The Process of PE Licensure in the United States

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Abstract: Licensure as a Professional Engineer (PE) in the United States is a five-step process. The **first step** to licensure as a PE in the U.S. requires an engineering degree from an ABET-accredited four-year university program in engineering. The **second step** requires engineering students to successfully complete the standard Fundamentals of Engineering (FE) written examination, which tests applicants on breadth of understanding of basic engineering principles, and optionally some elements of an engineering specialty. Completion of the first two steps typically qualifies for certification in the U.S. as an Engineer-In-Training (EIT), sometimes also called an Engineer Intern (EI). The **third step** is to accumulate a certain amount of qualifying engineering experience. In most states the requirement is four years completed under the supervision of a PE, and that acceptable experience must involve increasing levels of responsibility. However, in some states the requirement is less. Further, many states will also accept a Master's of Engineering degree for one year of work experience. The **fourth step** is to successfully complete a written Principles and Practice in Engineering (PE) examination, testing the applicant's knowledge and skills in a chosen engineering discipline (civil, electrical, industrial, mechanical, etc.). The **fifth and final step** is to apply for licensure in each individual state in which the engineer desires to practice engineering, and in many cases provide documentation of continuing engineering education during each renewal period (typically every two years) to maintain an active PE license in good standing.

As the population of the United States grew, self proclaimed engineers designed and constructed projects often with disastrous results. The accumulation of fatal construction projects served to focus the attention of the American public upon the engineering profession and the need for an authoritative regulation of practicing individuals. As a result, the first engineering registration laws were enacted in the single state of Wyoming in 1907, and, it took over 40 years for all remaining states to enact engineering statutes regulating the practice of engineering. Today, all 50 states in the union, the District of Columbia (Washington, DC) and four U.S. territories have registration laws governing the practice of engineering in order to safeguard the health, safety and welfare of the public. These laws are often both "title acts" and "practice acts", and prohibit people who are not licensed Professional Engineers (PE's) from advertising, using a business card, or otherwise indicating that they are an engineer; practicing; offering to practice, or by any implication holding themselves out as qualified to practice as an engineer. Professional licensure aims to protect the public by enforcing standards that restrict practice to qualified individuals who have met specific qualifications in education, work experience, and verified through an application and written examination.

Today there are approximately 1.7 million degreed engineers in the United States, of which only 465,000 are licensed Professional Engineers (PE's).

In the United States, licensure for the engineering profession is regulated by each individual state and territory. A typical state law will define the term "Professional Engineer" as a person who engages in professional engineering, practicing in the rendering of a service or creative work requiring education, training, experience in engineering sciences, and the application of special knowledge, in connection with any project where the public welfare - or the safeguarding of life, health or property - is concerned or involved.

Although the various states and territories strive for consistency in their licensure laws, uniformity doesn't exist. Each state has the right and the prerogative to modify their licensure laws for their own local conditions. Thus, an engineer licensed in one state does not necessarily have the legal right to practice engineering in another state. All states have the legal right to refuse licensure to an engineer if that person is not able to meet its specific state qualifications. State's rights are a basic structure of the U.S. government.

Recognizing these differences, engineering practitioners in the United States developed a "Model Law" in 1941 which serves as the guideline for each individual state's engineering licensure laws. By means of the Model Law and each state's engineering licensure laws, the lawmakers and the public have come to realize and acknowledge that engineering is a learned profession. Educational requirements for the licensing of engineers have been incorporated into the laws, as well as the requirement for the demonstration of good moral character, evidence of completion of academic and professional education, and evidence of experience satisfactory to the state licensure boards have all been included in the Model Law.

All 50 States and U.S. territories require licensure for engineers who offer their services directly to the public. While each individual state licensing board does have its own unique laws regarding engineering licensure, there is in general a four-step process for engineering licensure in the United States. Engineers who are licensed are called Professional Engineers. This licensure generally requires a degree from an Accreditation Board for Engineering and Technology (ABET) accredited engineering program, four years of relevant work experience, and completion of two written examinations. Engineering graduates can start the licensing process by taking the examination in two stages. The initial "Fundamentals of Engineering" (FE) examination can be taken upon or just prior to graduation. Graduates who pass this examination are commonly referred to as Engineers-in-Training (EITs) or engineer interns (EIs). After acquiring the required four years of suitable engineering experience

working under the supervision of a licensed PE, EITs can take the second examination, called the "Principles and Practice of Engineering" or PE exam, in their appropriate discipline.

