THE ENGINEERING PROFESSION AND THE PROFESSIONAL ENGINEER

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ABSTRACT

This paper addresses the methods and regulations adopted in leading industrial countries in the practice of the engineering profession. The steps leading to obtaining and maintaining professional engineering licensure are also addressed. The paper also discusses the feasibility of establishing a professional engineering board to provide for the licensing and regulation of persons in the practices of engineering and land surveying in the Kingdom of Saudi Arabia.

Keywords: *Engineering products, professional engineer, registration, licensure, engineering ethics, professional development.*

الملخص

تناقش هذه الورقة الأساليب والنظم المتبعة في الدول الصناعية الكبرى من أجل تقنين مزاولة مهنة الهندسة وكذلك الخطوات اللازمة للحصول على ترخيص مزاولة المهنة ، وتتطرق هذه الدراسة إلي إمكانية إنشاء نظم وهيئات وطنية مماثلة لتقنين مزاولة مهنة الهندسة تمشيا مع مايتلائم ومتطلبات الصناعات المختلفة بالمملكة العربية السعودية.

1. INTRODUCTION

Engineering products and applications are essential to everyday activities in our life. These include housing, transportations, communications, and other industrial processes. In order to safeguard life, health and property, and to promote public welfare, the practice of engineering is treated as a learned profession, and its practitioners shall be held accountable by high professional standards in keeping with the ethics and practices of other learned professions. Accordingly, the leading industrial countries have ruled that no person shall practice engineering unless registered as a professional engineer. A professional engineer is a person who, by reason of his knowledge of the mathematical and physical sciences, in addition to the principles and methods of engineering analysis and design acquired by engineering education and engineering experience, is qualified to practice engineering. Professional engineering licensure, in general, is acquired by submitting evidence of engineering qualifications, engineering experience, successfully passing the required exams, and maintaining professional development. A brief history of the professional licensure in three major industrial countries is presented

1.1 The Practice of Engineering in the United States of America

In the United States, the regulation of the practice of the engineering profession dates back to the beginning of the 19th century. The practice of engineering in the United States is regulated by the individual states. The first board of licensure for professional engineers was established in 1907 in the State of Wyoming. Other states followed. In the United States of America, a license is required before an engineer may practice before the public. The title *professional engineer* is restricted by law to those individuals who have demonstrated that they possess the necessary qualifications and have been licensed by the State to use the title, which is often abbreviated as "PE."

The licensure of engineers is the responsibility of each individual state, rather than the federal government. There is a licensing board in each state. As jurisdictional licensure laws were enacted and the mobility of engineers increased, intra-jurisdiction licensure problems began to develop. Increasingly, it became apparent that a national body was needed to coordinate information between the boards of licensure. In 1920, the Council was founded by seven of the thirteen jurisdictional boards having engineering and surveying licensing laws, [NCEES, 1999]. Council membership steadily increased as jurisdiction boards assumed legal status through legislation. When organized, the Council was given the name: Council of State Boards of Engineering Examiners. In 1925, the adjective “National” was added to the name. The Council was incorporated in 1938 under S.C. law as an eleemosynary corporation. The name, National Council of State Boards of Engineering Examiners (NCSBEE), was retained until 1967 when the name was changed to the National Council of Engineering Examiners (NCEE). In 1989, the name was revised to the National Council of Examiners for Engineering and Surveying (NCEES).

The National Council of Examiners for Engineering and Surveying (NCEES) is comprised of engineering and surveying licensing boards. These Member Boards represent all U.S. jurisdictions, [Alabama State Board, 1999]. Representing the Member Boards are individuals appointed at the jurisdictional level to represent and safeguard the general public. These board members serve as delegates to the NCEES and its committees. Thus, there are no individual members of the NCEES, rather the delegates represent their respective boards as members of the NCEES. Presently, the NCEES has 70 Member Boards. Council membership is geographically divided into four zones: Central Zone, Northeast Zone, Southern Zone, and Western Zone. The zones meet twice a year, usually in the spring and at NCEES Annual Meeting. These biannual meetings serve as a forum on topics of regional interest and concern as a prelude to NCEES Annual Meeting in August of each year.

