COUNCIL OF REGISTERED PROFESSIONAL ENGINEERS

CRPE Standard for Professional Engineering Competence

for the purposes of Registration under the CRPE Act

December 2007

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(As approved by the Council at its seating of 30 November 2007)

Defining and Specifying Acceptable Experience in Practice of Engineering

Incorporating a Proposed Revision of Professional Engineering Competence

Explanatory Note to this Paper

Council is frequently requested to state its position on the eligibility for registration of applicants employed as Lecturer/Senior lecturer, or Professor at Tertiary Institutions (e.g. University of Mauritius, etc). Council also faces queries from applicants whose "training" or "experience" has not been supervised by a Registered Professional Engineer.

University Teaching Experience on its own has not, until now, been recognised by Council as practice of engineering as defined in the Act. As regards unsupervised training Council has approved ad-hoc arrangements such as distant supervision by registered engineers. Council members have expressed the views that Council should state its policy in respect of these issues.

At Council Meeting of 25 August 2005, Council considered a paper on "Assessment of Two years Satisfactory Engineering Practice for Registration as Professional Engineer". The paper highlighted extracts from criteria set by various engineering bodies for accrediting engineering degree programmes. These included (i) The Engineering Council UK (**EC^{UK}**), (ii) The Accreditation Board of Engineering and Technology ABET (USA), and (iii) the Institution of Engineers Ireland. A draft "standard" for professional engineering competence developed by the Engineering Council Society of India was also considered for that purpose.

Council was agreeable that a draft document be developed embracing the essential and desirable competency statements which taken together would reflect a standard which could be accepted as the Council's Professional Engineering Competence Standard. These have been reflected in this paper, and have been used as a basis for prescribing experience requirements.

1. Introduction

This paper examines the provisions of the Act for guidance as to what constitutes "practice of engineering" or "experience in practice of engineering".

The term "Professional Engineer", in the context of the CRPE Act, designates a person who is, firstly, academically qualified for eventual registration as an Engineer, and, secondly, under Mauritian legislation, holds at least two years of experience in the practice of engineering. Most overseas engineering bodies prescribe a period of experience of at least 4 years for registration as Professional Engineer. In certain countries, regulatory bodies impose additional requirements, which may include written examinations, for granting a license to practice. These additional assessments are aimed at ascertaining knowledge of Codes of Practices, Conditions of Engineering Contracts, applicable National Legislation relating to public health and safety, environmental protection, etc., and in some cases they include engineering principles.

Notwithstanding the shorter (2-years) experience requirement, Council has a duty to ensure that the person registered under the Act has adequate engineering preparedness for independent engineering practice. He/she would be legally authorised to do so once registered. Any restrictions imposed on a registered engineer would be self imposed with due regard to the engineer's code of ethics and his/her professional competence and conscience. The responsibility for developing, enhancing and maintaining one's own professional competence lies with the Professional Engineer. He/she is equally responsible for the quality of engineering advice tendered, the accuracy and usefulness of the engineering report produced, as well as the integrity, safety and economic value of any design produced. Th engineer is accountable and liable for his/her work once registered as a Professional Engineer.

Certain amendments that Council may propose, if approved by Government, and eventually passed by Parliament and promulgated by Government, may eventually impose an obligation upon the engineer to maintain his/her competence. It will, never the less, be up to the engineer to maintain his/her effectiveness and employability throughout his/her useful career. Professional Engineers should recognise that mere registration does not and will not guarantee security of employment.

2. Legal Requirement

CRPE Act requires every applicant, seeking registration on the strength of an engineering degree or equivalent qualifications, to satisfy Council that he/she has two years of experience in the practice of engineering.

3. What is "practice of engineering"

The Act states that "**practice of engineering** ***means the advising on, the reporting on, the designing or the approval of designs of all public utilities, industrial works, ...".*** There follows a list of engineering works and plant, equipment, systems and facilities, built up infrastructure, etc exemplifying the engineering environment.

Section 20 "Saving" contains additional indications relating to "practice of engineering". Section 20(a) specifies that the work or profession of ***architects, bacteriologists, chemists, mineralogists, physicists or surveyors is not practice of engineering***. Section 20(b) adds that ***persons who are operating, executing or supervising any works as owner, contractor, superintendent, foreman, inspector or master are not engaged in practice of engineering***, since these are not prohibited practices. Section 20(c) states that ***the work of employees or subordinates of persons registered under the Act*** (i.e. Registered Engineers) has to be done ***under the direct responsibility, checking and supervision of a registered person*** (i.e. same or another Registered Engineer). Further, the ***work of such employees or subordinates cannot include final designs or decisions***.

4. Inference

A. Section 20(c) permits subordinates or employees of registered persons, which we consider to include, "Trainee Engineers", "Cadet Engineers", and "Assistant Engineers" to work towards their registration. However, such persons cannot be entrusted final designs or decisions responsibilities in engineering.

B. While Council may reasonably expect persons applying for registration to hold experience in engineering design and other engineering activities falling under the purview of practice of engineering as defined in the Act, it follows from Section 20.(c) that ***they should not be expected to have been engaged in <u>independent</u>*** ***"*****Final Design or Decisions**" in Mauritian jurisdiction.

C. It would follow, therefore, that that ***any engineering design work*** undertaken by an unregistered person, or " ***engineering decision***" produced by <u>such a person</u> would be illegal unless ***approved*** by a person registered under the Act. Full responsibility will lie with the registered person ***for the engineering design or decision***. Likewise any "***engineering advice***" or "***engineering report***" tendered by a person not-registered ***cannot constitute a "final engineering advice" or "final engineering decision***" and would ***need to be subject to approval and checking by a Registered.*** [Inserted "such a person" on 27 Nov 06: JS]

D. The above highlights the problematic situation of engineers working in organisations where there are no registered engineers. The following statements attempts to illustrate the situation:

D.1 Unregistered "engineers" should be practising under the direct responsibility, checking and supervision of a registered person. ***In the absence of a Supervising Engineer, their work should not be considered as practice of engineering***.

D2. Where Council has approved "***distant supervision***", then the status of the "**distant supervisor**" or "**mentor**" needs to be formalised and be acceptable to the applicant's "Employer", the "registered engineer", and the Council. The Supervisor's Employer may have to agree to the arrangement if he has to take his employer's time for the applicant.

D3. Section 20.c and Section 13 do not distinguish between engineers of different disciplines. But, it follows that the notion of ***supervision, checking***

and control implies the presence of a Supervisor with professional engineering competence relevant to the work of the "trainee", if he is to effect any realistic supervision, checking or control. For the same reason, the notion of "final design" or "decision" implies supervision by someone with professional competence in the discipline of practice.

D4. The applicant is required to satisfy Council that he has two years experience in the practice of engineering. Our legislation does not rule out engineering expertise developed and/or acquired while doing research work, or problem solving for the industry. It is common for engineering faculties of Tertiary Institutions to carry out research and problem solving for the industry, leading at times to production of prototypes. Consideration of these activities suggest that there could be an argument for recognising work such as engineering consultancy, performance testing, and any simulation done by University Engineering Staff as "practice of engineering"

5. Council's Stand on Assessing Qualifications.

Council considers that it has been empowered under legislation to determine whether any qualification, by whatever name called, viz., degree, diploma, or certificate, is of a standard satisfying its requirements for registration, and also to undertake this determination on graduation, that is, 2 years ahead of applicant's acquiring his experience.

Council's stand was vindicated by the Supreme Court in the case of AE Mungroo vs CRPE and AN Keenoo v CRPE (***Supreme Court Records 38519 and 38758 of January 1990***). Both appellants had contended that Council had "***no power to prejudge the question of a candidate's right to registration 2 years ahead of schedule, and also that the only power granted to the Council regarding degrees, diplomas and certificates, is to say, once for all at a given point in time, that degrees granted by University X are of an acceptable standard and thereafter blindly accept to register any applicant who produces a document emanating from that University***". Those grounds were rejected by the Supreme Court which even commended CRPE's practices. Supreme Court also expressed the view that Council could request evidence of satisfactory experience even from someone who secured an employment without going through Council's test. Future proposal for amendment may take this observation in account.

Council's procedure ensures that applicants who do not hold qualifications of acceptable academic standard are weeded out prior to undertaking practice of engineering or be given an opportunity to make up for shortcomings identified in their engineering knowledge and ability.

A consequence of this decision is that only experience gained after satisfactory completion of an approved /accredited engineering degree programme is accepted as "practice of engineering". Any "experience" claimed while studying for the basic registrable qualification is considered as a component of the degree programme, that is included therein, and as such it is not recognised a "practice of engineering"

6. Relevant Terminology

Discussions on engineering and technology, against the background of science, tend to lead to mix-up unless a recognisable divide is defined and kept in mind. We acknowledge borrowing the definitions given hereinafter from **The Malpas Report (2000) "*The Universe of Engineering: A UK Perspective",*** published by the UK Engineering Council.

"Science is the body of, and quest for, fundamental knowledge and understanding of all things natural and man-made; their structure, properties, and how they behave."

"**Pure Science** is concerned with extending this knowledge for its own sake."

"**Applied Science** extends this knowledge for a specific purpose."

"Technology is an enabling package of knowledge, devices, systems, processes, and other technologies, created for a specific purpose**."**

The Report also adds "The word technology is used colloquially to describe a complete system, a capability, or a specific device."

"**Engineering** is the ***knowledge*** required, and the ***process*** applied to conceive, design, make, build, operate, sustain, recycle, or retire, something of significant technical content for a specific purpose; - a concept, a model, a product, a device, a process, a system, a technology."

"Engineering knowledge is the growing body of facts, experience and skills in science, engineering and technology disciplines; coupled to an understanding of the fields of application."

"It is the *know what*"

It is mainly experience-based knowledge, which is more difficult to describe and communicate than "codified knowledge" because it must first be put into the context of an application.

"Engineering process is the creative process which applies knowledge and experience to seek one or more technical solutions to meet a requirement, solve a problem, then exercise informed judgement to implement the one that best meets constraints."

"It is the *know how***"**

"It requires knowledge and understanding of the underlying science, engineering, and constraints, of the context in which it is being practised, and special skills, both taught and gained by experience, to make it happen. It requires the exercise of judgement."

"It is the **bridge** between **science** and **technology"**

"It is the **bridge** between **technology** and **innovation."**

"Innovation is the successful introduction of something new. In the context of the economy, it relates to something of practical use that has significant technical content and achieves commercial success. In the context of society, it relates to improvements in the quality of life. Innovation may be wholly new, such as the first cellular telephone, or significantly better version of something that already exists.**"**

7. The Engineer's Responsibilities

The appellation "Professional Engineer", in most countries where the profession is regulated, implies an engineer whose level of professional competence has been assessed as acceptable for independent practice and who have had at least 4 years experience. A typical example is the UK "Chartered Engineer". Mauritius, Singapore and Malaysia are known exceptions where two years practice is required in lieu of the 4 years or more imposed elsewhere. The registered persons would probably make it to the level of professional competence of Chartered Engineers given a few more years of practice, in the appropriate environment. For Council's purposes, the definition of Chartered Engineer published in 2003 in "**The United**

Kingdom Standard for Professional Engineering Competence" by the **Engineering Council UK (UKSPEC 2003)** illustrates adequately what professional engineers are expected to do as part of their engineering practice.