In summary, engineering licensure in the United States follows a five (5) step process.

Step One: Graduation. The first step to licensure as a PE in the U.S. requires a degree from an ABET-accredited four-year university program in engineering. ABET is a non-profit organization that accredits post-secondary education programs in applied science, computing, engineering, and technology. Accreditation is intended to certify the quality of these programs, mainly in the United States but also internationally. Until the mid-1990's, ABET's accreditation criteria specifically outlined the major elements that accredited engineering programs must have, including the program curricula, the faculty type, and the facilities. However, in 1997, ABET adopted Engineering Criteria 2000 (EC2000). The EC2000 criteria shifted the focus away from the inputs (what material is taught) to the outputs (what students learned). EC2000 stresses continuous improvement, and accounts for specific missions and goals of the individual institutions and programs. The intention of this approach was to enable innovation in engineering programs rather than forcing all programs to conform to a standard, as well as to encourage new assessment processes and program improvements. ABET-accredited programs must request re-evaluation every 6 years to retain accreditation. Graduation from an ABET-accredited program is required for engineers who desire to become licensed. Currently, ABET accredits over 3,100 p. . .rams at more than 600 colleges and universities worldwide.

ABET accreditation is assurance that a college or university program meets the quality standards established by the engineering profession for which it prepares its graduates. Every ABET accredited engineering program must meet the quality standards set by the engineering profession. There are 30 professional and technical organizations that establish the quality standards used by ABET, of which the

National Society of Professional Engineers is one. It is important to note that ABET accredits post-secondary degree-granting programs housed within regionally accredited institutions and accredits programs only, not degrees, departments, colleges, or institutions.

In a typical ABET accredited four-year college curriculum, the first two years are spent studying mathematics, basic sciences, introductory engineering, humanities, and social sciences. In the last two years, most courses are in engineering, usually with a concentration in one specialty, such as civil, mechanical, electrical, etc. Some ABET accredited engineering schools have agreements with two year colleges whereby the college provides the initial engineering education and the engineering school automatically admits students for their last two years. ABET also accredits programs at the master's degree level, although fewer than 20 such graduate programs are currently ABET accredited. Accreditation at the master's level indicates that BOTH the baccalaureate and master's level accreditation criteria are met regardless of the nature of the baccalaureate degree conferred. Some five- or even six-year cooperative plans combine classroom study with practical work, permitting engineering students to gain on the job experience along with their formal education. In addition to the standard four-year engineering degree, some colleges do offer two- or four-year degree programs in engineering technology. These programs, which usually include various hands-on laboratory classes that focus on current issues in the application of engineering principles, prepare students for practical design and production work, rather than for ' bs that require more theoretical and scientific knowledge. Engineering technology graduates, however, are not qualified to be licensed as Professional Engineers under the same terms as graduates with bachelor's degrees in engineering. Some states will grant a license to those with an Engineering Technology degree with additional years of progressive engineering experience.

It is important to note that each of the 50 individual jurisdictions' licensure boards use ABET accreditation of programs as a verification of the educational component they

require as part of their own jurisdiction's licensure requirements. Although ABET is one of the signatories of the Washington Accord, the agreement does not mean that graduates of institutions in countries of Accord signatories will automatically be recognized by the various state engineering licensure boards as having come from an equivalent ABET-accredited program. Even though the Washington Accord does recognize the substantial equivalency of accreditation programs accredited by the signatories, it only "recommends" that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. Therefore, the acceptance of an engineering degree from a college or university outside the United States is at the discretion of each state and territories licensure board, and the agreements are not binding on colleges, universities, employers, or licensing agencies.

If an engineering graduate's degree is not from an ABET accredited program (most states will require that the graduate's credentials be substantially equivalent to that of a graduate of an ABET-accredited program), the National Council of Examiners for Engineering and Surveying (NCEES) offers a credentials evaluation service that compares the education of foreign-educated candidates (as well as those earning engineering degrees from domestic, non-ABET accredited programs) to established criteria standards. Applicants having engineering degrees from programs that are not accredited by ABET must demonstrate 32 college semester credit hours of higher mathematics and basic sciences, 16 college semester credit hours in a general education component that complements the technical content of the curriculum, and at least 48 college semester credit hours of engineering science and engineering design. However, it should be noted that it is the prerogative of each individual state or territory licensure board to review and accept the findings of NCEES.

