ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*		
Sub Discipline-specific Training Guideline for Civil Laboratory Technical Controller		
Status: Council Approved		
Document : R-05-CLTC -SC	**Concept B**	**16 March 2017**

Background: ECSA Registration System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for registration in specified categories are shown in Figure 1 which also locates the current document.

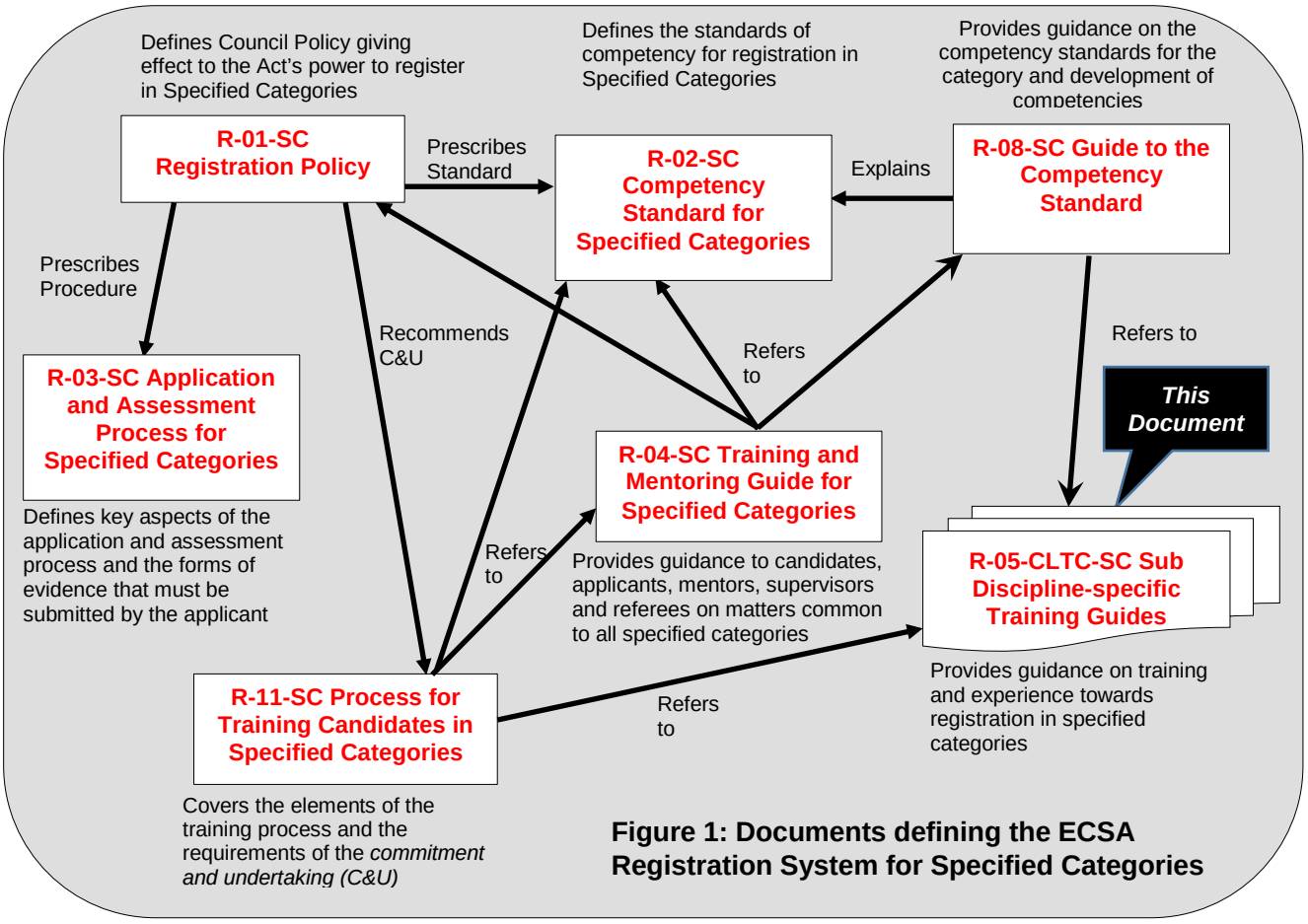

Figure 1: Documents defining the ECSA Registration System for Specified Categories

1. Purpose of this document

All persons applying for registration in the Specified Category for Civil Laboratory Technical Controller (CLTC) are expected to demonstrate the competencies specified in document R-02-SC at the prescribed level, irrespective of the type of materials applicable, through work performed by the applicant at the prescribed level of responsibility.

This document supplements the generic *Training and Mentoring Guide* R-04-SC and *the Guide to the Competency Standards for Registered Specified Category Practitioners*, document R-08-SC.

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

7.3.2 Duration of training and period working at level required for registration
7.3.3 Principles of planning training and experience
7.3.4 Progression of Training programme
7.3.5 Documenting Training and Experience
7.4 Demonstrating responsibility

The second document R-08-SC provides both a high-level and outcome-by-outcome understanding of the competency standards as an essential basis for this discipline-specific guide.

This Guide, as well as R-04-SC and R-08-SC, are subordinate to the Policy on Registration, document R-01-SC, the Competency Standard (R-02-SC) and the application process definition (R-03-SC).

2. Audience

This Guide is directed to candidates and their supervisors and mentors in the discipline of Civil Engineering and Civil Engineering Materials Testing Laboratories. The Guide is intended to support a programme of training and experience incorporating good practice elements.

This guide applies to persons who have:

1. Completed the education requirements by obtaining at least an accredited Higher Certificate (Engineering) type qualification, or through evaluation/ assessment;
2. Registered as Candidate Specified Category;
3. 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 a Candidate or not Training under a C&U

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 Specified Category Practitioner is permitted without being registered as a Candidate Specified Category or without training under a C&U. Mentorship and adequate supervision are however key factors in effective development to the level required for registration. A C&U indicates that the company is committed to mentorship and supervision.

