

AN INTRODUCTION TO PROFESSIONAL ENGINEERING LICENSING IN CALIFORNIA AND OTHER STATES

Engineers regard their calling as a profession. They feel they fit most, if not all, of the characteristics of a profession:

- Use knowledge and skills not possessed by the general public;
- Perform an important, even life-and-death, service for society;
- Exercise judgment and discretion in actions for their clients or employers;
- Take a high degree of personal responsibility for their work;
- Adhere to high standards of workmanship and ethical behavior;
- Perform work which is primarily intellectual (as opposed to physical), varied (as opposed to routine), and not readily subject to productivity measurements;
- May require a license for protection of the public;
- Risks loss of their right to practice for negligence or incompetence.

The results of engineering work -- including water and energy supply, transportation (land, sea and air), housing (residential and commercial), manufacturing, food processing, waste disposal and others -- impact our lives from the time we wake in the morning until we go to bed in the evening. As Andrew Smith, editor of the IEEE Industrial Applications magazine, wrote (November/December 2000, pp. 660-61):

"[T]here is probably little engineering work that does not have some beneficial effect on society somewhere down the line."

Engineering Licensing

Licensing of engineers and surveyors in the United States began in 1907 when Wyoming enacted the first licensing law, motivated by a desire to protect the public from incompetents doing surveys that affected property and water rights. Louisiana followed in 1908, and all the states had licensing laws by 1947 when the Montana legislature acted.

California's Professional Engineers Act was adopted in 1929 after the St. Francis dam collapse in the previous year. The Texas law was enacted in 1937 following a gas explosion in a school. Fortunately, other states adopted their laws without the stimulus of a major disaster.

Other events in the history of engineering licensing, with emphasis on the recognition of engineering branches in California, are shown on the following page. The following points of interest should also be noted:

- Corrosion, quality and safety engineering had licensing exams only in California; these exams were stopped effective 1/1/99;
- Fire protection engineering was recognized with a national exam starting in 1981; Control systems in 1992;
- Aerospace and ceramic engineering were recognized with national exams; the exams were stopped for low usage (ceramic in 1991, aerospace in 1997).

To make licensing palatable to large employers, licensing laws were enacted with an exemption for manufacturing and other major industrial firms. These companies believed that:

- They could evaluate prospective employees without reference to engineering licenses;
- They had the right to assign titles to employees as they pleased.

These attitudes, possibly plus concerns that licensed engineers might demand higher pay, resulted in the "industrial exemption" found in most state laws. Some states, like California, have an explicit exemption (Section 6747, recently amended to include not only employees of defined categories of employers but also consultants, temporary and contract employees of the same group of employers). In other states, an exemption may be implied by the definition of "practice of engineering" written into the law.

Licensing Chronology

(California events, except as noted)

1907	First licensing law enacted in Wyoming
1928	St. Francis dam collapsed – over 400 killed
1929	Licensing law enacted for civil engineers
1931	Licensing law amended to recognize structural engineering title
1937	Licensing law enacted in Texas after gas explosion in school killing over 200
1947	50 th licensing law enacted in Montana
1947	Chemical, electrical, mechanical and petroleum engineering recognized as title branches
1965	Metallurgical engineering recognized as title branch
1967	Industrial engineering recognized as title branch; electrical and mechanical engineering converted to practice branches
1968	Authority to recognize new branches moved from legislature to Board of Registration
1970s	Nine branches of engineering (agricultural, control systems, corrosion, fire protection, manufacturing, nuclear, quality, safety and traffic) recognized as title branches; Two branches (aerospace and ceramic) approved for recognition but not funded; Five branches (air pollution, communication, environmental, plumbing and welding) denied recognition
1984	Authority to recognize new branches moved from Board of Registration to legislature

Numbers of Engineers

The number of engineers in the United States is difficult to determine, for a variety of reasons. The total population depends on the definition: Does it include persons who:

- Have an engineering degree (even if they are not working as engineers)?
- Are called an "engineer" by their employers (even if they lack an engineering degree)?
- Call themselves an "engineer" (even if they do not have any engineering training)?

The number of licensed engineers is also not known precisely, because engineers may be licensed in more than one state or more than one branch of engineering.

Despite these uncertainties, it is generally agreed that there are approximately 2.1 million engineers in the United States, including 400-450,000 individuals with one or more licenses. A breakdown of these figures was provided by Paul Taylor (NCEES Licensure Bulletin, December, 1995):

Engineering Discipline	Approx. # Engineers	Approx. # Licensed	Percent Licensed
Civil	360,000	160,000	44
Mechanical	395,000	91,000	23
Electrical	803,000	73,000	9
Chemical	180,000	15,000	8
Industrial	133,000	11,000	8
Agricultural	40,000	5,000	13
Mining/Metals	30,000	5,000	17
Other	259,000	40,000	15
Total	2,200,000	400,000	18

A similar tabulation, illustrating the counting problems noted above, is presented in the following table. It appeared recently on an Internet site maintained by the Bureau of Labor Statistics. Notice the large number of engineers listed as "Other" in both tables.

Based on its general population, California would be expected to account for about 12 percent of the total numbers, perhaps more due to the concentration of high-tech industry in the state.

**Engineering Employment
Based on its general population**

<u>Specialty</u>	<u>Employment</u>
Electrical and electronics	357,000
Mechanical	220,000
Civil	195,000
Industrial	126,000
Aerospace	53,000
Chemical	48,000
Materials	20,000
Petroleum	12,000
Nuclear	12,000
Mining	4,000
All other engineers	415,000
Total, all engineers	1,462,000

Source: Bureau of Labor Statistics (BLS) 1998

Licensing Process

The licensing process for engineers is often described as being based on the "Three Es" -- Education, Examinations and Experience. National engineering organizations, both professional and technical, contribute to this process. The interdisciplinary organizations include:

ABET - Accreditation Board for Engineering and Technology

ABET's mission is "to assure quality and stimulate innovation in engineering, technology and applied science education."