Step Two: FE Examination. The second step requires engineering students to successfully complete a standard Fundamentals of Engineering (FE) written examination, which tests applicants on breadth of understanding of basic engineering

principles, and optionally some elements of an engineering specialty. Completion of the first two steps typically qualifies for certification in the U.S. as an Engineer-In-Training (EIT), sometimes also called an Engineer Intern (EI).

The FE examination is a closed book eight-hour, multiple-choice examination which covers mathematics, chemistry, physics, and engineering science. The FE exam contains 180 multiple-choice questions given over the course of a day. The multiple-choice afternoon portion tests junior/senior-level courses in seven distinct engineering areas. These include chemical, civil, electrical, environmental, industrial, mechanical and other engineering disciplines. All other disciplines can work the morning general examination portion, which tests science, mathematics, and engineering science knowledge at a junior/senior level. Examinees must select from one of the seven distinct engineering areas for the afternoon portion of the FE exam. It is recommended and most engineering students sit for the FE exam just prior to graduation. Currently the FE examination is only offered by the National Council of Examiners for Engineering and Surveying (NCEES) twice a year (April and October); however, in 2010 NCEES received authorization to develop plans to offer the FE exam via computer based testing (CBT) throughout the year starting in 2013.

For standardization, both the FE and PE exams are written and graded by a central organization: NCEES. However each state's licensure board individually sets the requirements needed to sit for the tests. All 50 states and Washington DC have engineering boards that are members of NCEES, which administers the FE and PE examinations. The following table reflects the 2010 pass rates as reported by NCEES for the Fundamentals in Engineering (FE) examination:

Fundamentals Exam	First-time takers	Repeat takers
Chemical	86%	46%
Civil	75%	33%
Electrical	72%	27%
Environmental	82%	38%
Industrial	69%	33%

Fundamentals Exam	First-time takers	Repeat takers
Mechanical	83%	34%
Other Disciplines	78%	32%

Upon graduation from an ABET-accredited college or university and receiving a passing score on the FE examination, roughly 78% of engineering graduates annually typically earn certification in the United States as an Engineer-In-Training (EIT), also called an Engineer Intern (EI).

NCEES also administers the FE and PE exams through agreements with foreign entities. NCEES currently administers exams in Canada, Egypt, Japan, and South Korea through agreements with local licensing bodies. The administrations in Egypt and South Korea began in 2009 through agreements with the American University in Cairo and the Korean Professional Engineer Association. NCEES just recently began to offer both examinations in Saudi Arabia through an agreement with the Saudi Council of Engineers.

Step Three: Work experience. The third step is to accumulate a certain amount of qualifying engineering experience. In most states the requirement is four years completed under the supervision of a Professional Engineer, and that acceptable experience must involve increasing levels of responsibility. However, in some states the requirement is less, depending on their individual licensing laws. Further, many states will also accept a Master's of Engineering degree for one year of work experience and some states will accept a Ph.D. degree, including at least one degree from an ABET accredited program, for one additional year of work experience.

The basic objective of engineering licensure in the United States is to assure minimum competence and sound judgment in professional engineering to protect the health, safety and welfare of the public. The basic objective of educational requirements leading to licensure in the United States is to assure

the public that the engineering applicant has the requisite knowledge of mathematics, science and engineering to correctly use them to solve engineering problems. The requirement for qualifying experience helps to make sure a candidate has acquired, through actual engineering practice, the professional judgment, capacity and competence in the application of the engineering sciences requisite to licensure as a PE.

Most states have broad language in order to help their licensure boards evaluate qualifying experience. The majority specify that qualifying engineering experience shall be progressive in complexity, and based on knowledge of engineering mathematics, physical and applied sciences, properties of materials, and fundamental principles of engineering design—but there are other means, too. Engineering experience can be gained by graduate engineering study or by engineering teaching as an instructor or higher position in an institution approved by the licensure board. And up to a maximum of one year of credit can be earned from engineering experience gained during a licensure board-approved co-op program. Less frequently, partial credit can be approved as qualifying engineering experience obtained from an engineering curriculum prior to graduation.

Non-qualifying experience is sometimes also defined by states. For example, experience in drafting, estimating, field surveying, and non-engineering military service, are typically *not* considered qualifying.

Step Four: PE examination. The fourth step is to successfully complete a written Principles and Practice in Engineering (PE) examination, testing the applicant's knowledge and skills in a chosen engineering discipline (civil, electrical, industrial, mechanical, etc.).