The Board of Directors consists of the President, the President-Elect, the Treasurer, the Immediate Past President, and the Vice President of each zone. The office of President constitutes a three-year term on the Board of Directors. The President serves one year as President-Elect prior to installation as President and one year as Immediate Past President

following his year in office as President of the NCEES. The office of President annually rotates between each zone.

A primary function of the NCEES is the preparation and scoring of licensing exams for engineering and surveying that are administered by the licensing boards. These examinations are the Fundamentals of Engineering (FE) examination, the Principles and Practice of Engineering (PE) examination, the Fundamentals of Land Surveying (FLS) examination, and the Principles and Practice of Land Surveying (PLS) examination.

1.2 The Practice of Engineering in Canada

The process of professional engineering licensure in Canada is, to a great extent, similar to that of the United States of America. Established in 1936, the Canadian Council of Professional Engineers (CCPE) is the national organization of the 12 provincial and territorial associations that regulate the practice of engineering in Canada and license the country's more than 160,000 professional engineers, [CCPE, 1998]. CCPE serves the associations, which are its constituent and sole members, by delivering national programs that ensure the highest standards of engineering education, professional qualifications and ethical conduct. The title "professional engineer" is restricted by law. Only those individuals who have demonstrated that they possess the necessary qualifications and have been licensed by a provincial board can use the title, which is often abbreviated as "P.Eng."

The Professional Engineers Act provides that every professional engineer shall have a seal denoting licensure, including the type of license held. The appearance of the seal on documents and drawings indicates that the documents and drawings are final and have been prepared under the supervision of a professional engineer who is assuming responsibility for them. In Canada, the practice of professional engineering is defined to comprise the following three tests: (a) any act of designing, composing, evaluating, advising, reporting, directing or supervising; (b) wherein the safeguarding of life, health, property or the public welfare is concerned, and (c) that requires the application of engineering principles, but does not include practicing as a natural scientist. If what one does meets all three tests, the person is practicing professional engineering and must be licensed by the association. To be licensed as professional engineers, applicants must demonstrate to the Association that they are qualified to practice engineering, [CCPE, 2001]. To be licensed, applicants must:

- be academically qualified;
- have obtained sufficient acceptable engineering work experience in their area of practice;
- have an understanding of local practices and conditions;

- be competent in the language of their jurisdiction of practice;
- be of good character; and,
- demonstrate an understanding of professional practice and ethics issues.

In 1965, the Canadian Council of Professional Engineers (CCPE) established the Canadian Accreditation Board (CAB), now known as the Canadian Engineering Accreditation Board (CEAB), to accredit Canadian undergraduate engineering programs that meet or exceed educational standards acceptable for professional engineering licensure in Canada. Applicants for licensure must meet the academic qualification requirement. There are two avenues for meeting this requirement: (a) a degree from a CEAB-accredited program or a CEAB-recognized program; or (b) successful completion of examinations.

In addition to the previous academic qualification requirements, professional engineering licensure in Canada requires both experience and examination. Engineering work experience should normally be obtained while applicants are enrolled as "Engineers-in-Training" (EITs). An EIT program provides the forum for standardizing an approach to the training of engineers, and helps EITs to develop those skills and habits necessary to make them qualified engineers who will be valued members of the engineering profession. Each Association should provide an EIT program to ensure that all EITs:

- obtain the appropriate preparation for licensing, including the technical content of the work experience and the growth in professional responsibility;
- obtain the necessary guidance and supervision;
- develop a commitment to lifelong learning to ensure continuing competency as a professional engineer;
- continue their education to enhance both the technical and non-technical aspects of their careers; and,
- develop an understanding of the nature of a self-regulating profession and an appreciation for the privileges and responsibilities of its members.

Applicants for licensure are required to pass an examination to confirm that they have sufficient knowledge of the ethical considerations and obligations that accompany the privileges of professional status, and the legal concepts relevant to professional engineering practice. This examination is called the Professional Practice Examination (PPE). It should be consistent with the CCPE Guideline. A national Professional Practice Examination program is available. The Professional Engineers Act provides mutual recognition of Registered/Licensed Engineers by jurisdictions of Canada, the United States of America and the United Mexican States to facilitate mobility in accordance with North American Free Trade Agreement.