This organization is responsible for visiting, evaluating and accrediting university and college programs in engineering, engineering technology and related sciences. ABET's Board of Directors includes representatives from 23 "Participating Bodies" (20 technical societies and 3 professional societies) and 5 "Affiliate Bodies" (4 technical societies and 1 professional society). The professional societies are the NCEES, NSPE, ASEE and ACEC (see below).

ABET's functions are carried out through four commissions, the Engineering (EAC), Technology (TAC), Related (RAC) and Computer (CAC) Accreditation Commissions. ABET procedures provide for separate evaluations of individual programs or departments, so that a school may have accredited programs in some disciplines and unaccredited programs in other disciplines.

There are about 320 universities with ABET-accredited engineering programs (29 in California) and about 250 colleges with ABET- accredited four-year programs in engineering technology, plus others offering two-year programs. The scope of ABET's activities is shown in the following statistics from its 2000 Annual Report:

- The EAC evaluated 404 programs at 109 institutions during the 1999-2000 year. As of October 1, 1999, there were 1647 EAC-accredited programs in 32 named disciplines, plus ten in "Other" disciplines; 1617 were 4-year programs and 30 were "advanced". ABET normally accredits at the BS or MS level, but not both, in any discipline at a particular school.
- The TAC evaluated 131 programs at 46 institutions during the 1999-2000 year. As of October 1, 1999, there were 391 TAC-accredited two-year programs and 334 four-year programs, for a total of 725 programs, in 26 disciplines. (Unlike the EAC, the TAC can accredit both two- and four-year programs in the same discipline at a single institution.)

Engineering Programs in California Accredited by EAC/ABET

(Source: 1999 ABET Accreditation Yearbook)

<u>School Name</u>	<u>Location</u>	<u># of Programs</u>
CA Institute of Tech.	Pasadena	3
CA State Univ.	San Luis Obispo	11
	Pomona	7
	Chico	6
	Fresno	4
	Fullerton	3
	Long Beach	5
	Los Angeles	3
	Northridge	4
	Sacramento	4
Univ. of California	Berkeley	7
	Davis	10
	Irvine	7
	Los Angeles	7
	Riverside	4
	San Diego	5
	Santa Barbara	3
	Santa Cruz	1
Harvey Mudd College	Claremont	1
Humboldt State Univ.	Humboldt	1
Loyola Marymount Univ.	Los Angeles	3
USN Postgraduate School	Monterey	2
Univ. of the Pacific	Stockton	5
San Diego State Univ.	San Diego	4
Univ. of San Diego	San Diego	1
San Francisco State Univ.	San Francisco	3
San Jose State Univ.	San Jose	8
Santa Clara Univ.	Santa Clara	4
Univ. of Southern CA	Los Angeles	7
Stanford University	Stanford	5

- The RAC evaluated 13 programs at 10 institutions during the 1999-2000 year. As of October 1, 1999, there were 19 RAC-accredited four-year programs and 40 MS-level programs, for a total of 59 programs, in four disciplines (industrial management, safety, surveying and mapping, and industrial hygiene).

Until 1999-2000, accreditation of computer-related programs was conducted by the Computer Science Accreditation Board (CSAB). CSAB, established with help from ABET, had accredited about 150 programs. The two accrediting bodies have now merged, and CSAB is operating as the ABET Computer Accreditation Commission (CAC).

ABET participates in some international activities, such as evaluating programs at foreign universities for "substantial equivalence" with ABET standards or helping other countries to establish similar accrediting bodies. It has entered into agreements with countries having comparable standards for mutual recognition of degrees for licensing purposes, including Canada and other signatories of the "Washington Accord". ABET is one of three bodies making up the USCIEP (United States Council on International Engineering Practice) which has worked to foster mobility between countries under NAFTA and similar agreements; the other bodies are NCEES and NSPE (see below).

ABET has recently established a service, available to licensing boards and employers, to verify and evaluate foreign educational credentials such as transcripts and diplomas.

NCEES - National Council of Examiners for Engineering & Surveying

The examination phase of engineering licensing is primarily in the hands of NCEES which prepares and scores most of the exams used for assessing the qualifications of applicants for engineering licenses.

NCEES objectives include improving licensing laws for engineering and surveying, fostering uniformity between states, promoting comity and reciprocity between states, observing international trends in engineering licensing, improving uniformity in standards of law enforcement and disciplinary action, and increasing the value of licensure.

NCEES is a federation of the engineering licensing boards in all fifty states of the United States, the District of Columbia, and four territories or possessions (Puerto Rico, Guam, Virgin Islands, and the Northern Mariana Islands). Membership in NCEES also includes fourteen separate boards for land surveyors and one independent board for structural engineers (Illinois). In all, NCEES membership comprises seventy boards. In some states, the engineering or engineering-surveying board also regulates one or more other professions such as architects, landscape architects, or geologists.

The state and territorial boards are responsible for determining who may take the various exams. That is, they are charged with determining if an applicant meets the jurisdiction's requirements for licensing, including evaluation of the applicant's education and experience, residence and/or citizenship, etc.

NCEES can adopt, by a vote at its annual meeting, recommended policies or procedures for its members, but it cannot dictate to them; the member boards have full authority for licensing in their respective jurisdictions.

NCEES developed a "Model Law" as a guide for states establishing a licensing program; no state has adopted the model verbatim, but traces of the model can be seen in many state licensing laws.