Passing the PE exam is required before one can become a Professional Engineer (PE) in the United States. It is the second exam required after successfully passing the

Fundamentals of Engineering exam. Upon passing the PE exam and meeting other eligibility requirements such as education and experience required by the individual state in which an engineer seeks a license, an engineer is then eligible to be licensed in their state to offer engineering services, and to stamp and sign engineering drawings, calculations, reports and engineering correspondence as a PE.

The PE exam is created and scored by NCEES. The PE exam is a written test offered twice a year (in April and October). No definitive date has been set to offer the PE exam through computer based testing (CBT), however NCEES is currently discussing the impacts of offering the PE exam through CBT.

PE exams are offered in the following engineering disciplines:

- Agricultural
- Architectural
- Chemical
- Civil (Construction, Geotechnical, Structural, Transportation, Water Resources and Environmental)
- Control Systems
- Electrical & Computer (Computer Engineering, Electrical and Electronics, Power)
- Environmental
- Fire Protection
- Industrial
- Mechanical (HVAC and Refrigeration, Mechanical Systems and Materials, Thermal and Fluid Systems)
- Metallurgical and Materials
- Mining and Mineral
- Naval Architecture and Marine Engineering
- Nuclear

- Petroleum
- Structural

Unlike the Fundamentals of Engineering (EIT) exam, outside reference sources are allowed for the PE exam. With the exception of the Structural PE exam, each of the other engineering discipline-specific PE exams is a written eight-hour test, consisting of two, four-hour sessions administered in a single day. The exams typically consist of 80 or 100 multiple choice questions. Several disciplines require a common morning breadth exam, which broadly covers the discipline; and then a more detailed afternoon depth exam, where the examinee selects a more detailed area of the discipline.

Beginning in 2011, the Structural Engineer (SE) exam will consist of a two-day exam with separate eight-hour components, for a total of 16 hours. The PE Structural exam is a breadth and depth exam in two components on two successive days. The eight-hour vertical forces (gravity/other) and incidental lateral component portion focuses on gravity loads and lateral earth pressures. The eight-hour lateral forces (wind/earthquake) portion focuses on wind/earthquake loads.

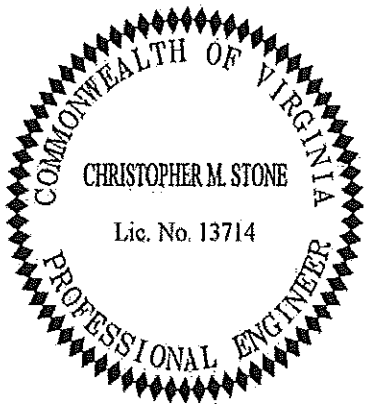
The following table reflects the 2010 pass rates as reported by NCEES for the Principles and Practice in Engineering (PE) examination:

PE Exam	First-time takers	Repeat takers
Agricultural	80%	0%
Architectural	75%	47%
Chemical	72%	46%
Civil	64%	35%
Control Systems	81%	60%
Electrical and Computer	66%	29%
Environmental	73%	23%
Fire Protection	64%	43%
Industrial	67%	21%
Mechanical	69%	41%

PE Exam	First-time takers	Repeat takers
Metallurgical and Materials	56%	33%
Mining and Mineral Processing	73%	38%
Naval Architecture and Marine	85%	75%
Nuclear	79%	80%
Petroleum	83%	29%
Structural I (replaced by the SE exam)	46%	25%
Structural II (replaced by the SE exam)	63%	29%

Step Five: Licensure and Continuing Professional Development. The fifth and final step is to apply for licensure in each individual state in which the engineer desires to practice engineering, and in many cases provide documentation of continuing engineering education during each renewal period (typically every two years) to maintain an active PE license in good standing.

Upon successfully receiving a passing score on the PE exam, an engineering applicant may submit an application for licensure in any of the 50 states or territories. The application for each of the 50 jurisdictions is unique, and evaluated by each individual state's professional engineering licensure board. In general the application requires graduation from an ABET accredited college or university, passing both the FE and PE exam, a set period of qualifying relevant experience, and five references, three of which must be licensed PE's. Only after the application is approved by that individual state's engineering licensure board is the applicant "licensed" as a Professional Engineer, but only in that state. Each licensed engineer receives a certificate and an engineering "seal" that is affixed to all engineering work (design drawings, reports, etc.) along with the engineer's signature and date.