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1.3 The Practice of Engineering in the United Kingdom

The practice of the engineering profession as well as the academic accreditation programs in the United Kingdom were traditionally regulated through the concerned professional engineering institutions. As a corporate body established by a Royal Charter and Bylaws granted in 1981, the **Engineering Council** became the national representative body of the Engineering Profession [The Engineering Council Royal Charter, 1981]. A successor to the formal Council of Engineering Institutions formed in 1964, it is a chartered body formed to promulgate good engineering practice and to coordinate the activities of 35 leading Institutions. Now, the Engineering Council is the national registration authority for professional engineers. The Engineering Council is responsible for regulating the Engineering Profession and in collaboration with the Engineering Institutions and other engineering bodies publishes and operates a code of conduct and disciplinary procedures.

The Council consists of the members of the Senate of the corporation and the voting members of the **Board for Engineers' Regulation** and of the **Board for the Engineering Profession** of the corporation. Different professional engineering institutions, which are approved by the Board for Engineers' Regulation as nominating bodies, nominate members of the corporation. The two Boards of the corporation are characterized as follows: -

i. The *Board for Engineers' Regulation*, which defines, monitors and reviews the education and training standards and the continuing and professional development of engineers and technicians registered with the corporation. The Board for Engineers' Regulation is also responsible for maintaining the register of engineers and technicians; and

ii. The *Board for the Engineering Profession*, which takes action in, the public interest to implement activities related to the whole engineering profession. In order to achieve this, the Board for the Engineering Profession facilitates the establishment of collaborative joint projects and ventures between participating Engineering Institutions.

The Senate shall have the right to veto or amend any resolution or decision of either of the Boards. The Senate consists of up to fifty-four members; 48 elected members and 6 appointed members. The Board for Engineers' Regulation consists of up to 16 senate members plus a number of co-opted members (nonvoting members). The Board for the Engineering Profession consists of up to 20 senate members plus a number of co-opted members (nonvoting members). The members of each Board represent a balanced regional and Electoral College distribution. The chairman of the Senate is elected among its members. The Senate endeavors to ensure that the chairman and other members of the Senate together represent a regional distribution and provide a reasonable balance among those having experience and knowledge of the major areas of industry and the significant engineering disciplines.

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The most popular route to registration is an undergraduate engineering degree, accredited by one of the 16 Institutions licensed by the Engineering Council. However, this is only a component of the formation package. The UK's relatively short engineering degree requires supplementation by a period of training and experience so that professional competence can be achieved.

The Engineering Council is the national registration authority for professional engineers. It promotes and regulates the profession to maintain a world-class engineering workforce in the UK. In addition to maintaining a register of professional engineers and technicians, the Council has set the Standards and Routes to Registration (SARTOR), which define the standard for registration as **Chartered Engineer (CEng), Incorporated Engineer (IEng),** and **Engineering Technician (EngTech)**, [The Engineering Council, 2001]. The Nominated Engineering Institutions assess applicants, against these standards, for Membership of the particular Institution and Registration with the Engineering Council. Anyone wishing to apply for Registration must apply through one of the Institutions. Applications are not accepted through the Engineering Council. The academic standard for each section of the Register is:

- **CEng** - exemplified by an appropriate qualification accredited as being at least equivalent in standard, such as an MEng degree. A further alternative is to achieve an accredited BEng (Hons) degree together with a *'Matching Section*'.
- **IEng** - exemplified by a three-year degree accredited for IEng or a Higher National Diploma (HND) followed by a year of further learning known as a *Matching Section*.
- **EngTech** - exemplified by a National Diploma or National Certificate in engineering.

A ***'Matching Section***' is a period of further learning, adding appropriate breadth and depth, to be completed in all cases where a candidate's initial accredited course does not fulfill the entire educational base requirements laid down in SARTOR. Matching Sections, can take a variety of forms such as full or part-time post-graduate courses, distance learning and work-based learning. In general, the applicant's qualifications and the course of study required to meet the registration standard are determined by the nominated Engineering Institutions.

The Engineering Council Examination has now been remodeled to provide a more flexible route to meet the academic requirements for entry to Chartered Engineer. The new structure offers a nationally recognized **Credit Accumulation & Transfer Scheme** (CATS) points which may permit the applicant to gain equivalent exemptions from other appropriate or higher level courses. The *Council's Certificate* provides 180 CATS points, and the *Council's Graduate Diploma* provides an additional 180 CATS points, which are acquired through a flexibly-structured system of courses, papers and examinations.

