include System Engineering. Candidates must include the cycles in which they have been involved and their contributions.

5.4 Risk and impact mitigation

Risk and impact mitigation must include the probability and impact of all the risks connected with the project. The project focus areas must be indicated on a risk matrix. Mitigation must include the time of mitigation and the person responsible. Solutions should include a Plan A and a Plan B. The risk document must be a live document through the life cycle of a project and must include the following:

- Technical risk
- Environmental risk
- Quality risk
- Commercial risk (late or wrong deliveries of equipment)
- Schedule risk
- Social risk
- Construction risk.

5.5 Implementation/Commissioning

Project Engineers must install, test and commission the necessary equipment or system for the desired result. This process must include all actions taken during construction (quality). This can refer to a project quality plan. During commissioning, Candidates must clearly indicate their contributions. Stated contributions can also refer to the commissioning plan.

5.6 Production

Candidates must state the requirement of the project in terms of delivery. They must refer to the initial production requirements for the project. They must also state whether they obtained results and if they did not, why they were unsuccessful.

5.7 Operation and maintenance

Candidates are required to state the operation requirements of the project. They must also state the percentage of the plant that is available for implementing the project as well as the maintenance philosophy and to substantiate what they have provided.

6. DEVELOPING COMPETENCY: ELABORATING ON SECTIONS IN THE GUIDE RELATING TO COMPETENCY STANDARDS (DOCUMENT R-08-PE)

6.1 Contextual knowledge

Candidates are expected to be aware of the VAs applicable to the Computer Engineering profession and the functions and services rendered by the associations to members.

6.2 Functions performed

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

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

- Judgement and responsibility
- Independent learning.

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

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

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

6.3 Statutory and regulatory requirements

Candidates are expected to have a working knowledge of the following regulations and Acts and how this legislation affects their working environment:

- Engineering Profession Act, 46 of 2000, including the ECSA rules and Code of Conduct
- Occupation Health and Safety Act, 85 of 1993 as amended by Act 181 of 1993 (latest revision used)
- Factory Regulations
- Machinery and Works Regulations
- Labour Relations Act, 66 of 1995
- Environment Conservation Act, 73 of 1989, as amended by Act 52 of 1994 and Act 50 of 2003
- Mine Health and Safety Act, 29 1996
- Industry-specific work instructions and specifications
- SANS applicable specifications.

Other Acts not listed here may also be pertinent to a Candidate's work environment. Candidates will be expected to have a basic knowledge of the applicable Acts.

6.4 Desirable formal learning

The following list of formal learning activities is by no means exhaustive, simply being a sample of useful courses.

- Project Management
- Conditions of Contract \ Value Engineering – NEC, JBCE, etc.
- Standards
- Specifications
- Preparation of specifications
- Negotiation Skills
- Engineering Finance
- Risk Analysis
- Quality Systems
- Occupation Health and Safety
- Discipline-specific courses
- Management
- Report Writing
- Planning Methods
- System Engineering
- Industrial Relations
- Public Speaking.

7. PROGRAMME STRUCTURE AND SEQUENCING

7.1 Best practices

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 the employer assigns to the Candidate.

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

The training programme should be such that the Candidate progresses through the levels of work capability (described in document **R-04-T&M-GUIDE-PC**) to ensure that by the end of the training period, 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.

Value Improved Practices (VIPs) are out-of-the-ordinary practices used to improve cost, schedule and/or reliability of capital construction projects. VIPs are:

- used primarily during front-end-loading
- formal, documented practices involving a repeatable work process
- predominantly facilitated by specialists from outside the project team.

Examples of VIPs include the following:

- Technology selection
- Process simplification
- Classes of facility quality
- Waste minimisation
- Energy optimisation
- Process reliability modelling
- Customisation of standards and specifications
- Predictive maintenance
- Design to capacity
- Value engineering
- Constructability.

7.2 Realities

Document **R-08-PE** adequately describes what is expected of persons whose formative developments have not followed conventional paths, for example, academics, researchers and specialists.

7.3 Generalists, specialists, researchers and academics

The overriding consideration is that irrespective of the route followed, the applicant must provide evidence of competency against the standard.

7.4 Multi-disciplinary exposure

Interface management between various disciplines needs to be formalised. Details of signed-off interface documents among different disciplines are essential.