If the trainee's employer has no C&U, the trainee should establish the level of mentorship and supervision the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The recognised Voluntary Association (VA) for the sub discipline should be consulted for assistance in locating an external mentor.

A mentor should be in place at all stages of the development process.

This guide is 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.

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

4. Civil Engineering Materials Testing and Analysis

Registered *Civil Laboratory Technical Controllers (CLTCs)* conduct tests on civil engineering construction materials, interpret, analyse and ensure validity of the test results.

The materials included in the Civil Engineering Materials Laboratory testing for example Soils, Gravels, Bitumen, Concrete, Asphalt, Cement, Geotechnical samples to name a few.

Each material type has a range of properties that is determined in a laboratory through various tests. The interrelation of the various properties and the manifestation there of on the results from various tests need to be evaluated and analysed. The Registered CLTC will evaluate and analyse the accuracy and relevance of the test results relative to the actual materials tested.

Some of the obvious advantages are:

- The registered CLTC would proactively investigate test reports and ensure correctness of results used by engineering professionals.
- A registered CLTC could offer trustworthy constructive advice or service to the industry within his or her field of competence.
- The registered CLTC must remain abreast of new development by Continuing Professional Development (CPD).
- Easy access to the CLTCs via known details could involve them in assisting with standard and regulation development.
- Registered CLTCs will receive recognition from industry.

5. Manager ability and competences

Registered *Civil Laboratory Technical Controllers (CLTCs)* shall be able to perform Laboratory Management production planning, liaison with clients, signing reports, implementation of quality control system.

6. Training Implications of the Nature and Organisation of the Industry

CLTCs may be employed in both the private and public sector.

Typically in the private sector they would be involved in laboratories providing services and materials to contractors, or in consulting engineering organisations. Civil Engineering Consultancies are generally appointed to develop and design civil works, for which materials investigations are conducted by laboratories. The CLTCs will conduct the investigation on site and conduct field testing. The Civil Engineering Contractor constructs the civil works in accordance with prescribed designs and materials' standards. The laboratory issues test results to which engineering professionals verify that the materials used in the construction meets the specifications. The CLTC issues the acceptance control results for the materials tested.

The public sector is responsible for service delivery and is usually the client; although in some departments construction is also performed. *CLTCs* are required at all levels of the public sector, including at national, provincial and local government level, state owned enterprises, and public utilities. *CLTCs* in the public sector largely handle the overseeing of implementation, operations and maintenance of infrastructure in government laboratories.

An extension of the public sector would include tertiary academic institutions and research organisations.

Interrelations of Specific Materials Types Recognised for Registration as a Civil Laboratory Technical Controller

Depending on the nature of business of each employer, Candidate *CLTCs* will select one or more of the materials type for the purpose of registration as a *CLTC*. The materials types and a number of interrelated properties for each type are given in **Appendix A**.

Ability to Provide Complete Training

Depending on where the candidate is employed, there may be situations where the opportunities in-house are not sufficiently diverse to develop all the competencies required in all the groups noted in document R-02-SC and in **Appendix B**. For example, the opportunity for developing problem solving competence (including design or developing solutions) and for managing engineering activities (including implementing or constructing solutions) may not both be available to the candidate. In such cases employers are encouraged to put a secondment system in place.

It has been fairly common practice that where an organisation is not able to provide training in certain areas that secondments are arranged with other organisations, so that the candidate is able to develop all the competencies required for registration. These secondments are usually of a reciprocal nature so both employers and their respective employees get the mutual benefit from the other party. Secondments between commercial and supplier's laboratories and between the public and private sector should be possible.

Problem solving is the essence of engineering. It is a logical thinking process that requires *CLTCs* to apply their minds diligently in bringing solutions to technically

specifically-defined problems.

This process involves the analysis of materials results, and integration of various elements in civil (materials) engineering as applied to materials investigations and construction control testing through the application of basic and engineering sciences.

The problem solving experience may be obtained in any of the following work categories:

6.1 Design or Development

Examples of acceptable design or development include, but are not limited to:

- Development of concrete mix designs with materials evaluated and analysed.
- Development of asphalt mix designs with materials evaluated and analysed.
- Development of soil stabilisation or modification mix designs with materials evaluated and analysed.
- Development of spray seal and slurry mix designs with materials evaluated and analysed

6.2 Operations

This would deal with both investigating and testing of materials in existing civil structures and from various sources for construction. The process and acceptance/quality control testing on material in the construction industry would also form part of the operations in which the Candidate CLTC will partake.

The C*LTCs* must, in performing the abovementioned work, apply engineering judgment to all work he or she does in the management of operations. This may include the ability to assess materials designs against set criteria.

6.3 Research and Development

This type of work may be performed in research and product development centres of business organizations or at the academic institutions. Candidate CLTCs must participate in research and development work that is predominantly of civil engineering nature, and this work must include application of the various aspects of materials engineering, including product or system testing under controlled experimental conditions.

7. Developing competency: Elaborating on sections in the Guide to the Competency Standard (R-08-SC)

Applicants are required to demonstrate the insight and ability to use and interface various aspects through verifiable performance in providing engineered solutions to practical specifically-defined problems experienced in their operating work environment. In addition applicants must develop the skills required to demonstrate the use of applicable engineering knowledge in optimizing the efficiency of operations.

Candidate CLTCs must be able to demonstrate that they have been actively involved in an civil engineering materials testing laboratory environment participating in the execution of practical work such that they have learnt sufficient details on basic

materials engineering to be able to exercise judgment in the workplace thereafter.

What is a sufficiently specifically-defined engineering problem?

We can summarise the definition of *specifically-defined* in *specifically-defined engineering problems* as follows:

"Composed of ***inter-related conditions***; requiring ***underpinning methods, procedures and techniques judgment*** to create a solution within a set of s***pecifically-defined*** **conditions"**

The design or development is a logical thinking process that requires *CLTCs* to apply their minds carefully in bringing solutions to specifically-defined problems. This process involves the analysis of various materials components, and integration of various elements in engineering through the application of basic and engineering sciences.