With regard to the engineering experience requirements, applicants for registration must complete periods of approved training, increasing experience and responsibility, and have these and their competence assessed through a Professional Review.

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2. THE ROUTE TO PROFESSIONAL LICENSURE

It is apparent from the presented review of how the engineering profession is regulated in three leading industrial countries that a national body was found necessary to unify the process of engineering licensure. The three major systems, reviewed previously, adopted the idea of establishing a notional engineering council to set the regulations, and to coordinate the licensing process among different provinces within the country. It is noteworthy to mention that the process of professional engineering licensure, in general, requires the satisfaction of specific requirements regarding the three basic components of academic education, experience, and examinations. The detailed requirements may vary from one system to another. The Canadian system is structurally similar to that of the United States of America except that of the examination component, wherein The Professional Practice Examination (PPE) is just a three-hour, closed-book exam on ethics, professional practice, engineering law and liability. The examination component in the American system, however, is more comprehensive and addresses the basics, principles and practice of engineering with emphasis on areas of specialization. The British system has a much more flexible examination system with many alternatives, which include formal written exams, papers, project-based assignments, and acquired credits by distant learning techniques. A unique feature of the British system, however, is that it provides a separate route to registration for technicians with a separate section in the registry under the title **EngTech.**

The preceding review reveals that the United States of America is a world leader in regulating the engineering profession, where the first board of professional engineering was established in 1907, and the National Council of Engineering was established in 1920. In addition, the specific requirements for professional licensure in the States are well defined, and the examination system is comprehensive. Accordingly, we will review the route to professional engineering licensure in the light of the system adopted in the United States of America, which will be detailed in the following sections:

2.1 General Requirements for Registration

The following are considered as minimum evidence satisfactory to the board that the applicant is qualified for licensure as a professional engineer: *Graduation and experience plus examinations.*

1. **Graduation in an approved engineering curriculum plus four years experience**. -- A graduate of an approved engineering curriculum of four years or more from a school or college approved by the board (definitions of approved curricula are given in the Appendix) who has successfully passed the eight-hour written examination in the fundamental engineering subjects and who has a specific record of an additional four years or more of progressive experience in engineering work of a grade and character

satisfactory to the board is admitted to an eight-hour written examination in the principles and practice of engineering. Upon passing this examination, the applicant is granted a certificate of licensure to practice engineering in the concerned state, provided the applicant is otherwise qualified.

2. **Graduation in an unapproved engineering curriculum plus six years experience.** -- A graduate of an unapproved engineering curriculum of four years or more who has successfully passed the eight-hour written examination in the fundamental engineering subjects and who has a specific record of an additional six years or more of progressive experience in engineering work of a grade and character satisfactory to the board shall be admitted to an eight-hour written examination in the principles and practice of engineering. Upon passing this examination, the applicant shall be granted a certificate of licensure to practice engineering in the concerned state, provided the applicant is otherwise qualified.

3. **Graduation in an approved engineering technology or related science curriculum plus eight years experience.** -- A graduate of an approved engineering technology curriculum of four years or more from a school or college approved by the board or a graduate of a related science curriculum of four years or more who has successfully passed the eight-hour written examination in the fundamental engineering subjects and who has a specific record of an additional eight years or more of progressive experience in engineering work of a grade and character satisfactory to the board shall be admitted to an eight-hour written examination in the principles and practice of engineering. Upon passing this examination, the applicant is granted a certificate of licensure to practice engineering in the concerned state, provided the applicant is otherwise qualified.

2.2 Examinations

i) The Fundamental of Engineering Exam (FE):

The Fundamentals of Engineering exam covers subject matter in a typical EAC/ABET-accredited baccalaureate-engineering curriculum, [NCEES, 1997]. The exam is frequently taken in the senior year of the program. This is an 8-hour exam covered in two sessions. The **morning session** consists of 120 questions that count 1 points each, for a total of 120 points., as detailed in Table 1.