Every engineer is bound by a code of ethics to only practice engineering in his or her

area of competence and to comply with the jurisdiction's code of professional conduct. Individuals violating the state's licensure laws are subject to discipline, including fines, suspension of practice rights or other consequences, following applicable legal proceedings.

Currently about 40 states require continuing education for PEs to maintain licensure. At least four state boards require that continuing education providers be pre-approved. These states are Florida, Louisiana, New York and North Carolina. Continuing education is usually measured in CEU's (Continuing Education Units) or PDH's (Professional Development Hours). A PDH is one clock hour (minimum of 50 minutes). A CEU is 10 PDHs. State licensure boards typically accept a PDH activity that meets the following criteria: "A course or activity whose purpose and objective are clear with a content that will maintain, improve or expand the skills and knowledge of the licensee's field of practice". Additionally, many states require that the course consist of "technical, ethical or managerial content relevant to the practice of engineering". Correspondence, distance learning and internet courses are typically accepted by all the states that require continuing education activities, provided that the course meets the licensure board's requirements and provided that completion of the course can be independently verified.

Since regulation of the practice of engineering is performed by the individual states in the U.S., areas of engineering involved in interstate commerce are essentially unregulated. These areas include much of Mechanical Engineering, Aerospace Engineering, and Chemical Engineering, and may be specifically exempted from regulation under an "Industrial Exemption". An industrial exemption covers engineers who design products such as automobiles that are sold (or have the potential to be sold) outside the state in which they are produced, as well as the equipment used to produce the product. Structures subject to building codes are not covered by an industrial exemption, though small residential buildings often do not require an engineer's seal.

Future Means Changes to PE Licensure in the U.S. Changes are in store in the near future for licensure in the United States. NCEES modified its Model Law in 2006 to require a B.S. in engineering from an ABET-accredited program plus a master's degree in engineering from an institution that offers ABET programs beginning in 2020. The current 2010 NCEES Model Law reflects the following requirements for licensure:

Licensure by Examination (Effective January 1, 2020)—The following individuals shall be admitted to an eight-hour written examination in the principles and practice of engineering and, upon passing such examination and providing proof of graduation, shall be licensed as a Professional Engineer, if otherwise qualified:

1) An engineer intern who satisfies one of the following education and experience requirements:
   a) Following the bachelor's degree, an acceptable amount of coursework resulting in a master's degree in engineering from an institution that offers ABET-accredited programs, or the equivalent, and with a specific record of 3 years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering
   b) Following a master's degree in engineering from an ABET-accredited program, a specific record of three years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering
   c) Following the bachelor's degree, an acceptable amount of coursework as defined in NCEES *Model Rules* Section 230.10 D from approved course providers and a specific record of four years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering
2) An engineer intern with a doctorate in engineering acceptable to the board and with a specific record of two years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practic . ngineering
3) An individual with a doctorate in engineering acceptable to the board and with a specific record of four years or more of progressive experience on engineering projects of a grade and a character which indicate to the board that the applicant may be competent to practice engineering.

These are Model Law provisions as of 2020, and would take effect only upon adoption by individual jurisdictions' legislatures and licensure boards.

In 2010, attendees of the NCEES Annual Meeting considered additional alternate

pathways to licensure. One of these alternates was to modify the current Model Law to include a candidate to sit for the PE examination if the candidate was a graduate from an ABET-accredited college or university that consisted of a comprehensive baccalaureate program of at least 150 semester credits, of which at least 115 credits are in engineering, science and mathematics, and of which at least 75 credits are in engineering topics.

Licensure as a professional engineer is intended to provide assurance to the public that the individual possesses the minimum qualifications needed in order to practice engineering while protecting the health, safety and welfare of the public. The licensure process is accomplished through a series of examinations combined with a required period of qualifying practical experience. This combined methodology has been found to be the most effective and practical way to license new engineers in the United States.

REFERENCES:

1) Accreditation Board for Engineering and Technology (ABET); http://www.abet.org
2) National Council of Examiners for Engineering and Surveying (NCEES); http://www.ncees.org
3) National Society of Professional Engineers (NSPE); http://www.nspe.org
4) CONSTANCE J, **"How to Become a Professional Engineer, the Road to Registration"**, McGraw Hill Book Company, 1988, Fourth Edition