Simple, straightforward calculation exercises and graphical representations from computer generated data are considered as sufficiently specifically-defined engineering design or development.

As part of demonstrating the application of theoretical knowledge, applicants must incorporate calculations with clearly defined inputs to the formulae used and detailed interpretation of the results obtained. They have to demonstrate how the calculated results have been used to provide the solution to the problem at hand, and the economic benefit to the project or the operating work environment.

Candidate *CLTC* must obtain experience in solving a variety of problems in their work environment, and the solution to these problems should also involve the use of fundamental engineering knowledge obtained through an accredited engineering programme. The problems that require scientific and engineering approach in solving them may be encountered in work required to be done in Civil Engineering Materials Testing Laboratories. From their early training years, candidates must actively seek opportunities to obtain experience in the area of synthesizing solutions to real life engineering problems encountered at the workplace in Civil Engineering Materials Testing Laboratories.

A suitable period of time and degree of practical participation should be sought in the laboratory environment learning the basic practices that are the essence of the civil (materials) discipline so that the Candidate CLTC's are capable of judging the efficacies of such practices in the general workplace thereafter.

7.1 Contextual Knowledge

Candidates are expected to be aware of the requirements of the engineering profession. The recognised Voluntary Association applicable to the *CLTCs* and their functions and services to members, for example, provide a broad range of contextual knowledge for the Candidate *CLTC* through the full career path of the Registered *CLTC*.

The practice area of CLTC's identifies specific contextual activities that are considered an essential component of the development of competence of the *CLTC*.

These include awareness of basic laboratory and construction activities and the competencies required of the engineer, technologist, technician, *CLTC* and Materials Tester. Exposure to practice in these areas will be identified in each programme within the employer environment.

ECSA's Registration Committee for Specified Categories with its discipline-specific assessing committee on Civil Engineering Materials Testing Laboratories performs the review of the Candidate's CLTC's portfolio of evidence at the completion of the training period.

7.2 Functions Performed

Special considerations in the Civil Engineering Materials Testing Laboratories group must be given to the competencies specified in the following groups:

A Knowledge based problem solving
B Management and Communication
C Identifying and mitigating the impacts of engineering activity
D Judgement and responsibility
E Independent learning
F Materials Testing Sub Discipline-Specific Requirements

It is very useful to measure the progression of the candidate's competency by making use of the Degree of Responsibility scales as specified in R-04-P, Table 4 and in clause 7.1 below.

Appendix B has been developed to align the CLTC's progression with the Degree of Responsibility Scale

It should be noted that the Candidate CLTC working at Responsibility level E carries the responsibility for work thus performed appropriate to that of a registered person except that the Candidate CLTC's supervisor is accountable for the Candidates recommendations and decisions.

7.3 Industry-related statutory and other requirements

Candidates are expected to have a working knowledge of the following regulations, Acts and standards, and how they affect their working environment:

- OHS Act – Occupation Health and Safety Act, 1993 (Act No. 85 of 1993), as amended by Act No. 181 of 1993.
- Environment Conservation Act, 1989 (Act No. 73 of 1989), as amended by Act No. 52 of 1994 and Act No. 50 of 2003.
- Labour Relations Act
- Industry specific work instructions.
- SANS and other international standards such as ISO, EN, DIN or US Federal Standards. Also refer to **Appendix A**.

Many other Acts not listed here may also be pertinent to a Candidate CLTC's work

environment. Candidate CLTC s will be expected to have a basic knowledge of the applicable Acts and to investigate whether any Acts are applicable to a particular work environment.

7.4 Recommended Formal Learning Activities

The following list of formal learning is a sample of some useful course types:

- CPD courses on specific disciplines and equipment types
- Elementary Project Management
- Negotiation Skills
- Risk Analysis
- Quality Systems
- Occupation Health and Safety
- Maintenance Engineering
- Environmental Impacts
- Report writing and communication
- Planning methods

8. Programme Structure and Sequencing

8.1 Best Practice

There is no ideal training programme structure or a unique sequencing that constitutes best practice. The training programme for each Candidate CLTC will depend on the work opportunities available at the time for the employer to assign to the candidate

It is suggested that the Candidate CTLC works with their mentors to select appropriate equipment to gain exposure to eventual responsibility for inspection and testing of materials.

The training programme should be such that Candidate CLTC progresses through levels of work capability, which is described in 7.3.4 of R-04-P, such that by the end of the training period, the Candidate CLTC must perform individually and as a team member meeting the engineering outcomes as well as the discipline-specific requirements at the level required for registration and exhibit degree of responsibility E.

The nature of work and degrees of responsibility defined in document R-04-P, Table 4, are used here (and in **Appendix B** below)**:**

A: Being Exposed	B: Assisting	C: Participating	D: Contributing	E: Performing
Undergoes induction, observes processes, work of competent practitioners.	Performs specific processes, under close supervision.	Performs specific processes as directed with limited supervision.	Performs specific work with detailed approval of work outputs.	Works in team without supervision, recommends work outputs, responsible but not accountable
Responsible to supervisor	Limited responsibility for work output	Full responsibility for supervised work	Full responsibility to supervisor for immediate quality of work	Level of responsibility to supervisor is appropriate to a registered person,

				supervisor is accountable for applicant's decisions

The Mentor and the Candidate CLTC must identify at which level of responsibility an activity provides the compliance with and demonstration of the various Outcomes. The evidence of the candidate's activities will be recorded on the appropriate system such that it meets the requirements of the Training Elements, **Appendix B**. ECSA will specify the applicable recording system in the Application for Registration form (Usually an Engineering Report with the associated Inspection and Test Report).

8.2 Orientation requirements

Including but not limited to:

- Introduction to Company
- Company Safety Regulations
- Company Code of Conduct
- Company Staff Code and Regulations
- Company records and record keeping
- Typical functions and activities
- Quality Management System

8.3 Realities

It is unlikely that the period of training will be only three years, the minimum time required by ECSA, irrespective of the materials type(s). Typically, it will be longer and would be determined amongst others by the availability of functions in the actual work situation.