The primary function of NCEES, the preparation and scoring of licensing exams, is done with the cooperation of technical societies in the various disciplines for which NCEES provides exams. The exam preparation process is described in Appendix A.

The current exams are:

Group I (Twice/year)	Group II (Once/year)
Chemical	Agricultural
Civil	Building Architectural
Environmental	Control Systems
Electrical	Fire Protection
Mechanical	Industrial
	Manufacturing
Structural I	Metallurgical
Structural II	Mining/Mineral
	Nuclear
	Petroleum
	Naval Architectural & Marine
	Engineering
Fundamentals	

Descriptions of these exams are given in Appendix B.

The Fundamentals Exam (FE), as the name implies, covers basic knowledge which should be possessed by all engineers. It is taken by all applicants for licensing, sometimes in the last year of their educational training.

The Principles-and-Practice-of-Engineering Exams (PE) are taken by applicants in their respective disciplines, usually after four or more years of experience.

NCEES sets the requirements for recognizing new disciplines and discontinuing low-usage exams. Individual boards can decide which of the NCEES exams they will administer, and they are free to write and administer other tests to meet their special needs.

Other Interdisciplinary Societies

NSPE - National Society of Professional Engineers

NSPE is a society concerned with the professional, as opposed to technical, interests of its members. Most of its members are licensed, although membership is open to unlicensed persons and engineers who have passed only the FE exam. NSPE operates nationally and through affiliated state societies, such as the California Society for Professional Engineers (CSPE).

NSPE and its affiliates lobby for legislation of general interest to engineers and take positions on issues concerning engineering practice.

ASEE - American Society for Engineering Education

ASEE is a society of individual members, predominantly academic administrators and faculty, although government and industrial people with an interest in engineering education are welcome to join. Its publications deal primarily with such matters as curriculum development, improved instruction, student grading, teacher evaluations, research, counseling, etc.

ASEE publishes periodic reports containing statistics on student enrollments and degrees awarded by discipline, school and year.

AAES - American Association of Engineering Societies

AAES is a federation of engineering societies. Its objectives are to coordinate the efforts of its member societies to provide reliable information to the general public about issues which affect the engineering profession; to collect, analyze and disseminate data to inform the general public of the relation between engineering and the national welfare; and to provide a forum for the engineering societies to exchange views on matters of common interest.

AAES supports an Engineering Workforce Commission which publishes reports on engineering employment, salaries, etc.

ACEC - American Consulting Engineers Council

ACEC's membership consists of individuals and firms providing independent professional engineering and related services. Its objectives are to protect the public welfare; safeguard the ethical standards of the profession; promote the professional and economic welfare of its members; and assist in advancing the science and practice of engineering.

Technical Societies

The NCEES exam process is supported by a number of technical societies which provide "subject matter experts" and other resources for developing and scoring examinations. The list includes:

AAEE	American Academy of Environmental Engineers
AIChE	American Institute of Chemical Engineers
ANS	American Nuclear Society
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
IEEE	Institute of Electrical & Electronics Engineers
ISA	Instrumentation, Systems & Automation Society
IIE	Institute of Industrial Engineers
SFPE	Society of Fire Protection Engineers
SME	Society of Manufacturing Engineers
SME-AIME	Society for Mining, Metallurgy & Exploration
SNAME	Society of Naval Architects & Marine Engineers
SPE	Society of Petroleum Engineers

Variations Between States

For convenience, the following discussion is confined to the fifty state boards for engineers. Also, structural and geotechnical/soils engineering, as well as land surveying, are not considered as these activities are irrelevant to a discussion of California's engineering "title" and "practice" branches.

The laws and regulations of the fifty states are similar in their most important aspects, but different in their details. For example, all states will license an engineer who has (in the following order) earned a four-year engineering degree from an EAC/ABET-accredited program; passed the Fundamentals of Engineering (FE) exam (also known as the Engineer-in-Training (EIT) exam); gained four years of acceptable experience; and passed a Principles-and-Practices of Engineering (PE) exam. Engineers licensed in accord with these requirements will also have an easier time if, later in their careers, they seek a license in another state.

The states differ in their treatment of applicants with degrees from four-year engineering technology programs (whether or not they are TAC/ABET-accredited) or related-science programs, or with no degree. Some states (e.g., Florida) will accept only applicants with EAC/ABET-accredited degrees; others (such as California) are more flexible in their definitions of qualifying educational credentials.

State laws contain exemptions which are not uniform from state to state. An indication of the variety in this area can be seen from the following summary of data for 42 states (from NCEES Survey Information, 2000):

<u>Exemption Description</u>	<u>Number Yes</u>	<u>Of No</u>	<u>States</u>
Employee of Prof. Engineer	33	9	
Employee of Public Utility	19	23	
Employee of Fed. Government	29	13	
Employee of State Government	8	34	
Employee of Manufacturing Firm	27	15	

There are also other differences between the state boards.

California's procedures for regulation of engineering practice differ from other states in the following ways, among others.

1. In California, engineers are licensed in three general categories:
 - Practice branches - civil, electrical and mechanical engineering
 - Authorities - structural and geotechnical/soils (which require a license in civil engineering prior to obtaining these additional licenses)
 - Title branches - agricultural, chemical, control systems, fire protection, industrial, manufacturing, metallurgical, nuclear, petroleum and traffic engineering

Engineers in all three categories can use the title "Professional Engineer" or "P.E." for short.

As implied by the designation, civil, electrical and mechanical engineers must be licensed to practice in their respective areas. (Structural and geotechnical/soils engineers are allowed to practice by virtue of their civil engineering licenses; they are not a subject of the title act study mandated by SB2030).