> **'Chartered Engineers'** *"are characterised by their ability to develop appropriate solutions to engineering problems, using new or existing technologies, through innovation, creativity and change. They might develop and apply new technologies, promote advanced designs and design methods, introduce new and more efficient production techniques, marketing and construction concepts, pioneer new engineering services and management methods. Chartered Engineers are variously engaged in technical and commercial leadership and possess effective interpersonal skills."*

A more elaborate definition was agreed in 1960 during a Conference of the Engineering Societies of Western Europe and the United States of America (EUSEC). It can be found in a document on the website of the Institution of Engineers Ireland dealing with Accreditation Standards.

The French View

Of equal interest is a French description of the professional engineer. The following reference to the professional engineer has been extracted from a Guidance Material "**Les Ecoles d'Ingénieurs**" published in October 2000 by the **Centre D'Information et de Documentation Jeunesse** (**CIDJ**):

> "Un savoir et des competences scientifiques de haut niveau, des postes et des fonctions tres divers" ….. "Homme clé de l'entreprise, l'ingénieur est celui qui conçoit et fabrique, mais aussi celui a qui l'on confie souvent l'organisation, le contrôle, la vente ou encore la direction des hommes. Un ingénieur peut occuper tous les postes ou s'exercent a la fois responsabilite et compétence technique. En croisant toutes les fonctions possibles de l'ingénieur: recherche et dévelopment, bureau d'études, méthode, essais ... on obtient autant des metiers différents. Cependant, trois types de postes semblent aujourd'hui les plus représentatifs de l'évolution du metier d'ingénieur: la recherche, la production, les affaires." ... "les études, la conceptualisation sont a la base de toute formation d'ingénieur."

[Note: The above year-2000 document highlighted a professional branching into **Ingenieur d'etudes**, **Ingenieur de production**, **Ingenieur d'affaires**. Current internet searches reveal a much wider range of engineering disciplines.]

8. The Practice of Engineering

Our 1965 legislation was probably adapted from what obtained around that time in one of the Provinces of Canada. It defines "**practice of engineering**" in terms of four key functions which are : "*advising*", "*reporting*", "*designing*" and "*the approval of designs*" in relation to public utilities, industrial works, etc, which can be referred to as engineering works and systems.

A reading of the definition of "practice of engineering" in the legislation of several countries where engineering practice is regulated, brings out the following key attributes of the engineer:

(a) **The Nature of the Engineer's Education and Training:** The engineer is educated through a University programme of studies that was accredited by a competent and authorised body, after which the engineer pursues an approved training programme, and acquires experience that is duly assessed as satisfying approved standards.

(b) **The Engineering Functions:** Consulting, advising, reporting, researching and investigating, evaluating, the planning, designing or the approving of design, responsible directing or supervising of construction or operation, as well as introducing and applying new technology and production techniques, marketing and construction concepts, pioneering new engineering services and management methods;

(c) **Application of Scientific and Engineering Principles and data in the engineer's practice:** The proper execution of the functions is contingent upon use of specialist knowledge, requiring or being based on the application of engineering principles and data, and calls upon engineering knowledge, skills, experience and judgement.

(d) **Health and safety concerns**: The engineer's professional service or act is of a nature that impacts upon public interest and welfare, which makes the safeguarding of life, public health or property a priority concern in engineering practice.

(e) **Area of Activity concerned**: The engineer's work environment generally spans both the public and private sectors of activity. Where engineering practice is regulated, legislation invariably applies to public or *privately owned* public engineering works, i.e. public utilities, structures, buildings, machines, equipment, processes, works or projects, and all other engineering works, etc, and all buildings necessary to the proper housing, installation and operation of the engineering works concerned.

(f) **Scope of Engineering works**: Most definitions contain a fairly extensive description of "engineering works" to permit readers to be clear as to what is engineering in the day to day life.

(g) **Clarification as to what is not included**: Certain jurisdictions, including Mauritius, take care of this issue through a Clause such as "Prohibited Practices" or "Saving". In some cases, the definition of "**practice of engineering**" contains an added leg that excludes the obvious situations, e.g.:
   (i) practising as a natural scientist
   (ii) any engineering service that may be provided in accordance with a prescriptive standard, i.e. as per documented procedures or criteria for carrying out a design, or a construction or production activity related to engineering, and where the application of the procedures or criteria does not require advanced scientifically based calculations.

9. An updated definition for "practice of professional engineering"

The observations made above enable the drafting of a definition that captures most of the components extracted from the various definitions. No conflict is seen between the current definition and the following proposed definition, which <u>should preferably</u> require "engineering works and systems" to be defined separately:

> "**practice of professional engineering**", in relation to **engineering works and systems**, means the ***provision of any service or performance of any act***, ***which***
>
> ***(a) requires or is based on***
> the application of engineering principles and data in the course of performance of a service or act, and

(b) includes:

(i) investigating, evaluating, planning, designing, and approval of design, and

(ii) directing and/or supervising of the construction, maintenance and operation of the works, and

(iii) advising and reporting on the design, reliability, safety and environmental aspects of the engineering works and systems, and

(c) concerns or involves

the safeguarding of life, health, property, public interest and welfare, and

(d) excludes

any engineering service that may be provided in accordance with a prescriptive standard, including the supervision of construction and maintenance of any work where the requirements at (a) do not apply, and works of a nature exemplified by the practice of a natural scientist.

"Engineering works and Systems", in relation to practice of engineering, ***means***

any works, structures, and systems, of an engineering nature, which may be designated by any one or more of the following terms: aeronautical, chemical, civil, computer, electrical, electronic, environmental, geological, hydraulic, industrial, mechanical, metallurgical, mining, nuclear, production, radio, software, structural, telecommunications, or by any other word, combination of words, or phrase that the Council may approve, to designate the general nature of any engineering works and systems, on the basis of the scientific and engineering principles applicable to the design, construction or production of the engineering works and systems; ***these may include***:

(i) works and systems relating to public or privately owned public utilities, including transportation systems and components, structures, buildings, machines, equipment, processes, or projects,

(ii) structures and enclosures accessory to, and intended to support or house, engineering works,

(iii) works related to the environment including those of pollution control, abatement and treatment,

(iv) works concerned with the extraction, transformation and utilisation of natural resources,

(v) systems relating to surveying and mapping,

(vi) bio-medical equipment and facilities,

(vii) computer software for control, automation, and activating and monitoring of engineering works, systems, equipment and processes and their design, and

(vi) other works deems by Council to be engineering works and systems under the purview of the Act.

Note: Regulations made by Council may make provision for Council to impose obligations upon applicants, including persons deemed to be practising professional engineering, to submit evidence of prescribed engineering education, qualifications, training, and experience, and any other requirements prescribed in this Act, including demonstrating that the person concerned has acquired certain abilities, or satisfies any of the Regulations made under the Act eligibility to practice.

10. The Draft Standard for Professional Engineering Competence

An engineer's Professional Competence is, of necessity, dependent on his/her educational standard, and his/her programme of studies, including any industrial attachment that was part thereof. The satisfactory completion of the degree programme should enable him/her to engage in engineering practice. The engineer may initially enlist as a trainee on an approved training and development programme. Given that, as from 1997 (SARTOR 97) the UK Engineering Council redefined its standard for eventual registration as Chartered Engineer in terms of 4-year degree courses, and clearly distinguished that standard from the standards prescribed for technical persons registrable as Incorporated Engineer and Engineering Technician respectively, and reconfirmed these standards in UK-SPEC (2003), the Standard of the UK Engineering Degree, as far as CRPE is concerned is the 4-year **EC^{UK}** accredited degree.

Council has no difficulty in adopting the UK Standard, now defined in terms of "learning outcomes" or "output standards", considering that Council has always been guided by the practices of the UK engineering bodies since the establishment of the Council of Engineering Institutions since 1965. However, the draft herein proposed for consideration can reasonably be considered to reflect an academic standard attained on completion of a 4-year engineering degree programme (i.e., at the end of the 2nd or Long Cycle programme), comparable with the requirements for registration as Chartered Engineer by **EC^{UK}**, or Professional Engineer by the **Accreditation Board of Engineering and Technology ABET (USA**) or the **Institution of Engineers Ireland**. It should also satisfy the **ESOEPE/EUR-ACE (European Accredited Engineer)** Framework Standards for the Accreditation of Engineering programmes.

Attached herewith is a revised draft Standard:**ANNEX_A**: **Draft Standard of Professional Engineering Competence**: **PART A: Core Objectives: *Graduate's Knowledge and Ability.***

11. The Specification of Experience

The local experience requirement being a 2-year period in the practice of engineering, it is appreciated that Applicants registered with Council on the basis of two years of practice cannot be considered as possessing the competence of those with 4 years experience in all the core objectives or desirable areas of practice, nor be expected to have the Professional Engineer's design experience. Our own legislation, while permitting design work by engineers under supervision, does not permit unregistered persons to produce work that is "final".

Council proposes that the Mauritian practice be guided by the trend overseas. Attached herewith as ANNEX_B is a draft, designated as ***The Draft Standard for Professional Engineering Competence*** of CRPE. It takes the Standard on "Graduate's Knowledge and Ability to the next logical sequence, by elaborating on the issues regarding which Council may, in the course of its assessment of the applicant's professional engineering competence, require the applicant~~'s~~ to demonstrate that he/she has the Knowledge, Understanding and Ability expected at the different stages in his/her formation.

Of immediate concern to Council is the nature of Training and Professional Development of the Graduate Engineer during the initial 2 years, that is, the statutory 2-year period of "practice of engineering". Council should specify what type of training it considers absolutely necessary for registration purposes, while bearing the legal requirement in mind.

The attached document: **ANNEX B: Part B of the Draft Professional Engineering Competence Standard**, sets out a proposed Minimum Standard, which should be interpreted against explanation contained in Section 12 of this paper.

The Standard carries the following explanatory notes:

Note-1: The Core Objectives **(Graduate's Knowledge and Ability)** of Part A (Sections 10.1 to 10.6), have been reproduced as Sections 11.1 to 11.6 in this ANNEX, and rephrased as **Knowledge and Competence Objectives to be demonstrated by Applicants for Registration**, i.e on completion of Training/experience requirements.

Note-2: The Guidance Material contained herein has been adapted from the Professional Engineering Competence standards and practices of several overseas engineering bodies. The overall standard reflected is that of person who has had at least 4 to 5 years of practice, including 2 -years approved training, that is of a level comparable to that set for Professional Engineers by many overseas Institutions.