Each candidate will effectively undertake a unique programme where the various activities carried out at the discipline-specific level are then linked to the generic competency requirements of R-08-SC and the **Compulsory Discipline-specific Requirements to be met during the Candidacy**.

8.4 Considerations for generalists, specialists, researchers and academics

Section 10 of document R-08-SC adequately describes what would be expected of persons whose formative development has not followed a conventional path, for example academics, researchers, specialists and those who have not followed a candidate training programme.

The overriding consideration is that, irrespective of the route followed, the applicant must provide evidence of competence against the standard and the **Discipline-specific Requirements**.

8.5 Moving into or Changing Candidacy Programmes

This Guide assumes that the Candidate CLTC enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the Candidate CLTC is supervised and mentored by persons who meet the requirements in document R-04-SC section 7.2.

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 be completed:

- The Candidate CLTC must complete the Training and Experience Summary (TES) and Training and Experience Reports (TER) for the previous programme or unstructured experience. In the latter case it is important to reconstruct the experience as accurately as possible. The TERs must be signed off.
- On entering the new programme, the Mentor and Supervisor should review the Candidate CLTC's development in the light of the past experience and opportunities and requirements of the new programme and plan at least the next phase of the candidate's programme.
- The Candidate CLTC must complete the Discipline-Specific Requirements Report (DSRR) on elements already covered during the first part of the candidacy.

8.6 Compulsory Discipline-specific Requirements to be met during the Candidacy

The Candidate assisted by Mentors and Supervisors must during candidacy ensure that he or she is conversant with the practical knowledge set out in the following table, and submit evidence as such in a form of a Discipline-Specific Requirements Report (DSRR), which forms part of the Application for Registration form.

Discipline-Specific Requirements Report **Form R-05-DSRR-CLTC (2016-07-01)**

Surname and Initials:

Use this form to report in about 100 words per statement under Requirements 1 to 5 below on the applicant's personal knowledge about the requirements. Attach to this report the actual work schedule and load test report for each equipment type (listed on page 1 of the Engineering Report. Form R-03-ER-SC) applied for, done by the applicant under the supervision of a registered CLTC.

DISCIPLINE-SPECIFIC KNOWLEDGE REQUIREMENTS:		
There is a critical need in the industry to identify people who are able to conduct the essential operations associated with analysis and issuing of Civil Laboratory Test Results. This will lead to competence in the field of work and thereby add value to the industry and improve the economy of the country. It will also lead to a balanced society in that learners will understand how the work they do fits into the greater engineering industry.		
1.	**Communicate at work**	
1.1	Oral communication is maintained and adapted as required to promote effective interaction in a work context.	
1.2	Information is accessed from standing instructions, visual information and a range of other workplace texts and responses where required are appropriate to the context.	
1.3	Written communication is clear and unambiguous and at an appropriate level for designated target audiences.	
2.	**Use mathematics and statistics in real life situations**	
2.1	Mathematical functions are used correctly to solve routine workplace problems and tasks.	
2.2	Findings on life related problems are interrogated in terms of their cause and solution.	
2.3	Mathematical techniques are effectively and accurately applied in real life situations.	
3.	**Interpolate Materials Properties from Test Result**	
3.1	Establish the requirement for retest of certain properties' tests.	
3.2	Issue and sign valid results.	
3.3	Provide estimation of Materials Properties' values based on related test results.	
4.	**Take responsibility for the Implementation of Quality Assurance for a Test Result**	
4.1	Inspections comply with laboratory best practice requirements.	
4.2	Understanding of the relevant OHS and SANS requirements is demonstrated.	
4.3	Unsafe conditions are identified and corrective actions are taken.	
4.4	Access to workplace is limited to involved personnel only.	
4.5	Test results are linked to established QA procedures and test methods.	
5.	**Produce and maintain administrative reports**	
5.1	Reports are generated, stored and retrieved.	
5.2	Different paths are used for obtaining information for schedules.	
5.4	Corrective action is implemented to improve quality of project work.	
5.5	Reports are used in providing administrative and financial control of the business.	
6.	**Manage Laboratory output**	
6.1	Tasks are prioritised to meet testing timeframes and specific requirements.	
6.2	Analyses of work requirements are compared with relevant business plans and microenvironment.	
6.3	Potential risks that may affect laboratory performance are recognised and appropriate actions are taken.	
6.4	Legislation that may impact on the work environment is identified and actions are taken to direct work activities to comply with the legislation.	
6.5	Requirements are ordered and procured in advance of being required.	

APPENDIX A:

EXAMPLES OF INTERRELATIONS OF SPECIFIC MATERIALS TYPES RECOGNISED FOR REGISTRATION AS A CIVIL LABORATORY TECHNICAL CONTROLLER

No.	Description of Interrelationships	Material Type
1.	Plasticity Index & Swell	Soils & Gravels
2.	Compressive Strength & Force & Sample Area	Concrete
3.	Compressive Strength & Curing Time & Curing Temperature	Concrete
4.	Aggregate Grading & Aggregate Flakiness	Aggregate
5.	Density & Saturation & Bearing Strength	Soils & Gravels
6.	Bitumen Content & Grading & Voids in Mix	Asphalt
7.	Viscosity & Temperature	Bitumen
8.	Compressive Strength & Stabilised Content & Sample Density	Soils & Gravels
9.	Grading & Grading Modulus & Fineness Modulus	Aggregate, Soils & Gravels
10.	Density & Moisture & Nuclear Density Gauge Correction	Asphalt, Soils & Gravel

Training Elements

This guide is written for the recent graduate who is training and gaining experience toward registration ("Benchmark Route"). Mature applicants for registration ("Alternative Route") may apply the guide retrospectively to identify possible gaps in their development

Synopsis: A candidate specified category practitioner should achieve specific competencies at the prescribed level during his/her development towards 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 to all engineering work performed after 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 approaches to do the work: 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 completed;**
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; and**
11. **Become conversant with your employer's training and development program and develop your own lifelong development program within this framework.**

Specifically-defined engineering work is usually restricted to applying standard procedures, codes and systems, i.e. work that was done before within the narrow field of application.