Engineers licensed in the title branches have an exclusive right to use the title identifying their area of practice, such as "chemical engineer" or "control systems engineer". However, anybody can practice in these same areas, provided they do not use the restricted titles.

In legal terms, engineers in the title branches actually have a "certification" from a government agency, similar to those granted by privately-operated certification bodies. However, because they have taken and passed NCEES exams used in other states and have satisfied the typical requirements for licensing in other states, they can generally qualify for a license by comity or reciprocity if they work in or move to another state.

The division of engineers into "practice" and "title" branches is unique to California. The characteristics of this licensing scheme are discussed below.

2. In California and eight other states (MA, LA, NV, IA, NE, VT, AK and RI), engineers are licensed "by discipline" and are called -- for example -- Civil Engineer, Electrical Engineer, etc., depending on the exam(s) they took and passed, although they can also use the title "Professional Engineer". Separate licenses are required for each branch of engineering in which an engineer wishes to practice.

In the other 41 states, engineers are examined in a specific branch of engineering but are then free to practice in any area in which they are competent. All licensed engineers are called "Professional Engineer" or "P.E.", regardless of the exam they took and passed.

[Note: In all states, as a matter of law or ethics, engineers are constrained to practice only in areas in which they are competent and proficient by reason of education and experience. In California, this constraint is explicitly stated in Section 415 of the Board's Regulations.]

3. Whereas many state boards administer any NCEES exam, California is selective and chooses NOT to administer some of the nationally-available exams (currently environmental, building, mining/mineral, and naval architecture and marine engineering).

States have the right to administer other special, state-specific exams, including supplementary exams on their state licensing laws, ethics, or other topics. California offers a unique exam in traffic engineering, requires additional tests in surveying and seismic safety for civil engineers, and gives a take-home test on the state licensing law to all applicants.

California formerly offered unique exams in corrosion, quality and safety engineering, but these exams were dropped.

Exams administered in the various states are listed in the following table .

State Licensing – Numbers and Recognized Branches

<u>State</u>	<u>Licensees Total*</u>	<u>PE or DISC</u>	<u>NCEES Exams Administered**</u>
CA	83,490	DISC	All but ENV, SDE, M/M
TX	48,108	PE	All
OH	32,165	PE	All
PA	31,396	PE	All
FL	26,769	PE	All
NY	25,788	PE	All
IL	19,756	PE	All
VA	19,463	PE	All
WI	18,860	PE	All
WA	18,720	PE	All
NJ	18,619	PE	CHE, CIV, ELE, MEC
MI	18,377	PE	All but PET, SDE
MA	18,017	DISC	All
NC	16,591	PE	All
CO	16,558	PE	All
IN	16,393	PE	All
MO	14,923	PE	All
LA	14,846	DISC	All
AZ	14,190	PE	All but SDE
GA	12,879	PE	All
MD	12,685	PE	All but SDE
SC	12,196	PE	All
KY	12,016	PE	All but SDE
AL	11,249	PE	All
MN	10,695	PE	All
OR	10,267	PE	All but M/M, SDE
OK	9,267	PE	All
KS	9,064	PE	All
AR	8,229	PE	All
MS	7,865	PE	All
NV	7,216	DISC	All but AGR, CSE, NUC, SDE
TN	7,050	PE	All
NM	6,382	PE	All but CSE, MAN, SDE
UT	6,183	PE	All
IA	6,033	Both	All but SDE
NH	5,680	PE	All
DE	5,637	PE	All
WV	5,393	PE	All
NE	5,367	DISC	All
ID	5,210	PE	All
ME	5,179	PE	All
HI	4,292	PE	AGR, CHE, CIV, ELE, IND, MEC
WY	3,592	PE	All

State	Licensees Total*	PE or DISC	<i>(Continued)</i> NCEES Exams Administered**
VT	3409	DISC	All
AK	3,212	DISC	CHE, CIV, ELE, ENV, MEC, M/M, PET
SD	2,717	PE	All
RI	2,613	DISC	CHE, CIV, ELE, ENV, MEC
ND	2,088	PE	All
CT	NA***	PE	All
MT	NA***	PE	All but SDE
Total	<u>676,694+</u>		

Sources: "NCEES 2000 Convention Reports"
 "NCEES 1999 Survey Information"

Notes: * Total, Resident and Non-Resident
 ** Except Structural
 *** NA = Not Available

Exams:	AGR- Agricultural	MAN- Manufacturing
	CHE- Chemical	MEC- Mechanical
	CIV- Civil	MET- Metallurgical
	CSE- Control System	M/M- Mining/Mineral
	ELE- Electrical	NUC- Nuclear
	ENV- Environmental	PET- Petroleum
	FPE- Fire Protection	SDE- Ship Design
	IND- Industrial	All = 15 Exams

4. California will license an applicant with an approved 4-year degree and 2 years of acceptable experience; the 49 other states require 4 years of acceptable experience.
5. California has a board consisting of seven public members, five engineers and a land surveyor; it is the only state board in which the public members constitute a majority.

For purposes of the present study, differences (1)-(3) above are the most significant. Therefore, the remainder of this section is devoted to a discussion of the consequences of California's practices relative to other states.

Consequences

The unique features of the California PE Act have the following consequences:

- In general, engineering reports, specifications, plans and other documents are supposed to be signed or stamped by the engineers who did the work contained therein. In California, some clients, plan-check departments, or other agencies will accept only documents signed or stamped by a "practice" branch engineer, i.e., a civil, mechanical or electrical engineer. This practice can lead to supervisors signing or stamping the work of their subordinates, which can create confusion over responsibility for the engineering work because the engineer signing and stamping the documents may have given them only a cursory review.