Note-3: Guidance Material given under each Core Objective, in the form of exemplifying Knowledge, Ability, and Competence issues, should serve as guidance to the Applicants themselves, and to their Mentors or "Distant Supervisors", regarding the knowledge and competence issues that Applicants will need to demonstrate on completion of their Training. The Guidance Material may equally assist members of the Professional Review Panels interviewing Applicants towards ascertaining whether Applicants have satisfied Council's requisites for registration under the Act.

Note-4: Indications are given in Section 13 as to the Competence level to be expected on completion of 2-years of training

In reference to Note_2, members may recognise in the Standards and accompanying Guidance Notes information extracted and adapted from publications of the Engineering Council (UK), Institution of Engineers Ireland, Institution of Civil Engineers (UK), Institution of Structural Engineers (UK), ABET (USA); also from an Annotated Template developed by Michael Carter in response to the ABET (USA) EC2000 Criterion-3 on the website of North Carolina: ***Annotated Template for program Outcomes***] www.engr.ncsu.edu/abet/criterion-3/template-3.html, and from the Framework Standards of Engineering Programmes developed by EUR-ACE (European Accredited Engineer) published on the websites of the respective institutions. The indirect contribution of these bodies towards our draft is acknowledged with thanks.

12. Assessment of Knowledge and Professional Competence

12.1 Quality of Training and Acceptable Experience

The qualifying phrases such as: "*have knowledge", "have knowledge and Understanding", "have ability to ..."* or *"having a working knowledge*", etc., already

offer guidance as to the extent of "expertise" that the graduates and applicants for registration need to demonstrate.
In our Draft Standard ANNEX B which looks at the engineer beyond his/her graduation into training and practice, the following key outcomes have been identified:

Knowledge and Understanding of Mathematics, Scientific, and Engineering principles

Knowledge and Understanding of Mathematics, Science and Technology, Engineering principles

Design, Creative and Innovative Skills

Application of theoretical knowledge and engineering principles to
(i) Engineering Analysis and Problem Solving
(ii) Engineering Design to meet specific requirements
(iii) Engineering Investigations (research and experimenting solutions)
(iv) Engineering Practice (acquiring practical skills in analysis, problem solving, designing and investigations).

Transferable Skills

Management and Leadership Skills
Responsibility for the Environment, Health and safety
Impersonal Skills and Communications
Broad Education, Values and Ethics, Commitment to Life-Long Learning.

12.2 Nature of Training and/or Experience

When determining the approach to the assessment of the training and experience of an engineering graduate, it should be borne in mind that the engineer has been educated with the primary intention of enabling him to undertake engineering design work. This means that it was to enable the graduate to make use of his/her theoretical and analytical knowledge, understanding and the ability imparted to him/her to develop his/her creative and innovative skills.

It is universally recognised among professional engineering bodies that Engineering Design is central to both the accreditation of engineering degree programme and the acceptance of a graduate engineer's training and/or experience as "practice of engineering" for the purposes of registration or licensure. The definition of "practice of engineering" in our legislation is quite explicit on this matter. Therefore, the Council (CRPE) and its several Professional Review Panels invariably look out for **evidence of the Applicant's involvement with engineering analysis, problem solving, engineering design or conducting research and experimenting**. The Review panels will particularly be interested in the approach of the engineer to his training and/or practice. The Applicant must demonstrate that his/her knowledge of mathematics, science, engineering principles, and his specialist engineering knowledge was called for and applied to enable him/her to understand and interface his /her environment, learn from it and in turn make his/her own contribution to the environment.

The Professional Review panels will also look at how the engineering graduate exploited the opportunities offered to him/her to his/her advantage, and improved and developed his/her knowledge and transferable skills.

12.3 Guidance from Overseas Engineering Bodies

Council's practices should not significantly different from the practices of major overseas engineering bodies, if Council's procedures are to be credible and acceptable to others. The following extracts from a document of the **National Society of Professional Engineers** of the USA, gives the following guidance about Qualifying Engineering Experience (for licensing in the US):

Note: In following extracts, the formatting in bold and/or Italics is not of origin

> **"Qualifying Engineering Experience**
> In order to constitute qualifying experience, the experience must meet a number of criteria.
> **First**, the experience should be from a major branch of engineering in which the candidate claims proficiency.
> **Second**, the experience must be supervised. That is, it must take place under the ultimate responsibility of one or more qualified engineers.
> **Third**, the experience must be of a high quality, requiring the candidate to develop technical skill and initiative in the application of engineering principles and sound judgement in reviewing such applications by others. The experience must be of a nature that the candidate develops the capacity to assume professional responsibility for engineering work.
> **Fourth**, the experience must be broad enough in scope to provide the candidate with a reasonably well-rounded exposure to many facets of professional engineering. Along with highly specialized skill in a particular branch of engineering, the candidate should acquire an acceptable level of competence in his or her basic engineering field, as well as the accessory skills necessary for adequate performance as a professional.
> **Finally**, the experience must progress from relatively simple tasks with less responsibility to work of greater complexity involving higher levels of responsibility. As the level of complexity and responsibility increases, the candidate should show evidence of increasing interest in broader engineering questions and continuing effort toward further professional development and advancement.
>
> In assessing whether the candidate is sufficiently competent and responsible to be entrusted with or independently engage in engineering work, or to supervise engineering work, ***state engineering licensure boards look for evidence of independent decision-making and assumption of personal accountability in design and application***. In short, while the experience must be gained while under the supervision of qualified professionals, it must also be professional in character. "

Additional Guidance (from Licensing Body of the State of Texas - US)

> "Experience that is considered most acceptable for licensure purposes generally falls into one of two categories: design or analysis.
> The most common type of acceptable experience is design. The common denominator in all design projects is the selection and use of recognized engineering principles and methodology to determine a solution to a problem. The final result of design work will almost always be details, plans, or specifications for use in creating a finished product.
> The second common type of acceptable experience is analysis. Common features of analysis activities include the use of mathematical modelling and acceptable data collection techniques to assess a problem, and the act of making a learned recommendation based on analytical findings. An analysis activity will almost always result in a conclusive report or recommendation.
> It should be noted here that many other types of activities would also be ***acceptable if your participation in those activities can be described in terms of design or analysis***. ***By asking yourself if you can describe your activity in terms such as "I calculated..., I***

designed..., I analyzed..., I recommended...," you can almost assure yourself that you are describing design and analysis."

13. Competence Standard

The Engineering Graduates will, given time, probably attain a fairly high level of professional competence in all the "outcomes" constituting the Standard. On graduation they will demonstrate Knowledge, Understanding and /or Ability that are considered mandatory for the accreditation/approval of the engineering degree. Council needs for its purpose to specify an expected standard of attainment on completion of 2-years of training/experience. An indication may be given as to what level is expected in say 5 years after graduation.

Example of UK Engineering Institutions (viz. Civil, Structural)

The Institute of Structural Engineers (UK), explains the standards, differentiated by letters **A, K, E**, and **B**, that it applies to the Core Objectives at the Initial Professional Development and the Professional Review Interview stages thus:
(see document at <http://www.istructe.org/exams/db/366.asp>:

- **A:** ***A general appreciation of the subject is required, as well as an understanding of how the subject may affect, or integrate with other subjects.***
- **K.** ***A knowledge and understanding of the subject and its application is required.***
- **E.** ***The subject should be performed independently or under supervision.***
- **B.** ***Perform the subject without supervision and be competent to advise others.***

The IStructE document adds "**It is important to note that you are not required to be experts in any of the objectives. You are simply to satisfy the minimum standard as specified in the Objective**."
Council of CRPE has similar views, and needs to be more mindful of the Note given that our "engineers" are assessed after 2-years of training, and not 4.

Council proposes the adoption of a slightly modified Code, using one or two letters, viz.,

- **A** a general Appreciation, as well as an understanding of how the issue may affect, or integrate with other subjects
- **KU** for ***K***nowledge and ***U***nderstanding of subject and its application,
- **EX** for ***E***ngineering e**X**perience, generally under Supervision
- **DA** for **D**emonstrate **A**bility, to Undertake task Independently
- **PE** for ***P***rofessional **E**ngineering competence for Independent Practice.

It would be expected that as the graduate acquires more and more experience, he would eventually attain a standard that would justify the designation "Professional Engineer" applied to him. The beginner (i.e. the graduate) or Trainee Engineer (the applicant) should record his/her personal progress in his/her Training logbook, which is submitted to Council of CRPE along with the Technical Report upon application for registration by those who have completed their two years of practice.

The Information contained in **ANNEX B** has been transferred to a spreadsheet designated **ANNEX C**. This document (**ANNEX C**) carries

indications as to the standard that should be attained by Applicants ***on Graduation, on Completion of 2 years of approved training***, and ***on Completion of 5 years of post graduation practice***. Professional Review Panels assessing Applicants for Registration under current legal provisions should be guided by the Standard relevant to the Applicants. **ANNEX_C** is not intended to be an exact or complete reproduction of the Guidance material of **ANNEX_B**, in spite of such similarity.

14 Approved Training Programme: Desirable Engineering Exposure

14.1 Need for Reviewing Guidance Material on Training and Development

Council currently influences the post graduation Training and Development of the engineers through Guidance Notes contained in its documents which are given to potential registrants when they apply to Council. The Guidance material which consists of two separate documents: **Guidance for Assessors**, and **Format for Technical Report** have outlived their time and need to be renewed.

A Graduate Engineer normally takes 4 years to attain a level of Competence comparable to the "Chartered" or "Professional" Engineer, and in that time he should develop his Knowledge, Understanding and Design and Management abilities to the level desirable for such a competence level. Whereas employers have means to ascertain the Management and other Transferable skills of employees, including graduate engineers, they normally do not ascertain the Engineering Knowledge and Understanding, and Design capabilities of the Engineer. This leads Council to decide that

(i) Under current legislation, priority of Council should be to ascertain applicant's knowledge and understanding of engineering principles as well as his /her ability to apply his/her knowledge to undertake work that involves engineering design, investigations and experimenting, and problem solving, while ensuring that he/she has developed a satisfactory awareness and understanding of Management and Transferable Skills.

(ii) Until legislation is amended, to permit registration of engineers with Competence Level similar to the overseas "Chartered Engineer" or "Professional Engineer", Council might wish to operate a scheme of voluntary registration of engineers with 5 years, or 7 years as in case of International Register of Engineers, under which Council could assess the Competence of Engineers in all Core Objectives, including **Management** and **Transferable Skills**, and register them at a level designated as Professional Engineer (Mauritius),

Most overseas institutions give indications to potential registrants on the nature and scope of training they would be prepared to accept for registration or licensing of the applicants as Professional Engineers, or, in the case of the UK, as Chartered Engineer. Institutions which also register or license the lower professional grade they designate as Incorporated Engineer, or Associate Engineer or Engineering Technologist, do prescribe the Qualifications, Training and Development requisites for such registrants.