Table 1: Morning General Exam

Topic	% of Questions
Chemistry	9 %
Computers	5 %
Dynamics	8 %
Electrical Circuits	10 %
Engineering Economics	4 %
Ethics	4 %
Fluid Mechanics	7 %
Materials Science/ Structure of Matter	7 %
Mathematics	20 %
Mechanics of Materials	7 %
Statics	10 %
Thermodynamics	9 %

The **afternoon session** consists of 60 questions that count 2 points each, for a total of 120 points. One has a choice of selecting a general afternoon session or a discipline-specific session. The general exam covers the same subject topics as the morning session, with a different percentage breakdown, and obviously more involved questions.

ii) The Principles & Practice of Engineering Exam (PE):

The Principles and Practice of Engineering exam is typically taken after passing the FE exam and upon obtaining at least 4 years of engineering experience (see Appendix) deemed acceptable to the licensing board. The PE exam goes beyond testing academic knowledge and may require knowledge gained in engineering practice. This is an 8-hour exam covered in two sessions. The format depends on the discipline, and exam formats change periodically [NCEES, 1994]. For exams on professional land surveying, one may consult references [NCEES, 1995-a, 1995-b].

Beginning with the October 2000 exam administration, the Civil Engineering PE exam adopted a breadth and depth format. The morning portion of the exam focuses on the breadth of civil engineering; it is 100% multiple choice and candidates must answer all questions. The afternoon portion of the exam is also all multiple choice; however, candidates choose one of five modules that examine a civil engineering specialty area in depth. The candidate must answer all questions in the module that is chosen. The PE exams in Electrical and Computer Engineering and Mechanical Engineering are the only other exams that are following the lead of Civil Engineering in adopting a breadth and depth format. The change took place in October 2001 for Mechanical Engineering and in April 2002 for Electrical and Computer Engineering.

2.3 Other requirements

In addition to satisfying the previously stated requirements, the candidate must submit references and must be of good character and reputation. These are stated as follows:

a) **References:** The applicant shall furnish on the application for licensure five reference names, and addresses. A minimum of three of the five references must be currently licensed professional engineers; however, it is desirable that all the references be licensed professional engineers who are qualified to evaluate the applicant's engineering training and experience.

b) **Character**: No person shall be eligible for licensure as a professional engineer, certification as an engineer intern, licensure as a professional land surveyor, or certification as a land surveyor intern who is not of good character and reputation

2.4 Approved Registration

Once the applicant has passed all the aforementioned requirements to the satisfaction of the Board, he is granted licensure and is consequently entitled to the following:

a) **License Number:** At the time an applicant is granted licensure by the Board, the applicant will be assigned a license number.

b) **Certificates of Licensure:** After the Board has received payment of the licensure fee from an approved applicant; a Certificate of Licensure with the license number will be issued.

c) **Seal of the Licensee:** Upon approval of licensure by the Board, licensees will be advised that they should secure an official seal which shall be applied to all drawings, specifications, reports, and other engineering or land surveying documents prepared by or under the direct control and personal supervision of the licensees.

2.5 Professional Development and Renewal

All licenses lapse on December 31 of a specified year. Each licensee will be mailed a form for renewal of licensure no later than two months prior to the date the license lapses. The renewal is granted upon satisfying the following three requirements:

a) Signing and returning the original renewal form to the Board.

b) Submitting a statement detailing the number of Professional Development Hours (PDH) with description of the associated engineering activities during the past year.

c) Payment of the renewal fee as determined by the licensing Board.

In the early nineties, most of the State Boards of Licensure manifested continuing professional competency in accordance with their code. Accordingly, each licensee is required to meet the continuing professional competency requirements for professional development as a condition for licensure renewal. Continuing professional competency obtained by a licensee should maintain, improve, or expand skills and knowledge obtained prior to initial licensure or develop new and relevant skills and knowledge. To demonstrate that a licensed professional engineer or professional land surveyor maintains an acceptable level of competency, a licensee must obtain the number of PDH (see Appendix) per renewal period as shown below. The requirement must be satisfied during the current renewal period except for the carryover permitted. A licensed professional engineer or licensed professional land surveyor must earn a minimum of fifteen PDH per annual renewal except for the carryover permitted. The number of professional development hours, which may be carried forward into the next renewal period, shall not exceed fifteen.