This practice has the secondary effect of denying engineers in the "title" branches opportunities for promotion to supervisory positions in organizations desiring to restrict their management posts to engineers allowed to sign or stamp documents.

- The California licensing scheme encourages the board to devote excessive amounts of time and effort to attempts to develop unique, precise, non-overlapping, and exclusive definitions of the various branches. (More than ten years were spent in attempts to develop a new definition of electrical engineering, which was not adopted.) This effort is futile because of inherent overlaps in the activities of engineering branches, arising from their common dependence on the same basic laws of physics, chemistry and mathematics.
- Existing "title" branch definitions are confusing because they do not follow a consistent pattern. For example, of the ten branches, four can "design", four can "plan", and one (nuclear) can do both, despite a lack of any definitions of these similar-sounding terms. One (fire protection) can do neither, despite an OAL (Office of Administrative Law) determination in 1990 that this restriction was unenforceable because "it had not been adopted as a regulation in accordance with the Administrative Procedure Act."
- The emphasis on sharp boundaries between branches creates a potential for disciplinary actions against engineers for working outside their nominal branches, e.g., charging a mechanical engineer with doing work reserved to civil engineers, without a showing that the work was done incompetently or negligently. This sort of disciplinary action does not protect the public, because it is not tied to competence; it breeds disrespect for the Board by creating the impression that "protecting turf" is more important than recognizing competence.
- An engineer with education and experience in a branch not recognized by the California Board, whether a resident of the state or a non-resident seeking licensure by comity, is forced to seek or accept a license in a branch of engineering which does not reflect his/her real competence. (By Section 6759 of the PE Act, the Board is required to license comity applicants "in the branch in which their experience and education indicate the closest relationship".) This problem will be exacerbated if the number of currently-recognized branches is reduced.

Effects of Changing California Law

The California Engineers Act could be amended to remove the distinctions between "practice" and "title" branches by adopting a general definition of engineering and dropping definitions of individual branches, licensing all engineers as "Professional Engineers", and offering all available NCEES licensing exams. These changes would correct the adverse consequences of the present licensing scheme described in the previous section.

Allowing all "title" engineers to take responsibility for their own work, e.g., by signing and stamping documents they have produced, would have a major benefit to the public: Losing one's license as a result of disciplinary action would have real meaning. (Under the present law, if a "title" engineer's license is revoked, he/she can continue to work by using a different title.) The possibility of losing the opportunity to work would inspire engineers to work more carefully and to exercise greater discretion in accepting assignments which might expose him/her to that risk.

Some people have argued that using "Professional Engineer" as a single title for all engineers would have adverse effects. These arguments make several points:

- Engineers would be encouraged to work outside their areas of competence.

Not likely if the Board makes clear that Rule 415 is still in effect and disciplinary action will follow any justified complaints that engineers are working outside their areas of competence.

- Employers, clients and the public need branch titles to know what individual engineers do.

Given that the public probably has a limited understanding of the work of engineers, with or without descriptive branch titles, this complaint has little merit.

The need for employers of engineers to inquire into their personal specialties would not change. It has always been true that most engineers licensed in electrical engineering, for example, are not qualified to work in all areas of their nominal field, from motor design to integrated circuits to high-voltage power transmission, even though their licenses give them the authority to do so.

This situation is now being reflected in the new NCEES "breadth-and-depth" exam formats. There are now five kinds of civil engineer, depending on the option chosen for the afternoon part of the exam: structural, water resources, transportation, environmental, and geotechnical (soils). There will soon be three kinds of mechanical engineer (HVAC-refrigeration, machine design, and thermal-fluid systems) and three kinds of electrical engineer (power, computers, and electronics-communications-controls). For reasons having to do with possible differences in passing scores for the depth modules, NCEES proposes to report exam results using scaled scores and not identify the selected depth module. Branch titles are now losing whatever descriptive powers they once had.

The Board could reduce this difficulty somewhat by a couple of methods. The roster could indicate the exam(s) passed by licensed engineers. And the Board could conduct a public education campaign, using such devices as a pamphlet titled "Hiring an Engineer", as it did following the Northridge Earthquake of 1994.

- Branch definitions are needed to assess engineering experience.

This argument has merit only if the Board must fit an engineer into a definite branch. Evaluation of experience is simplified if it must only be found to be "engineering experience" as opposed to experience as a technician, architect, scientist, or practitioner of some other profession.

If a general definition of engineering is inadequate for evaluating an engineer's experience, the collection of NCEES exam descriptions can be used as a supplementary source of information.

Granting "title" engineers the right to perform "incidental", "supplemental" or "occasional" work in other branches has been suggested as a remedy for the problem of overlaps between branches. Unfortunately, this suggestion does not address the degree of allowable overlap and, therefore, invites efforts to define exactly what is permissible. If only overlaps between the current "title" and "practice" branches are considered, there are $(3)(10) = 30$ areas common to two branches to be defined. If overlaps between all branches must be considered, there are $(13)(12)/2 = 78$ areas common to two branches. The Board's record in defining individual branches does not encourage much hope that this larger task could be carried out successfully.

APPENDIX A
NCEES EXAM DEVELOPMENT PROCESS

NCEES Exam Development Process

Recognition of Disciplines

Before an exam is developed, NCEES must decide that creation of a new exam will be regarded as appropriate by its member boards. The criteria for recognizing engineering disciplines are stated in NCEES Exam Policy 8 which currently reads:

“EP 8 Entry of New Discipline to PE Examination Status EP 8

- A. No discipline shall be added to the examination program unless there is an EAC/ABET-accredited program in the discipline.
- B. Requests for examination can be made only by a Member Board. Requests shall include proof of need, estimate of usage, and impact on protection of public health, safety, and welfare.
- C. Member Boards shall be notified one year in advance of the addition of any discipline to the examination program.”