Responsibility Levels: A = Being Exposed; B = Assisting; C = Participating; D = Contributing; E = Performing.

Competency Standards for Registration as a Specified Category Practitioner	Explanation and Responsibility Level
1. Purpose This standard defines the competence required for registration as a Specified Category Practitioner. Definitions of terms having particular meaning within this standard are given in text at the end of this Annexure and in document R-01-SC.	Discipline Specific Training Guides (DSTG) gives context to the purpose of the Competency Standards. Registered Specified Category Practitioner operate within the nine disciplines recognised by ECSA. Each discipline can be further divided into sub-disciplines and finally into specific workplaces or competency areas DSTG's 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 R-04-SC, Table 4)
2. Demonstration of Competence Competence must be demonstrated within ***specifically-defined engineering activities,*** defined below, by integrated performance of the outcomes defined in section 3 below at the level defined for each outcome. Required contexts and functions may be specified in the applicable Discipline Specific Training Guidelines.	Engineering activities can be divided into (approximately): 5% Complex (Professional Engineers) 5% Broadly Defined (Professional Engineering Technologists) 10% Well-defined (Professional Engineering Technicians) 15% Specifically-defined (Registered Specified Categories) 20% Skilled Workman (Engineering Artisan) 45% Unskilled Workman (Artisan Assistants) The activities can be in-house or contracted out; evidence of integrated performance can be submitted irrespective of the situation.
Level Descriptor: ***Specifically-defined engineering activities have*** several of the following characteristics: a) Scope of specific practice area is defined by specific techniques applied; change by adopting new specific techniques into current practice; b) Practice area is located within a wider, complex *context,* with specifically-defined working relationships with other parties and disciplines; c) Work involves specific familiar *resources,* including people, money, equipment, materials, technologies; d) Require resolution of *interactions* manifested between specific technical factors with limited impact on wider issues; e) Are *constrained* by operational context, defined work package, time, finance, infrastructure, resources, facilities, standards and codes, applicable laws; f) Have *risks* and *consequences* that are locally important but are specifically defined.	**Level Descriptor:** ***Specifically-defined engineering activities*** in the specific discipline is characterised by several or all of: a) *Scope* of practice area does not cover the entire field of the specific discipline (exposure limited to the relevant components of the specific-discipline and specific workplace). Techniques applied are largely well established and change by adopting new specific techniques into current practice is the exception; b) Practice area varies substantially with unlimited location possibilities and an additional responsibility to identify the need for *complex, broadly defined and/or well-defined* advice to be included in the specifically-defined working relationships with other parties and disciplines; c) The bulk of the work involves familiar, defined range of *resources,* including people, money, equipment, materials, technologies; d) Most of the impacts in the specific discipline are on wider issues, and although occurring frequently, are *specifically-defined* and can be resolved by following established procedures. e) The work packages and associated parameters are *constrained* by operational context with variations limited to different locations only. (Cannot be covered by laws, standards and codes only). f) Even locally important minor risks can have far reaching consequences.
Activities include but are not limited to: planning; investigation and problem resolution; improvement of materials, components, systems or processes, engineering operations, maintenance, project management, development and commercialisation.	***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 and general management. For Specifies Category Practitioners, research, development and commercialisation happen more frequently in some disciplines and are seldom encountered in others.

3. Outcomes to be satisfied:	Explanation and Responsibility Level
Group A: Engineering Problem Solving.	
Outcome 1: Define, investigate and analyse specifically-defined engineering problems (tasks)	**Responsibility level E** Analysis of an engineering problem means the "separation into parts possibly with comment and judgement".
Level Descriptor: ***Specifically-defined engineering <u>problems</u> have the following characteristics****:* (a) can be solved mainly by specific practical engineering knowledge, underpinned by related theory; ***and one or more of:*** (b) are fully defined but require feedback; (c) are discrete, specifically focused tasks within engineering systems; (d) are routine, frequently encountered and in familiar specified context; ***and one or more of:*** (e) can be solved by standardized or prescribed ways; (f) are encompassed by specific standards, codes and documented procedures; requires authorization to work outside limits; (g) information is concrete, specific and largely complete, but requires checking and possible supplementation; (h) involve specific issues but few of these imposing conflicting constraints and a specific range of interested and affected parties; ***and one or both of:*** (i) requires practical judgement in specific practice area in evaluating solutions, considering interfaces to other role-players; (j) have consequences which are locally important but within a specified category (wider impact are dealt with by others).	(a) practical problems for Specified Category Practitioners means the problem encountered cannot be solved by artisans because theoretical calculations and engineering decisions are necessary to substantiate the solution proposed; (b) further investigation to identify the nature of the problem is seldom necessary; (c) discrete means *individually distinct*: The problem is easily recognised as part of the larger engineering task, project or operation; (d) recognised that the problem is within the specific scope and occurred in the past or the work to be done is a standard operation – seldom something new; (e) solving the problem does not require the development of a new solution – find out how it was solved/done before; (f) encompassed means *encircled:* The standards, codes and documented procedures must be obtained to solve the problem and ; authorisation from Professionals responsible must be obtained to wave the stipulations; (g) the responsibility lies with the Specified Category Practitioner to check that the information received as part of the instruction is correct, and added to as is necessary to ensure the correct and complete execution of the work; (h) the problem handled by an Specified Category Practitioner must be limited to well know specific matters needing standardised solutions without possible complications; (i) practical solutions to problems include knowledge of the skills displayed by Practical Specialists and Engineering Artisans without sacrificing theoretical engineering principles and / or cutting corners to satisfy parties involved; (j) Specified Category Practitioners must realise that their engineering actions might seem to be of local importance only, but may develop into further problems where support from Engineering Professionals might be needed to deal with these consequences.
Competency Indicators: A structured analysis of specifically-defined problems typified by the following performances within the competency area is expected: 1.1 State how <u>you</u> interpreted the work instruction received, checking with your client or supervisor if your interpretation is correct 1.2 Describe how <u>you</u> analysed, obtained and evaluated further clarifying information, and if the instruction was revised as a result.	To perform an engineering task an Specified Category Practitioner will typically receive an instruction from a senior person (customer) to do this task, and must: 1.1 Make very sure that the instruction is complete, clear and within his/her capability and that the person who issued the instruction agrees with his/her interpretation. 1.2 Ensure that the instruction and information to do the work is fully understood and is complete, including the engineering theory needed to understand the task and to carry out and/or check calculations, and the acceptance criteria. If needed supplementary information must be gathered, studied and understood.
Range Statement: The problem (task) may be part of a larger engineering activity or may be stand alone. The design (planning) problem is amenable to solution by specific techniques practiced regularly. This outcome is concerned with the understanding of a problem: Outcome 2 is concerned with the solution.	**Please refer to clauses 4 to 7 of the applicable Discipline Specific Training Guide, document R-05-nnn-SC**