Following the promulgation of new Standards by the UK Engineering Council some Institutions of the UK have partnered with the Industry into devising Training and Development Schemes **(Initial Professional Development**) that comprise both the initial **IPD** of 2 years and the Professional Competence Development of a further 2 years. Graduates embarking on a Training Scheme that is not approved take longer to register. It is submitted that Council should review its Guidance Material and develop **Training and Initial Professional Development Guidelines** which could cater for the two years of experience required by Law.

Pending the development of a ***Guidance Material*** on **Initial Training and Professional Development (ITPD)**, Council may approve that the Material contained in Section 11 (**Annex_B**) be treated as relevant and applicable Guidance for Registration with Council, bearing in mind the additional Guidance contained in Section 12 and **ANNEX_C** regarding the Competence Level on completion of 2 years of Training and Experience.

14.2 Desirable Exposure to Engineering Practice

Council has a responsibility to ensure that the experience claimed by applicants for registration is of a nature that satisfies the requirement of law, i.e., they should ***be "reporting on, advising on, designing or approving designs....***" of public utilities, engineering works, etc. Consideration of the argument in paragraph **14.1**, along with the interpretation of our own legislation, and guidance drawn from sources quoted in this Paper, viz., definition of Professional/Chartered Engineer, definition of practice of engineering (as defined by others and proposed by us), the UK Professional Competence Standard, the criteria for acceptable Qualifying Experience set out by the National Society of Professional Engineers (US), etc., compel Council to specify that the two years experience should take the Graduate engineers through an **Initial Training and Development Programme** such as set out in the Schedule at **ANNEX D**

In this Schedule (**ANNEX D**) emphasis is laid on prescribing that design and design related activities cover at least 40% or some 40 weeks of the trainee engineers' training. This will include the following elements:

A. Engineering Design, Problem Solving and Investigations

(i) **Engineering Analysis and Problem Solving**, for a minimum of **15 weeks**
(ii) **Engineering Design or Related**, for a minimum of **15 weeks**
(iii) **Engineering Investigations** (search for solutions) for a minimum of **15 weeks**

Transferable Skills

B. Project Management and Leadership Skills, for a minimum of **40 weeks**

C. Responsibility for Environment, Health and Safety, for a minimum of **10 weeks**

D. Development of Interpersonal Skills and Communications, for a minimum of **5 weeks**

E. Broad Education, Values/Ethics, Commitment to Life-Long Learning for 5 weeks

The relevant Schedule (ANNEX D) carries the following notes:

Note a: It is recognised that during the initial 2 years, Graduate Engineers may not have opportunities to receive training in the 3 components of design (**A, B, and C**). They may in such cases plan their training in two

components, but CRPE Panel may require them to do further training to compensate for the shortfall in the required area of practice.

Note b: Applicants not having received training on Project Management Skills, would be expected to compensate for the shortfall with evidence of additional Training in Design Related Activities (A,B, and C).

Note c: It is recognised that Applicants may develop their skills and acquire the required level of ability in respect of items **C, D, and E** while acquiring experience in **Engineering Design Practice** and/or when getting experience in **Project Management and Leadership Skills**.

15. The Case of Applicants undertaking Engineering Consultancy, while lecturing in Engineering at Tertiary Institutions, e.g., University of Mauritius.

CRPE has faced a paradox ever since its establishment. It has legally registered Corporate Members of UK Engineering Institutions. In the past, many UK Chartered Institutions had recognised University teaching experience (at Senior levels) as experience for the purpose of admission as Corporate Members and eventually entitlement to Chartered Engineer status. For their membership purposes, the Institutions considered two years of research and teaching as one year of practice (in the industry), which implied that such members were satisfying corporate membership requirements in about 6 to 8 years, or more.

As regards registration of teaching personnel of Tertiary Educational institutions, Council needs to consider the following:

1. ***That it is for Council to decide and approve that an activity is engineering practice or not. For this, Council must determine ~~show~~ that the activity is appropriate ~~considered~~ to be included in the functions "Advising on", "Reporting on", "Designing" and "Approval of designs of" …. Public utilities..***
2. ***Our legislation does not prescribe the manner in which experience is gained,***
3. ***Neither the definition of practice of engineering, nor any other clause, specifically prohibits members of the University Academia from registration,***
4. ***There are instances of University Personnel (with engineering qualifications) who offer engineering services and advice to the industry, and even undertake research for consulting engineering firms,***
5. ***The University Lecturers are engaged in designing experiments to demonstrate engineering principles and their applications, and***
6. ***Undertake research work in engineering, including new and emerging technology, and***
7. ***Legislation restricts "final design or decisions" to registered persons.***

Council recognises that University lecturers are engaged in teaching 3rd and 4th year engineering students how to apply scientific and engineering knowledge to problem solving in engineering, and the essentials of engineering design. They also devise and guide students through the engineering laboratory work and tutorial sessions which are part of the curriculum. Some of them do engage in the provision of engineering and advisory services to the industry and to engineering consultancy firms. It is submitted that some of these elements do constitute practice of engineering, and

that such "***practice of engineering***" be assessed against set criteria to determine whether the aggregate experience constitutes acceptable experience for registration purposes.

A proposal is made hereinafter. It is submitted therefore that Council considers the following requirements, and if found fair and reasonable and not in conflict with our legislation, to approve that these become applicable to any applicants satisfying the requirements as set out in **ANNEX E**:

Briefly the requirements are :

(i) Provision of Engineering Consulting and Advisory Services to Industry or Engineering firms.

(ii) Overall period of teaching and consulting services should be a continuous period of at least 4 academic years (i.e 208 weeks).

(ii) The services provided should not be of a routine nature, such as testing products against prescriptive standards or criteria.

(iii) Their services must be checked and approved by the Client's Registered Engineers, or registered engineers engaged by them and acting on their behalf.

(iv) Design related activities should cover a period not lesser than 50 weeks in any continuous period of 4 years. The time may include visits, discussions, data collection, identifying problems areas, issues to be resolved, search for solutions, proposals, discussing solutions with clients representatives (registered engineers), advising and reporting, production and submission of design, monitoring of implementation , etc.

(v) Further, ***an aggregate of 120 weeks out of the 4-year period (208 weeks)*** should be spent as follows:

- Lecturing to 3rd and 4th year full time degree students on "Engineering design" or similar and engineering problem solving.
- Tutorial and Coaching Sessions for 3rd and 4th year engineering degree students on application of theoretical and practical methods to engineering design and solving of engineering problems.
- Lecturing on Engineering Principles, Systems, Design, and Innovation, Environmental Engineering, and Project Management to students enrolled on Master's Degrees in Engineering, including Environmental Engineering.

(vi) Mechanism for recognising extra time for preparation of courses, tutorials and experiments.

(vii) Recognition of any continuous period of industrial engineering practice exceeding 3 months by the applicant, while on leave from the University, or prior to his joining the University, or after expiry of his/her lecturing contract.

(viii) Applicants to submit evidence of, and demonstrate, exposure and experience aggregating some 20 weeks in respect of Transferable Skills (i.e Project Management and Leadership Skills, Engineer's Responsibility for Environment, Health and Safety, Interpersonal Skills and Communication, Need for Broad Education, Ethics and values, Commitment to Life Long learning. They should reckon at least 20 weeks in aggregate over activities relating to these issues.

They may for this purpose aggregate periods of visits to Works in progress on engineering sites, industrial visits, organising and/or attending seminars and workshops, making presentations to technical audiences, writing and publishing papers on the above issues, etc.

16. Special Cases requiring "Distant Supervision"

It is wished to include a closing paragraph on the case of Trainees in departments or organisations which, either do not employ registered engineers, or, if they do, the engineers may not have competence in the discipline in which the Graduate Trainee is qualified and requires to be trained.

An arrangement commonly referred to a "distant supervision" is approved by Council and has been in operation for many years now. This arrangement requires to be backed by a properly articulated policy decision of the Council, so that the mechanism is not left to be interpreted on a case by case situation. It is not known whether overseas engineering bodies have arrangements specifically addressing such situations, but they do have arrangements which perhaps permit trainees, in similar situations, to get their training.

Some institutions operate approved training and development schemes, and have designated Supervising Engineers, Mentors, Delegated Engineers, with well-defined responsibilities towards the Trainees. Council needs to develop special relations and arrangements with employers in an attempt to influence the training of young graduates, and thereby transform the graduate into an efficient, productive, creative, and professionally competent engineer who could render better service to the employer. It must be recognised that Council has had limited influence with employers other than the Government and Public Bodies which give Council the respect it deserves as a Regulatory Body.

The contents of ANNEX A, B, C, and D are applicable to all trainee engineers who intend to seek registration and eventually attain the full professional status equivalent to that of the UK Chartered Engineers and the North American Professional Engineers. Council should produce a Guidance Material specifically addressed to the "Distant Supervisors".

Council approves the current arrangements for "distant supervision" and make them subject to the following conditions:

#1. The Trainee must inform Council that there are no Registered Persons in his/her organisation who are prepared to Supervise his/her work or to be his/her "mentor" or his/her Supervising Engineer"

#2 Council needs to be satisfied that the work environment of the Trainee is one which provides opportunities for "practice of engineering" in that organisation.

#3. The employer must be agreeable to his/her staff (the Graduate Engineer) being supervised distantly by a registered person of his/her choice, or one proposed by Council, or by any other registered engineer which the Company itself is prepared to enlist for such a purpose. The "Distant Supervising Engineer" will be bound by his Code of Ethics and Confidentiality not to use any marketing or other commercially sensitive information that may come to his/her knowledge during his/her meeting with the trainee, to his/her advantage or to the detriment of the Trainee's employer. The Distant Supervisor will declare any conflict of interest that he/she perceives and requests Council to arrange for his/her replacement.

#4. The "Distant Supervising Engineer" needs to be approved by Council. For this purpose, he/she should signify in writing his/her agreement to be a "Distant Supervising Engineer" and would welcome this opportunity to follow the Training and Development of the Graduate Engineer, in line with Council's guidelines. He/she should also state the period during which he/she can render this service, if shorter than 2 years, or shorter than the time the Graduate may require to complete his/her training, for arrangements to be

made, (firstly by Trainee, or else by employer, or by Council), for the additional period that may be necessary.

#5. The "Distant Supervising Engineer" must be a person well briefed on Council's training requirements, if not he/she should call on the Registrar for briefing and collect Guidelines for "Distant Supervising Engineers"

#6. The "Distant Supervising Engineer" will sign the trainee's Log Book and any other form of Record Book that the Trainee maintains. The Distant Supervising Engineer will need to maintain his/her own diary of his/her meeting with the Trainees for Administrative Purposes, and eventually for signing the Trainee's Report.

#7. The Distant Supervising Engineer will need to inform Council, the Trainee, and the Employer, if at any time he/she considers that the nature of the Trainee's work/training will not satisfy the Council's requirements for registration.

#8. The Trainee Engineer shall make his/her own arrangements to meet his/her "Distant Supervising Engineer" at least once monthly, to discuss engineering issues and his/her progress; at any rate it must not be less than once every 3 months.