NCEES policy favors recognition of disciplines meeting the above-stated criteria. The NCEES Manual of Policy and Position Statements (revised August 2000) contains the following “Position Statement (PS)”:

“PS 1 Licensure

PS 1

In the interest of protecting the public, the NCEES strongly promotes the concept that all qualified individuals who practice or desire to practice engineering or land surveying seek licensure, whether exempted by statute or regulation or not....”

Recognition of disciplines meeting the requirements expressed in EP 8 occurs on a majority vote of the entire Council during the NCEES Annual Meeting. This event starts the work of creating a new exam, described in the following pages.

Exam Development

The NCEES exam development process adheres to recommendations contained in the STANDARDS FOR EDUCATIONAL AND PSYCHOLOGICAL TESTING, published (1999) by AERA for the AERA, APA, and NCME. (AERA is the American Educational Research Association; APA is the American Psychological Association; and NCME is the National Council on Measurement in Education.) This publication is an outgrowth of the EEOC Uniform Guidelines (1978) and the AERA/APA/NCME Standards (1985). (EEOC is the Equal Employment Opportunity Commission of the federal government.)

These standards provide that high-stakes licensing tests must be job-related and must be constructed and administered in accord with accepted standards concerning validity and fairness. Courts have upheld the use of exams based on these standards, along with requirements such as minimum education and experience levels, as acceptable elements of a licensing process.

The NCEES procedures for development of the Principles-and-Practice-of-Engineering (PE) exam specifications, for all of the national exams used in California, involve the following major steps:

- Develop a questionnaire, using input from practicing engineers, to determine their primary activities and the knowledges needed for their performance, to be ranked on a scale of 1 to 5 for their importance;
- Send the questionnaire to a large number (several thousand) of active, licensed practitioners in the field (persons most likely to understand the requirements for professional practice);
- Process the responses (several hundred or more) to determine the most important of the activities and knowledges for professional practice at the time of licensing (four or more years of experience following a four-year degree);
- Organize the important knowledges into 8 - 12 logically-related major areas or domains and determine the fraction of the exam to be devoted to each area or domain;
- Based on the duration and resulting total number of questions (eight hours and 80 multiple-choice questions) specified for NCEES exams, determine the number of questions in each area or domain;
- After necessary approvals, publish the specification as a guide for candidates for licensing in preparing to take the exam.

The exam specifications reflect the professional practices of large groups of engineers, large enough that the survey results have statistical significance. The specifications are not merely the opinions of a small committee or a few professors.

These exam specifications do not show some knowledges or skills needed for engineering practice, such as a knowledge of basic sciences and mathematics; the ability to speak, read and write the language of the area in which the engineer works; the ability to work cooperatively in groups; creative ability; knowledge of cultural subjects, economics and business operations; etc. These are inferred from possession of a college degree; tested in the Fundamentals-of-Engineering (FE) exam; irrelevant in a technical exam; or considered not testable in a standardized written exam.

Standards for fairness in testing demand that the exam specifications be published; candidates have a right to know the subjects on which they will be tested. (Supporters of license exams also publish STUDY GUIDES containing sample items and solutions, references, and other helpful information.) The exam specification is directly useful to candidates for licensure who are preparing to take the exam, as well as presenters of review courses offered a few weeks or months before the next licensing exam. It is also useful as a guide to colleges for devising a curriculum in a new (to the school) branch of engineering for students who may, in a more distant future, be candidates for licensing.

Following the administration of each test, statistical analyses are performed to evaluate the performance of each item; how many candidates selected each answer, not only the correct answer; how does the percent correct correlate with the total score; and how do these performance measures vary between the top, middle and lowest portions of the test population? These analyses are useful in identifying poor questions which should be dropped from the current or future tests.

Passing or cut scores are determined by a panel of experts, guided by NCEES's staff and consulting psychometricians.

Number of Exams Administered
(Data From NCEES)

Year	FE/EIT	PE
1980	37,500	16,200
1985	43,782	19,567
1990	46,428	27,321
1991	49,094	27,847
1992	51,811	29,521
1993	54,300	29,809
1994	50,236	29,748
1995	48,683	29,491
1996	45,638	30,644
1997	41,914	26,835
1998	38,730	26,174
1999	38,403	26,277
2000	37,236	26,917

NCEES PE Exam Takers For 2000
(National Totals)

Branch	Exam Takers
Group I	
Civil	16,145
Mechanical	4,337
Electrical	3,076
Structural I	1,039
Environmental	844
Chemical	699
Sub-Total	26,140
Group II	
Industrial	176
Fire Protection	171
Control Systems	145
Petroleum	81
Agricultural	56
Mining/Mineral	52
Manufacturing	40
Metallurgical	37
Nuclear	21
Sub-Total	779
Total	26,919

APPENDIX B
NCEES EXAM DESCRIPTIONS

(Taken from www.ncees.org)

Agricultural ■

EFFECTIVE October 2001 (Revised 7/27/00)

	Approximate Percentage of Examination
I. Soil and Water	19%
A. Hydrology	6%
1. Principles of hydrology	
2. Open channel hydraulics	
3. Hydrogeology	
4. Principles of surface and subsurface drainage	
B. Soil Conservation Systems	5%
1. Principles of soil physics	
2. Soil mechanics	
3. Sediment transport	
4. Erosion control and slope stabilization	
C. Water Management	8%
1. Water quality	
2. Evapo-transpiration	
3. Principles of nutrient management/loading rates in soils	
4. Principles of irrigation	
II. Power and Machinery	17%
A. Systems	6%
1. Agricultural mechanization	
2. Machine/commodity interactions	
3. Machine/soil interactions	
4. Stability analysis	
B. Machine Design	5%
1. Machine component design	
2. Understand stress/strain relationships	
3. Materials selection	
4. Fatigue analysis	