Outcome 2: Design or develop (plan) sustainable solutions to specifically-defined engineering problems (tasks).	**Responsibility level C** 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".
Competency Indicators: This outcome is normally demonstrated after a problem analysis as defined in outcome 1. Working systematically to synthesise a solution to a well-defined problem, typified by the following performances is expected: 2.1 Describe how <u>you</u> designed or developed and analysed alternative approaches to do the work. Impacts and sustainability checked. Calculations attached 2.2 State what the final solution to perform the work was, client or your supervisor in agreement	The task given must be fully understood and interpreted; solutions developed (designed) to execute. To synthesise a solution means "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 do an engineering task or solve a 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 <u>the theoretical calculations to support each alternative must be done and submitted as an attachment</u>. The alternatives must be within the legal boundaries imposed. 2.2 The Specified Category Practitioner 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 a Professional 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 submitted deviating from those specified.
Range Statement: The solution conforms to specific established methods, techniques or procedures within the specifically-defined competency area. Engineering should not look only to decrease impacts, but also to restore and regenerate through design.	Applying theory to *specifically-defined engineering* work is done in a way that's been used before, probably developed by Professionals in the past, and documented in written procedures, specifications, drawings, models, examples, etc. Specified Category Practitioners must seek approval and engineering verification for any deviation from these established methods.
Outcome 3: Comprehend and apply knowledge embodied in established specific engineering practices and knowledge specific to the field in which he/she practices.	**Responsibility level E** Comprehend means "to understand fully". The jurisdiction in which a Specified Category Practitioner practices is given in **Clauses 4 to 7 of the applicable Discipline Specific Training Guide, document R-05-nnn-SC**
Competency Indicators: This outcome is normally demonstrated in the course of design, investigation or operations, confined to the competency area. 3.1 State what HCert level <u>engineering standard procedures and systems you</u> used to execute the work, and how HCert level theory was applied to understand and/or verify these procedures; 3.2 Give <u>your</u> own HCert level theoretical calculations and/or reasoning on why the application of this theory is considered to be correct (Actual examples).	Design (development) work for Specified Category Practitioners is mostly to utilise, configure, certify, test, verify, etc. manufactured components or proven engineering or management systems, and repetitive design (development) work using an existing design (development) as an example. Specified Category Practitioners apply existing codes, policies and procedures in their design (development) work. Investigations on specifically-defined incidents and condition monitoring and operations mostly on controlling, maintaining and improving engineering systems and operations. 3.1 The understanding of specifically-defined procedures and techniques must be based on fundamental mathematical, scientific and engineering knowledge. Specific procedures and techniques applied to do the work accompanied by the underpinning theory must be given. 3.2 Calculations confirming the correct application and utilisation of equipment and/or systems listed in the Discipline Specific Training Guide R-05-nnn-SC must be done on practical *specifically-defined* activities. Reference must be made to standards and procedures used and how it was derived from H Cert level theory.
Range Statement: Applicable knowledge includes: (a) Technical knowledge that is applicable to the practice area irrespective of location, supplemented by locally relevant knowledge, for example established properties of local materials. (b) A working knowledge of interacting disciplines confined to the competency area. Codified knowledge in related areas: financial, statutory, safety, management and sustainability. (c) Jurisdictional knowledge includes legal and regulatory requirements as well as prescribed codes of practice.	(a) The specific location of a task to be executed is the most important determining factor in the layout design and utilisation of equipment and/or systems. A combination of educational knowledge and practical experience must be used to substantiate decisions taken including a comprehensive study of laws, policies, procedures, standards, environment, manpower, materials, components and projected customer requirements and expectations. (b) In spite of having a working knowledge of interacting disciplines, Specified Category Practitioners must appreciate the importance of working with specialists like Civil Engineers on structures and roads, Mechanical Engineers on fire protection equipment, Architects on buildings, Electrical Engineers on communication equipment, etc. The codified knowledge in the related areas means working to and understanding the requirements set out by specialists in the areas mentioned. (c) Jurisdictional in this instance means "having the authority", and Specified Category Practitioners must adhere to the terms and conditions associated with each task undertaken. They may even be appointed as the "responsible person" for specific duties in terms of the OHS Act.