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The professional development hours must be earned through qualifying educational activities, which may be sponsored by an individual, organization, association, institution, societies, or other entity, which provides an educational activity for the purpose of fulfilling the continuing professional competency requirements. The qualifying educational activities for continuing professional competency shall include, but not be limited to:

a) Successfully completing or auditing college or university sponsored courses,

b) Successfully completing courses with awarded continuing educational units (CEU),

c) Attending seminars, tutorials, short courses, correspondence courses, televised courses, or videotaped courses,

d) Attending in-house programs sponsored by corporations or other organizations,

e) Teaching or instructing as described in (a) through (d) above,

f) Authoring published papers, articles, or books,

g) Making presentations at technical meetings,

h) Attending qualifying program presentations at related technical or professional meetings,

i) Receiving a United States patent.

All of such activities as described in (a) through (i) above must be relevant to the practice of engineering or land surveying and may include technical, ethical, or managerial content. The conversion to PDH units from other units is as described in Table 2.

Table 2: Equivalent PDH units

Educational/Professional activity	**PDH**
One University semester hour of credit	45
One University quarter hour of credit	30
One Continuing education unit (CEU)	10
One Hour of acceptable professional development education	1
Teaching in any of the above activities	(i)
Successful auditing of a university or college course	(ii)
Authorship of papers, books, and patents	(iii)

i) Multiply the corresponding PDH by a factor of 2.

ii) Multiply the corresponding PDH by a factor of 1/3.

iii) Credit earned equal preparation time spent not to exceed 10 PDH per publication or patent. Already published papers or awarded patents are considered.

In general, the Board does not accept self study, regular employment including repetitive teaching of the same course without updating course material, service club meetings, equipment demonstrations, membership on Boards or Committees, enrollment without attending the course, conversational language courses for personal use, and other activities not relevant to engineering or land surveying and not educational in nature.

3. CONCLUDING REMARKS

The previous limited survey, based on the available literature, shows how the leading industrialized countries have recognized, at a very early stage - almost a century ago, the importance of regulating the practice of the engineering profession. Accordingly, accreditation boards, engineering councils, and boards of licensure were established with well-defined missions and bylaws.

The preparation of the future engineer normally starts with pre-college school education wherein the student is taught the basic principles of physics. The educational process progresses through college education where the breadth of the acquired information in physics and mathematics is widened. In addition, the engineering students learn how to relate and apply the theoretical knowledge to various engineering problems. The academic education, however, is just one component of the qualification required of a professional engineer. The second component, which is considered vital to the practice of engineering, includes learning specific skills gained trough practical experience. The third component, which is regulatory in nature, is manifested by a third party supervision, or a body that testifies to the competence of the engineer to offer services to the public.

It is noteworthy to mention that the engineering education in the Kingdom of Saudi Arabia adopts the highest standards followed in the leading industrial countries. Most of the engineering programs in the Kingdom are regularly evaluated by ABET, and accredited through the ABET Substantial Equivalency Criteria. The Substantial Equivalency Criteria set by ABET (see Appendix) for evaluating engineering programs in countries other than USA, is also the criteria used by NCEES for recognizing such engineering programs. Consequently, the engineering graduates of the Saudi universities possess equivalent academic qualifications as their counterparts in the leading industrial countries.

On the application front, the major industrial companies in the Kingdom adopt the latest international standards in training and supervising the entry level engineers, and guide them in developing their careers as professional engineers. Such companies hold their engineers accountable by high professional standards in keeping with the ethics and practices of the profession. However, the practice of engineering in the smaller industrial establishments, and consulting companies, or by freelance practitioners is not well monitored. In such private enterprises, the engineer offers services to the public within the frame of a two-party deal. That is, there is no third party, which testifies to the competence of the engineer for undertaking the contracted task.

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As the engineering applications exist in our everyday activities like housing, furniture, roads, transportation, communications, medicine, and many other means of daily life, a licensing board needs to be created to protect the public by helping to safeguard health and property, and to promote the public welfare by providing for the licensing and regulation of persons in the practices of engineering and land surveying. The proposed Saudi Board for Professional Engineers may be created with the knowledge and experience gained from other existing world leading corporations, but with specific codes and bylaws that are drafted to comply with the local industrial applications and the needs of the general public. The board in collaboration with the Saudi professional engineering societies, the engineering institutions and other engineering bodies shall publish and operate a code of conduct and disciplinary procedures, provide licensure, and maintain a registry for licensed professional engineers. It is important to note that the regulation of the practice of the engineering profession is crucial at this stage in order to cope with the rapid pace of industrialization in the Kingdom, which is manifested by ambitious projects in water desalination, natural gas and oil recovery, steel mill development, and operation of modern petrochemical industry, possibly one of the largest in the world.