7.5 Orientation requirements

The following orientation requirements should be undertaken, as indicated in Appendix: Training Elements:

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

7.6 Moving into or changing candidacy training programmes

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

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

REVISION HISTORY

Revision number	Revision date	Revision details	Approved by
Rev. 0: Draft A	29 July 2020	First Draft	Working Group
Rev. 0: Draft B	07 Sept 2020	Final Draft	Working Group
Rev. 0 Draft C	02 October 2020	Review by the Executive	Executive: RPS - EL Nxumalo
Rev. 0 Draft D	15 October 2020	Recommendation for Stakeholder consultation	RPSC
Rev 0 Draft E	02 November 2020	Stakeholder Consultation	RPS & Stakeholder Relations
Rev 0 Draft F	29 January 2021	Review and recommendation for approval.	Executive: RPS - EL Nxumalo
Revision. 0	13 April 2021	Approval	RPSC

The Discipline-specific Training Guide for:

Candidate Professional Engineer in Computer Engineering

Revision 0 dated 13 April 2021 and consisting of 30 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research Policy and Standards **(RPS).**

.... 15/04/2021

Business Unit Manager Date

.... 19/04/2021

Executive: **RPS** Date

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

APPENDIX: TRAINING ELEMENTS

1	**Introduction**
1.1	***Induction programme (typically 1–5 days)***
1.1.1	Company structure
1.1.2	Company policies
1.1.3	Company Code of Conduct
1.1.4	Company safety regulations
1.1.5	Company staff code
1.1.6	Company regulations
	Exposure to Practical Aspects of Engineering (typically 6–12 months) and covers how things are: (Responsibility levels A & B)
1.2.1	(Experience in one or more of these sectors but not all) Manufacturing
1.2.2	Design and development
1.2.3	Manufacturing
1.2.4	Deployment / Verification
1.2.5	Testing
1.2.6	Commissioning
1.2.7	Operation
1.2.8	Maintenance
1.2.9	Fault location
1.2.10	Problem investigation
2	**Design**
2.1	***Experience in design and application of design knowledge (typically 12–18 months) Focus is on planning, design and application (Responsibility level C & D)***
2.1.1	(In one or more of the above sectors) Analysis of data and systems
2.1.2	Planning of networks and systems
2.1.3	System modelling and integration
2.1.4	System design
2.1.5	Network/circuit design
2.1.6	Component/product design

2.1.7	Software design
2.1.8	Research and investigation
2.1.9	Preparation of specifications and associated documentation
2.1.10	Preparation of contract documents and associated documentation
2.1.11	Development of standards
2.1.12	Application of quality systems
2.1.13	Configuration Management
3	**Engineering tasks**
3.1	***Experience in the execution of engineering tasks (rest of training period). Focus should be on projects and project management (Responsibility Level E)***
3.1.1	(Working in one or more of these sectors but not all) Design
3.1.2	Design and development
3.1.3	Manufacturing
3.1.4	Deployment
3.1.5	Installation
3.1.6	Commissioning
3.1.7	Maintenance
3.1.8	Modifications
3.2	***Organising for implementation of 3.1 (Responsibility Level E)***
3.2.1	Manage resources
3.2.2	Optimisation of resources and processes
3.3	***Controlling for implementation or operation of 3.1 (Responsibility Level E)***
3.3.1	Monitor progress and delivery
3.3.2	Monitor quality
3.4	***Completion of 3.1*** (Responsibility Level E)
3.4.1	Commissioning completion
3.4.2	Documentation completion
3.4.3	Documentation handover
3.5	***Maintenance and repair of 3.1***
3.5.1	(Responsibility Level E) Planning and scheduling maintenance
3.5.2	Monitor quality

3.5.3	Oversee maintenance and repair
4	**Risk and impact mitigation**
4.1	***Impact and risk assessments***
4.1.1	(Responsibility Level E)
4.1.2	Risk assessments
4.2	***Regulatory compliance***
4.2.1	(Responsibility Level E) Health and safety
4.2.2	Codes and standards
4.2.3	Legal and regulatory
5	**Managing engineering activities**
5.1	***Self-management***
5.1.1	Manages own activities
5.1.2	Communicates effectively
5.2	***Team environment***
5.2.1	Participates in and contributes to team planning activities
5.2.2	Manages people
5.3	***Professional communication and relationships (networking)***
5.3.1	Establishes and maintains professional and business relationships
5.3.2	Communicates effectively
5.4	***Exercising judgement and taking responsibility***
5.4.1	(Responsibility Level E) Ethical practices
5.4.2	Code of Conduct Exercises sound judgement in the course of complex engineering activities
5.4.3	Is responsible for decision-making in some or all engineering activities
5.5	***Competency development***
5.5.1	Plans own development programme
5.5.2	Constructs initial professional development record