Group B: Managing Engineering Activities.	Explanation and Responsibility Level
Outcome 4: Manage part or all of one or more *specifically-defined* engineering activities.	**Responsibility level E** Manage means "control".
Competency Indicators: The display of personal and work process management abilities within the competency area is expected: 4.1 State how <u>you</u> managed yourself, priorities, processes and resources in doing the work (e.g. bar chart); 4.2 Describe <u>your</u> role and contribution in the work team.	In engineering operations and projects Specified Category Practitioners will typically be given the responsibility to carry out specific tasks and/or complete 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 Depending on the task, Specified Category Practitioners can be the manager, team leader, a team member, or can supervise appointed contractors.
Outcome 5: Communicate clearly with others in the course of his or her specifically-defined engineering activities	**Responsibility level E**
Competency Indicators: Demonstrates effective communication by: 5.1 State how <u>you</u> presented your point of view and compiled reports after completion of the work. 5.2 State how <u>you</u> compiled and issued instructions to entities working on the same task	5.1 Refer to Range State for Outcome 4 and 5 below. Presentation of point of view mostly occurs in meetings and discussions with immediate supervisor. 5.2 Refer to Range State for Outcome 4 and 5 below.
Range Statement for Outcomes 4 and 5: Management and communication in *specifically-defined engineering* involves: (a) Planning activities; (b) Organising activities; (c) Leading activities; (d) Implementing activities, and (e) Controlling activities. Communication relates to technical aspects and wider impacts of professional work. Audience includes peers, other disciplines, clients and stakeholders audiences. Appropriate modes of communication must be selected. The Specified Category Practitioner is expected to perform the communication functions reliably and repeatedly confined to the competency area,	(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) Implementing means to "carry an undertaking, agreement, or promise into effect". (e) Controlling means the "means of regulating, restraining, keeping in order; check". Specified Category Practitioners participate in writing or adhere to specifications for the purchase of materials and/or work to be done, recommend on tenders received, place orders and variation orders, write work instructions, report back on work done, draw, correct and revise drawings, compile test reports, use operation and maintenance manuals to write or apply work procedures, write inspection and audit reports, write commissioning reports, prepare and present motivations for new projects, compile budgets, report on studies done and calculations carried out, report on customer requirements, report on safety incidents and risk analysis, report on equipment failure, report on proposed system improvement and new techniques, report back on cost control, report on environmental impact and sustainability, etc.

Group C: Impacts of Engineering Activity.	Explanation and Responsibility Level
Outcome 6: Recognise the foreseeable social, cultural, environmental and sustainability effects of *specifically-defined* engineering activities generally	**Responsibility level D** 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". Sustainable is defined in the definitions below.
Competency Indicators: This outcome is normally displayed in the course of analysis and solution of problems within the competency area, by typically: 6.1 Describe the social, cultural, environmental impact and long term sustainability of this engineering activity; 6.2 State how <u>you</u> communicated mitigating measures to affected parties and acquired stakeholder engagement.	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. 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.

Outcome 7: Meet all legal and regulatory requirements, protect the health and safety of persons and adhere to sustainable practices in the course of his or her specifically-defined engineering activities.	**Responsibility level E**
Competency Indicators: 7.1 List the major laws and regulations applicable to this particular activity and how sustainability practices and health and safety matters were handled; 7.2 State how you obtained advice in doing risk management for the work and elaborate on the risk management system applied.	 7.1 The OHS Act is supplemented by a variety of parliamentary acts, regulations, local authority by-laws, standards and codes of practice. Places of work 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; 7.2 It is advisable to attend a Risk Management (Assessment) course, and to investigate and study the materials, components and systems used in the workplace. The Specified Category Practitioners seeks advice from knowledgeable and experienced specialists if any doubt exist that safety and sustainability cannot be guaranteed.
Range Statement for Outcomes 6 and 7: Impacts and regulatory requirements include: (a) Impacts to be considered are generally those identified within the established methods, techniques or procedures used in the specific practice area; (b) Regulatory requirements are prescribed; (c) Apply prescribed risk management strategies; (d) Effects to be considered and methods used are defined; (e) Prescribed safe and sustainable materials, components and systems. (f) Prescribe maintenance protocols; (g) Persons whose health and safety are to be protected are both inside and outside the workplace.	 (a) The impacts will vary substantially with the location of the task, e.g. the impact of laying a cable or pipe in the main street of town will be entirely different to construction in a rural area. The methods, techniques or procedures will differ accordingly, and is identified and studied by the Specified Category Practitioners before starting the work. (b) The Safety Officer and/or the Responsible Person appointed in accordance with the OHS Act usually confirm or check that the instructions are in line with regulations. The Specified Category Practitioners is responsible to see to it that this is done, and if not, establishes which regulations apply, and ensure that they are adhered to. Usually the people working on site are strictly controlled w.r.t. health and safety, but the Specified Category Practitioners checks that this is done. Tasks and 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. (c) Risks are mostly associated with elevated structures, subsidence of soil, electrocution of human beings, moving parts on machinery, fraud and corruption and theft. Risk management strategies are usually done by more senior staff, but are understood and applied by the Specified Category Practitioners. (d) Effects associated with risk management are mostly well known if not obvious, and methods used to address, clearly defined. (e) Usually the safe and sustainable materials, components and systems are prescribed by Professionals or other specialists. It is the responsibility of the Specified Category Practitioners to use his/her knowledge and experience to check and interpret what is prescribed and report anything that he/she is not satisfied with. (f) Draw up maintenance systems and procedures from Codes of Practice and Manufacturer's Instructions. (g) Staff working on the task or project as well as persons affected by the engineering work being carried out.

Group D: Exercise judgment, take responsibility, and act ethically.	**Explanation and Responsibility Level**
Outcome 8: Conduct engineering activities ethically.	**Responsibility level E** Ethically means "science of morals; moral soundness". Moral means "moral habits; standards of behaviour; principles of right and wrong".
Competency Indicators: Sensitivity to ethical issues and the adoption of a systematic approach to resolving these issues is expected, typified by: 8.1 State how you identified ethical issues and affected parties and their interest and what you did about it when a problem arose. 8.2 Confirm that you are conversant and in compliance with ECSA's Code of Conduct and why this is important in your work.	Systematic means "methodical; based on a system". 8.1 Ethical problems that can occur include tender fraud, payment bribery, alcohol abuse, sexual harassment, absenteeism, favouritism, defamation, fraudulent overtime claims, fraudulent expenses claimed, fraudulent qualifications, misrepresentation of facts, etc. 8.2 ECSA's Code of Conduct, as per ECSA's website, is known and adhered to. Applicable examples given.