#9. Where specialist advice or assistance is required to be given to the trainee and that the Distant Supervisor does not possess the specialist knowledge, he/she may direct the Trainee to Council or to some other Engineer who can supply the advice.

#10. The Distant Supervising Engineer must agree to hold at least one Annual Appraisal Session with the Trainee where the Supervisor and Trainee could together review the training undergone, and attempt to address the following issues:

- Has the Training gone in line with Guidance issued by Council ?
- What are the areas of concern to the Trainee, and to the Supervisor as regards the training?
- Is there a valid reason for trainee to review his/her arrangement with his/her employer, move into another departments within the same company, or ask for a change in his/her "responsibilities and duties" ?
- Will the Trainee be in a position to complete his Training in the period remaining out of the nominal 24 months ?
- Does the Trainee feel confident that he/she can, if the need arises, exercise independent judgement within his/her area of practice?
- Etc.

#11. Council will expect the Distant Supervising Engineer to submit his/her own assessment of the trainee's training to the Council, with a Copy to the Trainee outlining:

- The areas in which he/she believes the Trainee has acquired a satisfactory working level of competencies.
- The areas in which he/she believes there are shortfalls in the training, but he/she believes that these are not serious and can be compensated for by the trainee in a near future.
- The areas of practice where he/she believes the Trainee needs further training towards his/her registration.
- His/her own view of the Trainee's potential as an independent Consulting Engineer, and of the trainee's Strategic Competence Development and Further Learning Plan, if any that the Trainee is working on.

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Part A: Core Objectives - *Graduate's Knowledge and Ability*

***Section 10 of "Practice of Professional Engineering" issued by the Council Registered Professional Engineers in November 2006**

Upon the successful completion of a 4-year approved/accredited programme of studies (i.e combined 1st and 2nd Cycle, or Long Cycle***) in any engineering discipline, any graduate should be capable of demonstrating the following qualities and competencies:***

10.1 Knowledge of Mathematics, Science, Technology and Engineering Principles

The Graduates will have acquired adequate and sound knowledge of mathematics, sciences and technology, including software and information systems, engineering principles, and specialist engineering knowledge, and will have developed an ability to apply their knowledge to the optimisation of existing and emerging technologies.

10.2 Application of Engineering Knowledge to Analysis and Problem Solving, Engineering Design, and Engineering Investigations.

The Graduates will have the ability to apply theoretical and practical methods (Engineering Principles and Mathematics):

(a) to analyse and solve engineering problems and evaluate the effectiveness of their solutions.

(b) to design a system, component, or process, to meet specified needs, and

(c) to conduct investigations of technical issues consistent with their level of knowledge and understanding, including ability to design and conduct experiments, analyse and interpret data, towards designing and developing an engineering solution,

(d) to acquire practical skills in undertaking assignments requiring engineering analysis, problem solving, designing and conducting investigations.

10.3 Management and Leadership

Graduates will demonstrate that they have acquired the knowledge and understanding of, and ability to use, techniques, skills, and modern engineering tools, including management practices and procedures necessary for engineering practice, and will have the ability to see through the operation of a supply and execution of an engineering contract.

10.4 The Engineer's Responsibility for the Environment, Health and Safety.

Graduates will have knowledge of the impact of engineering design on the quality of environment, health, safety, and the quality of life. They will, consequently, acquire an ability to recognise and assess risks to quality of life and to design and implement measures and safeguards to enhance quality of environment and life, and also ensure sustainability.

10.5 Interpersonal Skills and Communications

Graduates will recognise that in the course of their normal professional practice, they will interact with peers, subordinates, clients, administrators, policy makers and the public, and therefore, they need to demonstrate that:

(a) they have an ability to communicate effectively with peers, and the engineering community and society at large.
(b) they have an ability to use communication techniques, skills, and tools for that purpose, and
(c) they have an ability to function as an individual and on multi-disciplinary teams.

10.6 Need for Broad Education, Recognition of limits of own Professional Competence, Values and Ethics in Professional Practice, and Commitment to Life-Long learning.

Graduates will :
(a) have acquired a broad education in engineering and allied fields, as may be necessary, for optimum performance in the course of their professional practice.
(b) have the ability to recognise the limits of personal knowledge and skills, while exercising independent judgement.
(c) demonstrate an understanding of need for practising high Ethical Standards, manifesting their Sense of Values and Responsibility in professional practice,
(c) recognise the need for, and demonstrate their commitment and ability to engage in a process of life long learning, and
(d) demonstrate that they have a knowledge of contemporary issues.

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Part B: Professional Engineering Competence

*** Section 11 of "Practice of Professional Engineering" issued by the Council of Registered Professional Engineers in November 2006.**

Note-1: The Core Objectives **(Graduate's Knowledge and Ability)** of Part A (Sections 10.1 to 10.6), have been reproduced in this ANNEX, and rephrased as **Knowledge and Competence Objectives to be demonstrated by Applicants for Registration**, i.e on completion of Training/experience requirements.

Note-2: The Guidance Material contained herein has been adapted from the Professional Engineering Competence standards and practices of several overseas engineering bodies. Taken together, all the Knowledge and Competence Objectives reflected the Standard of person who has had at least 4 to 5 years of practice, including 2 -years approved training, that is, of a level comparable to that set for Professional Engineers by many overseas Institutions.

Note-3: Guidance Material given under each Core Objective, in the form of exemplifying Knowledge, Ability, and Competence issues, are intended as guidance to the Applicants themselves, and to their Mentors or "Distant Supervisors", regarding the knowledge and competence issues that Applicants will need to demonstrate on completion of their Training. The Guidance Material will equally assist members of the Professional Review Panels interviewing Applicants towards ascertaining whether Applicants have satisfied Council's requisites for registration under the Act.

Note-4: Indications are given in Section 13 as to the Competence level to be expected on completion of 2 -years training.

Knowledge and Competence objectives to be demonstrated by Applicants for Registration

11.1 Knowledge of Mathematics, Science, Technology and Engineering Principles

Applicants *will be expected to demonstrate that they have acquired adequate and sound knowledge of mathematics, sciences and technology, including software and information systems, engineering principles, and specialist engineering knowledge, and have an*

***ability to apply their knowledge to the optimisation of existing and emerging technologies*.**

For the above purpose, they should demonstrate a theoretical approach:

i. in enabling the application of technology in their engineering practice and their engagement in continuous improvement of facilities and systems,
ii. in enabling the introduction and exploitation of emerging technologies, and
iii. in engaging in creative and innovative development of engineering technology

Towards ascertaining their knowledge, ability, and approach to engineering practice, and their ability to apply their knowledge to the optimisation of existing and emerging technologies, they may be required to demonstrate their:

i. Knowledge of Materials and Components (properties and processes) generally utilised in engineering and sufficiently for them to specify their usage in their own practice.
ii. Understanding and knowledge of scientific and engineering principles underpinning engineering, and in particular, in the design and operation of systems and facilities in their own area of practice.
iii. Analytical ability to compute value of parameters or components influencing, or contributing to, or responsible for an observed outcome in their field of practice.
iv. Ability to assess needs of users and marketing needs, and the formulation of marketing strategies.
v. Ability to identify constraints and exploit opportunities towards engaging in innovative and creative activities, and promoting new applications.
vi. Ability to improve quality of products and services, and evaluating new and emerging technology, and facilitating their entry.

11.2 Application of Engineering Knowledge to Analysis and Problem Solving, Engineering Design, and Engineering Investigations

11.2a Applicants *will demonstrate their ability to apply theoretical and practical methods (*engineering principles and mathematics*) to analyse and solve engineering problems and evaluate the effectiveness of their solutions. They should demonstrate their ability:*

i. to understand the functions and design of any engineering systems, structures, facilities, equipment, components, or processes within their engineering discipline, and to use their knowledge, including mathematical analysis and computer modelling, to analyse the design of engineering products,

processes and methods, and to search for and apply innovative methods of problem solving.

ii. to investigate engineering problems (e.g., failure, unreliability, operational instability, other departures from designed and desirable performance), towards identifying contributory causes and source(s): viz., design quality, production (materials, processes or workmanship, test and acceptance), use, operation, maintenance, environment, etc.), and propose solutions and supply justification.

iii. to appraise and review engineering designs, and proposing solutions for improving economic efficiency, operational performance, enhancing capacity and productivity, and evaluating solutions.

iv. to recognise an engineering problem as an opportunity for self development, and bringing change, innovation and improvement in their practice.

v. to represent a problem in a form that makes finding solutions more efficient and effective, viz. model, flow chart, diagram or table as appropriate.

11.2b Applicants *will demonstrate their ability to design a system, component, or process to meet specified needs.*

They may be requested to demonstrate, that in a given situation requiring a viable design to be produced within the scope of the design brief, they have knowledge and ability of a nature exemplified by the following:

i. Knowledge and understanding of design methodologies, and ability to make use of that knowledge and understanding to design solutions to unfamiliar problems, possibly involving other disciplines.

ii. Ability to interpret design brief, have knowledge of task required as well as the applicable criteria (safety, reliability, environmental), and the parameters influencing outcome, and to conceive alternative design schemes.

iii. Ability to assess (and select) a particular design scheme against the technical and other criteria which may influence the use and marketing of the end product, viz. standards, cost, quality, reliability and durability, etc., and the wider societal, health and safety, environmental and commercial considerations.

iv. Ability to check a design produced from using proprietary software, (outputted results, designed components, formulae, data used, computations, etc), against design produced with own design knowledge.

v. Ability to make engineering judgement in work involving complexity, technical uncertainty and incomplete information.

vi. Abilty to generate and develop new and original ideas and methods.

vii. Knowledge of problems likely to arise during design, in each design scenario, and envisage solutions to these eventualities.
viii. Ability to write instructions for production of model or prototype and its testing against criteria established for project.
ix. Ability to accurately document their work to highlight the problem areas and knowledge gained from exercise.

11.2c Applicants *will demonstrate their ability to conduct investigations of technical issues consistent with their level of knowledge and understanding, including ability to design and conduct experiment, and analyse and interpret data, towards designing and developing an engineering solution.*
They may for that purpose be requested to demonstrate their ability to:

i. Explain a specific result or observation in a process, including a departure from expected performance, and developing a hypothesis around the significant dependent and independent variables, responsible for the result.
ii. Develop and design an experiment to test their hypothesis, define the tasks to be carried out, state the scientific and engineering principles involved, and carry out such analytic, modelling and experimental investigations as may be necessary. They may be required to demonstrate their knowledge of controllable and non-controllable parameters likely to influence the value of the experiment.
iii. Conduct experiment; measure and collect data, and do a critical evaluation of data; explain the results and draw conclusions, and follow up with a review, and present and justify the design.
iv. Propose, on the basis of results of an experiment, possible solutions, i.e. design changes, for obtaining a positive change in the outcome.
v. Use appropriate methods, including search of literature, data bases and other sources of information, for research and other technical investigations consistent with their level of knowledge and understanding.
vi. Represent data (in tabular and/or graphical forms) so as to facilitate analysis and explanation of the data, and drawing of conclusions as to the hypothesis, and, if necessary, permit modification to the experiment.
vii. Document the experimental procedure, data, observations, analysis, and their conclusions.