C. Power and Energy Systems	6%
1. Internal combustion engines	
2. Electrical circuit analysis	
3. Hydraulic power circuits	
4. Power requirement analysis	
5. Mechanical power transmission	
III. Processing / Handling of Biological Products	12%
A. Unit Operations	8%
1. Mass transfer between phases	
2. Principles of unit operations	
3. Standards, codes, and regulations	
4. Principles of post harvest storage	
B. Characterization of Biological Products	4%
1. Fundamental physical chemistry	
2. Particle characterization and dynamics	
3. Bulk solids characterization	
4. Compatibility of biological materials	
IV. Structures and Environment	19%
A. Structural Systems	7%
1. Structural loads and standards	
2. Structural analysis	
3. Foundation design	
4. Provisions of structural materials design specification/codes	
5. Standards for post-frame building design	
B. Environmental Systems	7%
1. Steady state heat and mass balances	
2. Ventilation rate requirements	
3. Ventilation system requirements	
4. Insulation requirements	
5. Moisture control standards for building construction	
6. Air quality standards/requirements in agricultural buildings/confined spaces for humans, animals, plants, and produce	

C. Facilities Planning	5%
1. Functional and space requirements for agricultural production facilities	
2. Electrical wiring/lighting devices	
3. Construction materials	
4. Requirements for hazardous materials storage facilities	
V. Biological Systems	10%
A. Biological Processes	6%
1. Principles of organic and biochemistry	
2. Aerobic and Anaerobic Processes	
3. Ergonomics	
B. Environmental and Ecological Systems	4%
1. Environmental assessment techniques	
2. Awareness of ecological processes	
VI. Agricultural Engineering Principles	23%
A. Core Agricultural Engineering Knowledges	13%
1. Applied fluid mechanics	
2. Psychrometric processes	
3. Heat transfer applications	
4. Structural and Materials Analysis	
5. Mass and energy balances	
6. Water relationships	
B. Equipment Applications	8%
1. Pump applications	
2. Fan applications	
3. Sensors, instrumentation, and control systems	
C. Professional Practice	2%
1. Engineering practice including knowledge of Canon of Ethics, engineering economics, communication, role of codes, standards and specifications	
Total	100%

Notes

1. The knowledge areas specified under A, B, C, ... etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
2. This exam contains 80 multiple-choice questions. Examinee works all questions.

Building Architectural ■

EFFECTIVE APRIL 2003 (Reviewed 3/8/00)

	Approximate Percentage of Examination
1. GENERAL KNOWLEDGE	12%
A. Building Systems	5%
1. Functions of building systems (e.g., architectural, structural, mechanical, electrical, & plumbing)	
a. VAV box vs. constant volume and impact on structures	
2. Fire protection systems relevant to electrical, mechanical, & structural design/components	
3. Conditions for retrofit or re-use of existing structure with respect to system integration	
4. Aspects of building performance that affect human comfort	
5. Knowledge of which building systems or functions are critical in emergencies	
6. Understanding of framing alternatives as they relate to electrical, mechanical, & structural design	
B. Construction and Building Materials	4%
1. Terminology -- lighting, electrical, mechanical, and structural	
2. Basic construction methods and materials	
3. Knowledge of material behavior and properties (e.g., heat transfer, volume change)	
C. Lateral Load and Displacement Issues	1%
1. Lateral load and displacement effects on mechanical, electrical, architectural systems	
D. Codes, Regulations, Statutes	2%
1. Model codes	
2. Code of ethics	
3. ADA and its implications for electrical, mechanical, & structural design components	
2. CONSTRUCTION MANAGEMENT	15%
A. Economic and Financial Issues	6%
1. Control of Purchase Order, monitoring items relative to lead time & place of item, etc.	
2. Building cost estimating	
3. Value engineering	
4. Quantity take-off methods	
5. Bonding, taxes, profit/overhead, & permits on estimating	

B. Construction Processes	4%
1. Erection process and sequence as it affects load transfer and support	
2. Administration of information (e.g., discovered site conditions, change orders, etc.)	
C. Project Management	5%
1. Scheduling (sequence of activities)	
2. Quality control throughout project	
3. Impact on design and construction of alternative project delivery systems	
3. ELECTRICAL & LIGHTING SYSTEMS	23%
A. Theory	9%
1. Electrical power circuit theory	
2. Short-circuit theory	
3. Load flow	
4. Power factor correction	
5. Over current protective device coordination	
B. Basic Electrical Knowledge	14%
1. Grounding systems	
2. Basic electrical construction methods & materials	
3. Over current protection	
4. Branch circuit and feeder conductor sizing	
5. Lighting systems	
6. HVAC systems (knowledge specifically related to power distribution issues)	
7. Life safety systems (e.g., generators, batteries, exit lighting, fire alarms)	
8. National Electrical Code	
4. MECHANICAL SYSTEMS	23%
A. Theory	8%
1. Fan laws	
2. Pump laws	
3. Psychrometrics	
4. Air pressure drop (static pressure/velocity pressure)	
5. Humidity/latent load (e.g., moisture added or removed)	