Outcome 9: Exercise sound judgement in the course of *specifically-defined* engineering activities	**Responsibility level E** Judgement means "good sense: ability to judge".
Competency Indicators: Exhibition of judgement is expected by**:** 9.1 State the factors applicable to the work, their interrelationship and how you applied the most important factors; 9.2 Describe how you foresaw work consequences and evaluated situations in the absence of full evidence.	 9.1 The extent of a project or task given to a junior Specified Category Practitioners is characterised by the limited number of factors and their resulting interdependence. He/she will seek advice if educational and/or experiential limitations are exceeded. Examples of the main engineering factors applied must be given. 9.2 Taking risky decisions will lead to equipment failure, excessive installation and maintenance cost, damage to persons and property, bankruptcy, poor service delivery, etc. Give examples.
Range Statement for Outcomes 8 and 9: Judgement is expected both within the application of the candidate's category specific methods, techniques and specific procedures and in assessing their immediate impacts. Judgement in decision making involves: (a) taking limited risk factors into account some of which may be ill-defined; **or** (b) consequences are in the immediate work contexts; **or** (c) identified set of interested and affected parties with defined needs to be taken into account.	In engineering about 15% of the activities can be classified as *specifically-defined* where the Specified Category Practitioner uses standard procedures, codes of practice, specifications, etc. Judgement must be displayed to identify any activity falling outside the *specifically-defined* range, as defined above by: (a) Seeking advice when risk factors exceed his/her capability. (b) Consequences outside the immediate work contexts, e.g. long-term, not normally handled. (c) Interested and affected parties with defined needs outside the *specifically-defined* parameters to be taken into account.

Outcome 10: Be responsible for making decisions on part or all of all of one or more *specifically-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."
Competency Indicators: Responsibility is displayed by the following performance: 10.1 Show how you used HCert level theoretical calculations to justify decisions taken in doing engineering work. Attach actual calculations; 10.2 State how you took responsible advice on any matter falling outside your own education and experience; 10.3 Describe how you took responsibility for your own work and evaluated any shortcoming in your output	 10.1 The calculations, for example fault levels, load calculations, losses, return on investment, etc. are done to ensure that the correct material and components are utilized. 10.2 The Specified Category Practitioner does not operate on tasks at a higher level than *specifically-defined* and consult professionals if elements of the tasks to be done are beyond his/her education and experience, e.g. power system stability, legal actions, etc. 10.3 This is in the first instance continuous self-evaluation to ascertain that the task given is done correctly, on time and within budget. Continuous feedback to the originator of the task instruction, and corrective action if necessary, forms an important element.
Range Statement: Responsibility must be discharged for significant parts of a one or more *specifically-defined* engineering activity.	The responsibility is mostly allocated within a team environment with an increasing designation as experience is gathered.
Note 1: Responsibility for the evaluation of work in a supervisory capacity.	

Group E: Initial Professional Development (IPD)	Explanation and Responsibility Level
Outcome 11: Undertake independent learning activities sufficient to maintain and extend his or her competence	**Responsibility level D**
Competency Indicators: Self-development managed by typically: 11.1 Provide <u>your</u> strategy adopted independently to enhance professional development. (IPD report); 11.2 Be aware of the philosophy of employer in regard to professional development.	 11.1 If possible, a specific field of the sub-discipline is chosen, available developmental alternatives established, a program drawn up (in consultation with employer if costs are involved), and options open to expand knowledge into additional fields investigated. 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 be in charge of experiential development towards Specified Category Practitioner registration level. Knowledge of the employer's policy and procedures on training is essential.
Range Statement: Professional development involves: (a) Taking ownership of own professional development; (b) Planning own professional development strategy; (c) Selecting appropriate professional development activities; and (d) Recording professional development strategy and activities; while displaying independent learning ability.	 (a) This is <u>your</u> professional development, not the organisation you are working for. (b) In most places of work training is seldom organised by some training department. It is up to the Specified Category Practitioner to manage his/her own experiential development. Specified Category Practitioners frequently end up in a 'dead-end street' being left behind doing repetitive work. If self-development is not driven by him/herself, success is unlikely. (c) Preference must be given to engineering development rather than developing soft skills. (d) Developing a learning culture in the workplace environment of the Specified Category Practitioner is vital to his / her success. Information is readily available, and most senior personnel in the workplace are willing to mentor, if approached.

Definitions

"Alternative Route": See section 7.3 of document R-01-SC

"Benchmark Route": See section 7.3 of document R-01-SC:

"***Competency area***" means the performance area where all the outcomes can be demonstrated at the level prescribed in a specific technology in an integrated manner.

'Engineering science' means 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.

"Engineering problem" means a problematic situation that is amenable to analysis and solution using engineering sciences and methods.

'Ill-posed problem" means problems whose requirements are not fully defined or may be defined erroneously by the requesting party.

"Integrated performance" means that 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" means a measure of performance demands at which outcomes must be demonstrated.

Management of engineering works or activities" means the co-ordinated activities required to:

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

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

"Outcome" at the *specified category* level means a statement of the performance that a person must demonstrate in order to be judged competent.

"Practice area" means 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" means the required extent of or limitations on expected performance stated in terms of situations and circumstances in which outcomes are to be demonstrated in a particular competency area.

"Specified Category" means a category of registration for persons who must be registered through the Engineering Profession Act or a combination of the Engineering Profession Act and external legislation as having specific engineering competencies normally 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.

"Sustainable development" means development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Revision History

Version	Date	Revised/Approved by	Nature of Revision
Concept A	19 February 2016	CRC Working Group	Needs input from CLTC Registration Committee and CRC Specified Category Working Group
Concept B	20 October 2016	COTO MTC & NLA-SA public participation	Input from industry incorporated
Concept B	30 January 2017	PDSGC	Approved subject to name change from CLM to CLTC
Concept B	6 February 2017	CRC	Noted and approved
Concept B	16 March 2017	Council	Approved
ECSA CONTROLLED COPY		**Executive: Policy Development and Standards Generation**	 John Cato **2017-03-17** Date