11.2d Applicants *should be required to demonstrate that, in the course of their training/practice, they have acquired practical skills in carrying out assignments requiring engineering analysis, problem solving, designing and conducting investigations. They may be required to demonstrate that:*

i. they have explored their engineering environment for new opportunities, towards enhancing products, processes, systems and services.
ii. they have had opportunities to undertake design work, under supervision, for review by persons registered as Professional Engineers, and have discussed their work with peers and seniors.
iii. they have had opportunities to evaluate new technology for marketing and commercialisation by employer or client.
iv. they have had opportunities to undertake a review of a specific design, with a view to ascertaining specific performance parameters, and determining technical, operational or environmental reasons for a departure, if any, from designed or specified operational performance, or, for instance, for improving its economic efficiency or operational performance, where feasible.
v. they have had opportunities to discuss, with their supervisors or mentors as appropriate, alternative solutions and designs, based on their knowledge of materials appropriate to each solution.

11.3 Management and Leadership

Applicants *will demonstrate that they have acquired the knowledge and understanding of, and the ability to use, techniques, skills, and modern engineering tools, including management practices and procedures, necessary for engineering practice, and will have the ability to see through the operation of a supply and execution of an engineering contract.*

Towards that end, they may be required to demonstrate their:

i. Knowledge and Ability to use Project Management tools and techniques (e.g., Gant Chart, PERT/CPM, mathematical modelling, computer simulation) and Project Management software, for controlling and co-ordinating project execution.
ii. Knowledge and ability to Interpret of Basic Financial Statements (Balance Sheet), Appraise projects using discounted cash-flow techniques (NPV, IRR).
iii. Ability to prepare and control cash flows, forecasts, budgets, and identify elements affecting business profitability.
iv. Knowledge and ability to lead teams, develop human resources to meet changing technical and managerial needs, as well as methods and procedures for assessment of service quality and performance of individuals and teams; they also have knowledge of quality management and ability to bring about continuous improvement in their environment.
v. Knowledge and ability to manage projects; programming and control of manpower, project resources, finances, and administrative support; decision processes (use of statistics, uncertainty, probability, curve fitting); legal and contractual

issues, including settlement of disputes and litigation procedures; cost reduction and efficiency improvement measures; safety, health and environment safeguards during contract execution; training and development of human resources for new production technology), etc., variations, etc; handing-over /acceptance certification

vi. Knowledge and Understanding of Procurement Procedures, Tender Specifications, Contract documents and Conditions of Contract for Engineering works, Evaluation of tenders, etc.

vii. Knowledge and understanding of contracts pricing; safeguarding against adverse market trends influencing their costs (i.e., raw materials, labour, manufacturing processes, taxes),

viii. Awareness of the legislation impacting upon their practice: regulation of their practice, labour laws, applicable health and safety issues in Design and during Construction, construction industry building regulations, Government taxes, etc.,

ix. Knowledge of Responsibility of Engineer and other key players in the administration and execution of engineering contracts; Experience in Producing Design brief, procurement of design and construction services; production techniques (manufacture, assembly, construction, use of machinery and equipment), material testing procedures, engineering construction, production, assembly, acceptance test techniques and experience in handling tools and machinery, support systems, production programmes and activities sequencing.

x. Understanding, assessment, and management of Risks in project management and business; the implications of health, safety and insurance and industrial relations issues for the proper execution and financial viability of engineering contracts; Limitations of Risks assessment and management techniques.

11.4 The Engineer's Responsibility for the Environment, Health and Safety

Applicants *will demonstrate their knowledge of the impact of engineering design on quality of environment, health and safety, and quality of life. They will, therefore, have acquired the ability to recognise and assess risks to quality of life, and to design and implement measures and safeguards to enhance quality of environment and life, and ensure ensuring sustainability.*

They may be required to demonstrate that:

i. they are aware of the common environmental threats to quality of environment and life, including pollution by contaminates, and are generally knowledgeable of applicable control procedures and safeguards.

ii. they have the ability to recognise, monitor and assess risks to the quality of environment within own area of responsibility and

practice, as well as hazards to safety, welfare and health, and prioritise the risks for remedial intervention.

iii. they are familiar with legislation (relevant to their practice) governing quality of environment, the safety, health and welfare of society, and its influence on the design process and solutions implemented.

iv. they have knowledge of the influence of the environmental threats on the design process and solutions implemented, and of the technology utilised for monitoring environmental parameters in their field of practice, and interpreting relevant data.

v. they have an appreciation of effects and constraints that planning, sustainability, and environmental impact assessment can have on design, and additionally, have the ability to use their imagination, creativity and innovative endeavour to conceive and develop products and services which maintain and enhance the quality of the environment as well as the quality of life of the community within approved budgets.

vi. they have knowledge of environmental and sustainability issues that can be raised by the project implementation methods and procedures and the selection of materials. They have ability to recognise need, if any, for specialist environmental and sustainability advisers to be brought in to handle such issues.

11.5 Interpersonal skills and Communications

Applicants *will demonstrate that they have acquired the ability to interact with individuals and groups, including peers, subordinates, clients, administrators, policy makers, and the public, in the course of their normal professional practice.*

For these purposes, they may be required to demonstrate their:

(a) Ability to communicate effectively with peers and the engineering community and society at large, by displaying:

i. a good command of the language of communication, and knowledge of effective communication techniques.

ii. their ability to write correctly and to express clearly and unambiguously when writing letters, memos, abstracts, summaries of technical papers, Technical Documents and Reports, etc.

iii. their care, seriousness and expertise in the preparation, ownership and presentation of factual information orally and in writing, and

iv. while in employment, their technical competence through the style and content of their written communication, including e-mail messages and reports.

(b) Ability to use communication techniques, skills, and tools for that purpose, by displaying

i. their knowledge of and ability to use the techniques, skills and modern engineering tools, (Autocad or similar package , Spreadsheets, Word processors, graphics and communications), and other tools for improving productivity and efficiency, and for communicating and making presentation in their practice
ii. their ability to ascertain the reliability and integrity of any software they use for design work.
iii. their knowledge and understanding of management information systems, and the use and promotion thereof in their work place.

(c) Ability to function as an individual and as member of multi-disciplinary teams, by demonstrating:

i. their ability and display of leadership skills in the management of meetings, (i.e., presiding over meetings, leading discussions, ensuring active participation of all present, taking notes, accepting and acknowledging feedback, and recording proceedings.
ii. their ability to understand concerns of peers, seniors, juniors, clients, employers and public, and ability to display flexibility and confidence when dealing with change.
iii. their understanding of group dynamics, and ability to motivate and encourage group discussions at presentations, workshops, seminars, and other situations where opportunities arise for self development and educating others.
iv. their ability to identify situations leading to conflicts, and employing communication strategies for establishing and maintaining productive working relationships.
v. their ability to work with people in other fields.

11.6 Need for Broad Education, Recognition of limits of own Professional Competence, Values and Ethics in Professional Practice, and Commitment to Life-Long Learning.

11.6a Applicants will demonstrate *their having acquired a broad education in engineering and allied fields, as may be necessary, for optimum performance in the course of their professional practice, and should additionally have the ability to recognise the limits of personal knowledge and skills, while exercising independent judgement.*

For that matter, they will demonstrate that:

i. When required to exercise independent judgement, in situations calling for specialist knowledge outside their own competence, they will recognise the limits of their own personal knowledge and skills, and will demonstrate an ability to accurately formulate the problem and the desired outcome for a solution by the specialist or peer.
ii. they have knowledge and understanding of the limitations of techniques, tools, and methods used in own practice.

iii. they have ability to integrate knowledge from different areas of practice, within and outside own area of practice, in a manner consistent with own level of knowledge and practice.
iv. they have ability to recognise personal liability when exercising independent judgement.

11.6b Applicants *will demonstrate an understanding of need for practising high ethical standards, and manifesting their sense of values and responsibility in professional practice. Towards that end they may be required to demonstrate:*

i. that they can recognise and identify ethical issues pertinent to a project, including issues relating to copyright and access to and use of intellectual property rights.
ii. that they work to a code of high standard of personal integrity and sense of values in their personal conduct.
iii. that are committed and adhere to the Code of Ethics promulgated by their their professional engineering body or other association of which they may be members.
iv. that they recognise having obligations to society, the profession and the environment, and that they are committed and adhere to implementing high professional standards dictated by the applicable Codes of Practices, and manage and apply safe systems of work.
v. that they have an understanding of the impact of engineering solutions in a global and societal context, and will engineer their solutions accordingly, and will, for that purpose, undertake engineering activities in a way that contributes to sustainable development.

11.6c Applicants *shall recognise for the need for, and demonstrate their commitment as well as ability to engage in a process of life long learning.*

They may be required to show that:
i. their appreciation for the need and motivation to pursue further education and training during their lifetimes, in both engineering and other areas, and will consequently seek and seize opportunities for improving their education and training.
ii. their commitment to a strategic plan to continuously update their knowledge and skills in order maintain their competency through their active practice.
iii. they maintain access to information on technological advances, results of research work in engineering, new and innovative products and services, processes, and engineering tools.
iv. they are able to use critical information seeking tools to access internet resources, engineering journals, patent materials, standards, etc.

11.6d Applicants *should demonstrate that that they have knowledge of contemporary issues.*

They may be required to demonstrate that:

i. they are have access, by attendance or other means, to commonly known sources of information such as educational programmes, the electronic and printed media, seminars, workshops, lectures, journals, magazines, etc., and are thus informed on contemporary issues.

ii. they have knowledge of trends in the education and training of professional engineers, including new technology introduced and taught in their own area of practice.

iii. they are aware of issues of particular interest to engineers and initiatives taken by engineers generally and those within their own field of practice.

iv. they have awareness and appreciation of issues relating to humanities, history, geography, climate, technological advances, world events, legislation affecting citizens rights, others impacting on the health and welfare of society and generally on their quality of life, etc.