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APPENDIX

Definitions and Terminology

- **Practice of Engineering:** Any professional service or creative work, the adequate performance of which requires engineering education, training, and experience in the application of special knowledge of the mathematical, physical, and engineering sciences to such services or creative work as consultation, testimony, investigation, evaluation, planning, design and design coordination of engineering works and systems, planning the use of land and water, teaching of upper level engineering and design engineering subjects, performing engineering surveys and studies, and the review of construction or other design products for the purpose of monitoring compliance with drawings and specifications; any of which embraces such services or work, either public or private, in connection with any utilities, structures, buildings, machines, equipment, processes, work systems, projects, and industrial or consumer products; equipment of a control, communications, computer, mechanical, electrical, hydraulic, pneumatic, or thermal nature, insofar as they involve safeguarding life, health, or property; and including other professional services necessary to the planning, progress, and completion of any engineering services.

- **Practice of Land Surveying:** Professional services, including, but not limited to, consultation, project coordination, investigation, testimony, evaluation, planning, mapping, assembling, and interpreting reliable scientific measurements and information relative to the location, size, shape, areas, volumes, or physical features of the earth, improvements on the earth, the space above the earth, or any part of the earth, and the utilization and development of these acts and interpretation into an orderly survey map, plan, report, description, or project. Project coordination shall include the coordination of those technical submissions as prepared by others. The practice of land surveying shall exclude functions unique to engineering as specified by rules of the board.

- **Professional Engineer:** This is abbreviated by **PE** in the State Board Registry, USA, or **PEng** in the Provincial Registry, Canada, or **CEng** (Chartered Engineer) in the Engineering Council Registry, UK. A person who, by reason of his or her special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design, acquired by engineering education and engineering experience, is qualified to practice engineering as hereinafter defined and has been licensed by the board as a professional engineer.

- **Professional Land Surveyor:** This is abbreviated by **PLS** in the State Board Registry, USA. A person who has been duly licensed as a professional land surveyor by the board, and who is a professional specialist in the technique of measuring land, is educated in the principles of mathematics, the related physical and applied sciences, the relevant

requirements of law for adequate evidence and all requisites for surveying of real property, and is qualified to practice land surveying as defined by the Board.

- The term - **graduate of an approved engineering curriculum -** means a graduate of an engineering program accredited by the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET) at the time of graduation or within a two year period of graduation. This term shall also mean a graduate of a master or doctoral degree program offered by a school or college of engineering offering at least one EAC/ABET baccalaureate engineering program provided the school or college of engineering has petitioned the Board for approval for this degree and the Board has granted this approval.

- The term - **graduate of an unapproved engineering curriculum -** means a graduate of an engineering program, which has not been accredited by EAC/ABET but has been accredited by a regionally accredited commission and is approved by the Board.

- The term - **graduate of an approved engineering technology curriculum -** means a graduate of a four year engineering technology program accredited by the Technology Accreditation Commission (TAC) of the Accreditation Board for Engineering and Technology (ABET) at the time of graduation or within a two year period of graduation.

- **Qualifying Experience:** Professional Engineer applicants will usually gain experience by working under the supervision of a licensed professional engineer. Experience must be progressive and of an increasing standard of quality and responsibility and usually follows graduation. Experience may also be gained by working with a licensed professional engineer who closely observed the applicant s work as an associate within the same company and the same location. Verification of experience must be by the licensed professional engineer supervisor, the licensed professional engineer associate, or in some other relationship that assures the Board that the experience received is substantially equivalent to supervision under a licensed professional engineer. It is the responsibility of the applicant to have the verification forms provided in the application package completed and returned directly to the Board by the endorser.

- **Professional Development Hour (PDH):** A contact (clock) hour consisting of not less than 50 minutes of instruction or other qualifying educational activities, which may be sponsored by an individual, organization, association, institution, or other entity, which provides an educational activity for the purpose of fulfilling the continuing professional competency requirements.

- **ABET Substantial Equivalency:** The term means comparable in program content and level of educational experience but not necessarily identical in format or method of delivery. It implies that (as stated by NCCES) the graduates of these programs possess the necessary competencies to begin professional engineering practice at the entry level.

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