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Professional Engineering Competence Standard at Review Stages

Knowledge and Competency Requirements for Registration as Professional Engineers

Note: In the ***Professional Standard*** columns, letters **A, KU, DA, EX, PC** stand for varying Levels of Competence,viz., [**A=A**ppreciation], **[KU=K**nowledge & **U**nderstanding], [**DA=D**emonstrate **A**bility], [**EX**=Has acquired **E**ngineering e**X**perience], [**PE=P**rofessional Engineer]

Core Objectives		**Professional Standard**		
Graduates from an engineering degree programme approved by CRPE, or by a body recognised by CRPE as competent for its purpose, may be required to demonstrate that they have the Appreciation, Knowledge and Understanding and/or Ability stated against each of the Core Objectives stated hereunder.		Minimum on Graduation	Minimum at Registration (2-Years on)	Expected Competence (5-years on)
1	**Knowledge of Mathematics, Science, Technology, and Engineering Principles**			
	Applicants to demonstrate *that they have adequate and sound knowledge of Mathematics, Sciences and technology, engineering principles, and specialist engineering knowledge, and that they have ability to apply their knowledge to optimisation of existing and emerging technologies. They should have*	**KU**	**DA**	**PE**
	Knowledge and Understanding of Materials (properties and processes) and their applications in own field of practice.			
	Understanding and knowledge of scientific and engineering principles underpinning design and operation of specific systems and facilities in own area of practice.			
	Ability to compute value of parameter or component influencing or producing an observed or desired effect in a system in their own area of practice,			
	Ability to undertake assessment of users' needs, marketing needs, and formulation of marketing strategies; ability to identify constraints, exploit opportunities and engaging in innovative and creative activities.			
	A theoretical approach to new products, processes, systems and services; improving quality of products and services; evaluating and facilitating entry of new technology in their own practice.			
2	**Application of Engineering Knowledge to Analysis and Problem Solving, Engineering Design, and Engineering Investigations**			
2a	**Applicants to demonstrate ability *to apply theoretical and practical***	**DA**	**EX**	**PE**
	Understand the functions and design of any engineering system, structures, facilities, equipment, components, or processes within their engineering discipline.			
	Use knowledge, including mathematical analysis and computational modelling, to analyse the design of engineering products, processes and methods, and to search for and apply innovative methods of problem solving			
	Solve problems that are unfamiliar, incompletely defined, and have competing specifications			
	Investigate engineering problems such as failure, unreliability, instability and other departures from designed performance, towards identifying contributory causes and source, and to propose solutions and supply justification.			
	Appraise and review engineering designs, and propose solutions for improving economic efficiency, operational performance, enhancing capacity and productivity, and evaluating solutions.			
	Recognise an engineering problem as an opportunity for innovation and improvement, and for bringing change, innovation and improvement in their practice.			

Graduates from an engineering degree programme approved by CRPE, or by a body recognised by CRPE as competent for its purpose, may be required to demonstrate that they have the Appreciation, Knowledge and Understanding and/or Ability stated against each of the Core Objectives stated hereunder.		Minimum on Graduation	Minimum at Registration (2-Years on)	Expected Competence (5-years on)
2b	**Applicants to demonstrate ability *to design a system, component, or process, to meet specified needs. E.g., in a given situation requiring a viable design to be produced within the scope of the design brief, they have knowledge and ability of a nature exemplified by the following:***	**DA**	**EX**	**PE**
	Understanding design methodologies, and ability to make use of that knowledge and understanding to design solutions to unfamiliar problems, possibly involving other disciplines.			
	Interpreting design brief, demonstrating knowledge of the task required and of the applicable criteria (safety, reliability, environmental), and parameters influencing outcome; Conceiving alternative design schemes.			
	Assessing and selecting a particular design scheme against the technical and other criteria which may influence utilisation and marketing of the end product, viz. standards, cost, quality, reliability, etc., and the wider societal, health and safety, environmentaland commercial considerations.			
	Checking a design produced from using proprietary software against design by conventional method.			
	Making engineering judgement in work involving complexity, technical uncertainty and incomplete information.			
	Generating and developing new and original ideas and methods.			
	Understanding problems likely to arise during design, in any design scenario, and envisage solutions to these eventualities.			
2c	**Applicants to demonstrate ability *to conduct investigations of technical issues consistent with their level of knowledge and understanding, including ability to design and conduct experiments, and analyse and interpret data towards designing and developing an engineering solution. They may be required to demonstrate their ability to:***	**DA**	**EX**	**PE**
	Explain results or observations in a process, including a departure from expected performance, and developing a hypothesis around the significant dependent and independent variables responsible for the result.			
	Design an experiment to test the hypothesis; defining the tasks to be carried out, stating the scientific and engineering principles involved as well as the controllable and non-controllable parameters likely to influence value of experiment, and carrying analytic, modelling and experimental investigations as may be necessary.			
	Conduct the experiment; measure, collect and evaluate data; present data in a manner to facilitate analysis and interpretation; explain results and draw conclusions, justify design.			
	Use appropriate methods, including search of literature, use of data bases and other sources of information, for research and other technical investigations consistent with their level of knowledge and understanding.			
2d	**PRACTICE*:* Applicants to demonstrate *that, during their training and/or experience, they have undertaken works of the following nature:***	**KU**	**EX**	**PE**
	Exploring their engineering environment for new opportunities, towards enhancing products, processes, systems and services.			
	They have undertaken and/or participated in design work, under supervision, and discussing their work with persons registered as Professional Engineers.			
	They were involved with evaluation of new technology for marketing and commercialisation by their employer or client.			
	They reviewed any design, towards ascertaining its designed performance parameters, and determining the technical, operational or environmental reasons for a departure, if any, from designed or specified operational performance, or, design changes for improving its economic efficiency or operational performance.			
	They have discussed, with their mentors, alternative solutions and designs, based on their knowledge of materials appropriate to each solution.			

Graduates from an engineering degree programme approved by CRPE, or by a body recognised by CRPE as competent for its purpose, may be required to demonstrate that they have the Appreciation, Knowledge and Understanding and/or Ability stated against each of the Core Objectives stated hereunder.			Minimum on Graduation	Minimum at Registration (2-Years on)	Expected Competence (5-years on)
3	**Management and Leadership Skills.**				
	Applicants to demonstrate *their knowledge and understanding of, and ability to use, the techniques, skills, and modern engineering tools, including management practices and procedures, necessary for engineering practice, and will have the ability to see through the operation of a supply and execution of an engineering contract.*				
	(I)	**They will display their Knowledge and Understanding *of techniques, skills, and modern engineering tools, including management practices and procedures, as well as the Ability to make use of them. In particular they will demonstrate their knowledge and understanding of*** :	**KU**	**EX**	**EX**
	Project Management tools and techniques (e.g., Gant Chart, PERT/CPM, mathematical modelling, computer simulation) and Project Management softwares; ability to use them for controlling and coordinating project execution.				
	Basic Financial Statements (Balance Sheet) and Ability to undertake Project Appraisal and costing using discounted cash-flowtechniques-NPV, IRR				
	Preparation and control of Cashflows, forecasts, budgets, and ability to identify elements affecting business profitability				
	Methods and procedures for assessment of service quality and performance; .				
	Project Management; Programming and control of manpower, project resources, finances and administrative support; decision processes (use of statistics, uncertainty, probability, curve fitting)				
	(ii)	**Ability *to see through the operation of supply and execution of engineering contracts. Applicants should demonstrate their:***	**KU**	**EX**	**PC**
	Knowledge and Understanding of Procurement Procedures, Tender Specifications, Contract documents and Conditions of Contract for Engineering works, Evaluating Tenders, etc.				
	Knowledge and Understanding of contract pricing; safeguarding against market trends influencing cost (raw materials, labour, manufacturing processes, taxes, etc); Ability to monitor and control activities and events responsible for cost overruns and influencing profitability of business.				
	Awareness of legislation impacting upon their practice in relation to contracts management: regulation of their practice, labour laws, applicable Health and Safety issues in Design and during Construction, Construction Industry Building Regulations, Government taxes, etc.				
	Knowledge of Responsibilities of Engineer and other key players in the administration and execution of engineering contracts, exemplified by reference to some Standard Forms of Contracts				
	Ability to act as project team leader, direct and control programme execution, and undertake the necessary liason with management; handling and executing requests for design changes, variations, etc.; handing-over / acceptance certification. undertake quality assessment of engineering services, carryout performance appraisal, engage in continuous improvement programmes				
	Experience in Producing Design brief, procurement of design and construction services; production techniques (manufacture, assembly, construction, use of machinery and equipment), material testing procedures, engineering construction, production, assembly, acceptance test techniques and experience in handling tools and machinery, support systems, production programmes and activities sequencing.				
	Understanding, assessment and management of Risks in project management and business; the implications of health, safety, insurance and industrial relations issues for the proper execution and financial viability of engineering contracts; Limitations of Risks assessment and management techniques.				

Graduates from an engineering degree programme approved by CRPE, or by a body recognised by CRPE as competent for its purpose, may be required to demonstrate that they have the Appreciation, Knowledge and Understanding and/or Ability stated against each of the Core Objectives stated hereunder.			Minimum on Graduation	Minimum at Registration (2-Years on)	Expected Competence (5-years on)
4	**Engineer's Responsibility for the Environment, Health, and Safety.**				
	Applicants will demonstrate *that they have knowledge of the impact of engineering design on quality of environment, health and safety, and quality of life, and have, further, acquired the ability to recognise and assess risks to quality of life, and, consequently, to design and implement measures and safeguards to enhance quality of environment and life, and ensure sustainability. For these purposes, they will demonstrate:*		**KU**	**DA**	**PE**
	Awareness of common environmental threats to quality of environment and life, including pollution by contaminates, and are generally aware of applicable control procedures and safeguards.				
	Ability to recognise, monitor,and assess risks to the quality of environment within own area of responsibility and practice, as well as hazards to safety, welfare and health, and prioritise the risks for remedial intervention.				
	Knowledge of legislation (relevant to their practice) governing quality of environment, safety health, and welfare of society, and its influence on the design process and solutions implemented. .				
	Have appreciation of effects and constraints that planning, sustainability and environmental impact assessments (EIAs) can have on design				
	Awareness that the design of facilities and their operation have an influence on both energy consumption and emission of greenhouse gases, and that these factors may lead authorities to impose environmental protection taxes.				
	Ability to conceive and develop new products and services which maintain and enhance quality of environment and quality of life of the community.				
	Have knowledge of environmental and and sustainability issues that can be raised by the project implementation methods, procedures, and the selection of materials. Ability to recognise need for specialist environmental and sustainability advisers for handling such issues.				
5	**Interpersonal Skills and Communications**				
	Applicants will demonstrate *that they have acquired the ability, in the course of their normal professional practice, to interact with individuals and groups, including peers, subordinates, clients, administrators, policy makers and the public, such that they will need to have ability to:*				
	a	***Communicate effectively with peers, the engineering community and the society,***	**KU**	**DA**	**PE**
	b	***Use communication techniques, skills and tools for that purpose,***	**KU**	**DA**	**PE**
	c	***Function as an indivdual and on multi-disciplinary teams.***	**KU**	**DA**	**PE**
	For the above purposes they may be required to demonstrate that:				
	They have a good command of language and good writing standard and skills in their their memos, letters, abstracts, and Reports, as well as when making summaries of technical reports, when preparing and delivering presentation				
	They have knowledge and ability to use the techniques, skills, and modern engineering tools, (Auto-Cad or similar package, Spreadsheets, Word processing, graphics and communication), and other tools for improving productivity and efficiency, for making presentation and communication.				
	They have Ability to ascertain reliability and integrity of software they use for design, and ensure data security				
	They are Conversant with management information systems, and Intellectual property rights issues.				
	They have leadership skills and have ability to chair and handle meetings, encourage and motivate group discussions; Understanding of group dynamics.				
	They have Ability to identify situations of conflict and distractions, in the course of meetings or dealings with peers, etc, and resorting to strategies for establishing and maintaining a productive working relationships.				

Graduates from an engineering degree programme approved by CRPE, or by a body recognised by CRPE as competent for its purpose, may be required to demonstrate that they have the Appreciation, Knowledge and Understanding and/or Ability stated against each of the Core Objectives stated hereunder.			Minimum on Graduation	Minimum at Registration (2-Years on)	Expected Competence (5-years on)
6	**Need for Broad Education, Recognition of Limits of Professional Competence, Values and Ethics in Professional Practice, and Commitment to Life - Long learning.**				
	Applicants may be required to demonstrate:				
	a	***that they have a broad education in engineering and allied fields, as may be necessary, for optimum performance in the course of their professional practice, and that they have ability to recognise limits of personal knowledge and skills, while exercising independent judgement;***	**KU**	**DA**	**PE**
	b	***their commitment to a high ethical standard, sense of values, and responsibility in professional practice;***	**KA**	**DA**	**PE**
	c	***their commitment and ability to engage in a process of life long learning;***	**KA**	**DA**	**PE**
	d	***that have a knowledge of contemporay issues.***	**KA**	**DA**	**PE**
	For the above purposes they may be required to demonstrate:				
	that in the exercise of independent judgement, they will recognise the limits of personal skills, knowledge and competence, and personal liability, and will have ability to accurately formulate the problem and the desired outcome for a solution by a specialist; they will work to a plan to enhance knowledge, skills and competence;				
	their Knowledge and understanding of the limitations of techniques, tools, and methods used in own practice.				
	their Ability to integrate knowledge from different different areas of practice, within and outside engineering, in own practice, in a manner consistent with own level of knowledge and practice.				
	their Ability to recognise ethical values pertinent to a project, including issues relating to copyright and access and use of intellectual property rights.				
	their Commitment to work to a Code of high personal integrity and sense of values in personal conduct and own practice and to a Code of Ethics relevant to their practice.				
	that they recognises their obligations to society, the profession, and to the environment, and show their Commitment to the Codes of Practice applicable to own practice.				
	their Ability to manage and apply safe systems of work while maintaining an ethical balance between obligations to society and business demands.				
	their Knowledge and understanding of impact of engineering solutions in a global and societal context, and ability to undertake engineering activities in a manner that contributes to sustainable environment.				
	they have a knowledge and professional proficiency enhancement plan, which includes provision for pursuing further education and training, in engineering and otherwise, and exploring opportunities for such purpose, and keeping abreast of technological advances.				
	that they maintain active links with professional engineering institutions towards ensuring access to information on technological advances, results of research work in engineering, new and innovative products and services, tools and processes.				
	their ability to use critical information seeking tools to access internet resources, engineering journals, patent materials, standards, etc. in the pursuit of knowledge and competence building plan.				
	that they have access to common sources of information on contemporary issues: viz., educational programmes, the electronic and printed media, attending seminars, workshops, lectures, journals, magazines, subscriptions.				
	their knowledge of trends in the education and training of professional engineers, including new technology developed, and taught as part of the study programme for students graduating in own area of practice.				
	their awareness and appreciation of issues relating to humanities, history, geography and climate, technological advances, world events, legislation affecting rights of citizens, etc.				

Guidance on Elements of Satisfactory Practice of Engineering.

Note: Desirable Exposure to Engineering Practice

Council has a responsibility to ensure that the experience claimed by applicants for registration is of a nature that satisfies the requirement of law, i.e., they should ***be "reporting on, advising on, designing or approving designs....***" of public utilities, engineering works, etc.

Consideration of the legal requirement (and Council's interpretation of the statutory definition and other provisions of the Act), and guidance drawn from sources quoted in this Paper, viz., definition of "**Professional/Chartered Engineer**", definition of "**practice of engineering**" (as defined by others and proposed by Council), the **UK Professional Competence Standard**, the criteria for acceptable **Qualifying Experience set out by the National Society of Professional Engineers (US)**, etc., compels Council to specify that the two years experience should take the Graduate engineers through an **Initial Training and Development Programme** such as set out in the Schedule at **ANNEX D** .

This Schedule should be read together with the following:

ANNEX A: **Draft Standard of Professional Engineering Competence**: **PART A: Core Objectives: *Graduate's Knowledge and Ability.***

ANNEX B: Part B of the Draft Professional Engineering Competence Standard (Knowledge and Competence Objectives to be demonstrated by Applicants for Registration, i.e. on completion of Training/experience requirements).

ANNEX C): **Professional Engineering Competence Standard at Review Stages**, giving Guidance on standard that should be attained by Applicants ***on Graduation, on Completion of two years of approved training***, and ***on Completion of 5 years of post graduation practice***.

Engineering Activity	Min. Overall Training Period:104wk
A. Engineering Design Practice	**Min 40% [40 wk]**
Engineering Analysis and Problem Solving: *Note a* Analysis and solving engineering problems, etc.	**15 weeks (Min)**
Engineering Design or Related : *Note a* Designing, participating in design team, etc.	**15 weeks (Min)**

Engineering Investigations (search for solutions) **15 weeks (Min)**
Note a
Evolve hypothesis to explain results or observations of an engineering process; devising modelling, simulation, experimenting to test hypothesis.

B. Project Management and Leadership Skills **Min 40%[40 wk]**
***Note b**
Project planning/monitoring and appraisal Techniques, tools, etc and Management. Project Risk management

C. Responsibility for Environment, Health and Safety **Min 10% [10 wk]**
***Note c**
Impact of engineering design on quality of environment, health and safety. Assessment of risks to quality of life, etc.

D. Development of Interpersonal Skills and Communications **Min 5% [5 wk]**
***Note c**

E. Broad Educatn, Values/Ethics, Commitment to Life-Long Learning. Min 5%[5 wk]
***Note c**

Note a: It is recognised that during the initial 2 years, Graduate Engineers may not have opportunities to receive training in the 3 components of design (**A, B, and C**). They may in such cases plan their training in two components, but CRPE Panel may require them to compensate for the shortfall in any required area of practice, by additional training in other components.

Note b: Applicants not having received training on Project Management Skills, would be expected to compensate for the shortfall with evidence of additional Training in Design Related Activities (A,B, and C).

Note c: It is recognised that Applicants may develop their skills and acquire the required level of ability in respect of items **C, D, and E** while acquiring experience in **Engineering Design Practice** and/or when getting experience in **Project Management and Leadership Skills**.

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This Schedule is explained in Section 14 of Council's Paper "Practice of Professional Engineering".

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Guidance on Elements of Satisfactory Practice of Engineering.

Applicable to Applicants Engaged in Provision of Engineering Consulting and Advisory Services to the Industry and to Consulting Engineering firms or other Customers

Applicable Criteria for Determining the Acceptability or Otherwise of Experience claimed as Practice of Engineering by Teaching Personnel of Tertiary Educational Institutions.

#1. Applicants should comply with normal application and registration procedure.

#2. Experience claimed by way of provision of engineering consultancy services, while in employment of the University of Mauritius or other Tertiary Educational Institutions should be cover a continuous period of 4 academic years(208 weeks).

#3. Applicant must, mandatorily, have provided engineering consultancy services, by way of engineering advice, proposals on engineering solutions, assistance with drafting of engineering performance specifications, participation in exercise leading to selection of major industrial plant, machines, equipment, including upgrading of plant, machines, equipment and infrastructure, designing of systems, components or processes to meet specific needs, as well as undertaking performance tests, of a nature different from routine operations which he/she or the University performs on a commercial basis.

#4. Consultancy work must have had explicit approval of the University, etc.

#5. All consultancy work included for the purpose of #2 above must satisfy Section 20 of the Act, e.g. approved by a person, or carried out on behalf of person, registered under the Act. For this purpose, Council requires evidence that the engineering services delivered to any client (i.e., Consulting Engineering firms, Public Body, etc) were subject to the checking and approval of a registered person in the employment of or acting on behalf of the Client, with the necessary competence to check and approve any engineering design or decision of a "final" nature.

#6. The aggregate of time accounted for under #3 above should be at least 50 weeks in any continuous period of 4 years, including visits, discussions, data collection, identifying problems areas, issues to be resolved, search for solutions, proposals, discussing solutions with clients representatives (registered engineers), advising and reporting, production and submission of design, monitoring of implementation, etc.

#7 An aggregate of 120 weeks should be spent as follows:

(a) Lecturing to 3rd and 4th year full time degree students on "Engineering design" or on such subject modules which are intended to impart to students the knowledge required and ability to design systems, components or process to meet specific needs, as well as to design and conduct experiments, analyse and interpret data, and apply engineering knowledge to solve engineering problems.

(b) Tutorial and Coaching Sessions for 3rd and 4th year engineering degree students on application of theoretical and practical methods to engineering design and solving of engineering problems.

(c) Any lecture time spent lecturing on Engineering Principles, Systems, Design, and Innovation, Environmental Engineering, and Project Management to students enrolled on Master's Degrees in Engineering, including Environmental Engineering.

(d) 25% of all Laboratory work directly supervised at the level of 3rd year and 4th year Engineering Degrees.

(e) The aggregate of the periods under #7(a), (b), (c) and (d) to be increase by 25% to provide for time employed in preparing for the lectures, laboratory and tutorial sessions, the aggregate obtained not exceeding 120 weeks.

#8. Notwithstanding the above provisions, any continuous period of industrial engineering practice exceeding 3 months by the applicant, while on leave from the University, or prior to his joining the University, or after expiry of his/her lecturing contract, will be admissible as engineering practice subject to the practice being in compliance with Council requirements.

#9. Applicants should also submit evidence to the effect that they have also had demonstrable exposure and experience in respect of Transferable Skills (i.e. Project Management and Leadership Skills, Engineer's Responsibility for Environment, Health and Safety, Interpersonal Skills and Communication, Need for Broad Education, Ethics and values, Commitment to Life Long learning. They should reckon at least 20 weeks in aggregate over activities relating to these issues.

They may for this purpose aggregate periods of visits to Works in progress on engineering sites, industrial visits, organising and/or attending seminars and workshops, making presentations to technical audiences, writing and publishing papers on the above issues, etc.

#10. When combining periods of experience under #8 with other periods towards aggregating the 208 weeks required under #2, they should double the period under #8, and deduct from 208 weeks to determine the aggregate period of training/experience required to be included in relation to activities carried out as staff of the Tertiary Educational Institution.

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This Schedule is explained in Section 15 of Council's Paper "Practice of Professional Engineering", issued by the Council of Registered Professional Engineers in November 2006..

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December 2007