B. Basic Mechanical Knowledge	15%
1. Types of pumps and pumping systems	
2. Fire protection sprinkler and standpipe classifications	
3. Steam pressure classifications	
4. Pipe expansion (e.g., expansion joints, loops, anchors)	
5. Duct materials	
6. Insulation (e.g. piping, ductwork)	
7. Valves and fittings	
8. Outside air quantities/ventilation per codes/ASHRAE standards	
9. Combustion air requirements/sizing	
10. HVAC system types (e.g., air cooled/water cooled, air, heat pumps, split systems)	
11. Chiller types	
12. Boiler types	
13. Criteria for diffuser/register/grille selection (throw, noise, pressure drop)	
14. Sanitary waste and vent systems (routing, sizing, slope)	
15. Domestic waste (routing, sizing, slope)	
16. Roof drainage (routing, sizing, slope)	
5. STRUCTURAL SYSTEMS	27%
A. Loads and Analysis	11%
1. Types and methods of calculating design loads (e.g., wind, live)	
2. Different types of analysis and design philosophies or methods	
3. Material and member behavior in response to specific loading conditions	
4. Structural serviceability issue requirements (e.g., vibrations, deflections)	
B. Design	16%
1. Design and construction requirements for fire (e.g., firewalls, material fire rating)	
2. Material-specific code requirements	
3. Structural systems	
4. Elastic and plastic design procedures	
5. Connections	
6. Foundation types and design procedures	

Total = 100%

Notes

1. The knowledge areas specified as A., B., C., ... etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
2. This examination contains 80 multiple-choice questions. Examinee works all questions.

Chemical

EFFECTIVE BEGINNING WITH APRIL 2000 EXAMINATION (Revised May 17, 1999)

	Approximate Percentage of Examination
1. MASS AND ENERGY BALANCES process stoichiometry and material balances; process energy balances; conservation laws	20%
2. HEAT TRANSFER industrial heat transfer including but not limited to the following: heat exchanger design and performance; energy conservation; conduction, especially insulation problems; convection; radiation, especially furnace design; evaporation	15%
3. FLUIDS piping network problems; pump sizing or pump performance; compressor sizing or compressor performance; control valve selection problems; fluid flow through beds; two-phase flow; Bernoulli equation applications	15%
4. THERMODYNAMICS estimation and correlation of physical properties; chemical equilibrium; heats of reaction; application of first and second laws; vapor-liquid equilibrium; combustion; refrigeration	10%
5. MASS TRANSFER typical applications including but not limited to the following: gas absorption and stripping; distillation; liquid-liquid extraction and leaching; humidification and dehumidification; drying	15%
6. KINETICS interpretation of experimental data and reaction rate modeling; commercial reactor design from rate model and/or product distribution; comparison of reactor types; reaction control	10%

7. PLANT DESIGN

15%

process and equipment design including but not limited to the following: optimization of design; general safety considerations; environmental and waste treating; solids separation; vapor-liquid separations; flow sheets; HAZOP (hazard and operational) analysis; fault tree analysis; scheduling techniques; sizing and fabrication of equipment; material selection; life cycle cost; process control such as sensors, transmitters and controllers, control loops, and simulation; material science as concerned with physical and chemical properties of matter, strength of materials, crystallographic structure, phase diagrams, latent heat, PVT data and relationships, and molecular structure

Total = 100%

Note

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics analyses.
2. This examination contains a total of eighty (80) multiple-choice questions. Examinee works all questions.

Civil

EFFECTIVE October 2000 (Revised 4/14/00)

The civil engineering examination is a breadth and depth examination. This means that **all** examinees work the breadth (AM) exam and **one** of the five depth (PM) exams. The five areas covered in the civil engineering examination are environmental, geotechnical, structural, transportation, and water resources. The breadth exam contains questions from all five areas of civil engineering. The depth exams focus more closely on a single area of practice in civil engineering.

CIVIL BREADTH (AM) EXAM

Approximate Percentage of Examination

1. ENVIRONMENTAL

20%

- A. Wastewater Treatment -- wastewater flow rates, unit processes.
- B. Biology -- toxicity, algae, stream degradation, temperature, disinfection, water taste & odor, BOD.
- C. Solid/Hazardous Waste -- collection, storage/transfer, treatment, disposal, and quantity estimates, site & haul economics.
- D. Ground Water and Well Fields -- groundwater flow, aquifers (e.g., characterization).

2. GEOTECHNICAL

20%

- A. Subsurface Exploration & Sampling -- drilling and sampling, soil classification, boring log interpretation, soil profile development.
- B. Engineering Properties of Soils -- index properties, phase relationships, permeability.
- C. Soil Mechanics Analysis -- pressure distribution, lateral earth pressure, consolidation, and compaction.
- D. Shallow Foundations -- bearing capacity, settlement, and allowable bearing pressure.
- E. Earth Retaining Structures -- gravity walls, cantilever walls, earth pressure diagrams, stability analysis.

3. STRUCTURAL 20%

- A. Loadings -- dead & live loads, wind loads.
- B. Analysis -- determinate analysis, shear diagrams, moment diagrams.
- C. Mechanics of Materials -- flexure, shear, tension & compression, deflection.
- D. Materials -- reinforced concrete, structural steel, and timber, concrete mix design, masonry.
- E. Member Design -- beams, slabs, columns, reinforced concrete footings, retaining walls, trusses.

4. TRANSPORTATION 20%

- A. Traffic Analysis -- capacity analysis.
- B. Construction -- excavation/embankment, material handling, optimization, scheduling.
- C. Geometric Design -- horizontal curves, vertical curves, sight distance.

5. WATER RESOURCES 20%

- A. Hydraulics -- energy dissipation, energy/continuity equation, pressure conduit, open channel flow, flow rates, friction/minor losses, flow equations, hydraulic jump, culvert design, velocity control.
- B. Hydrology -- storm characterization, storm frequency, hydrographs, rainfall intensity & duration, runoff analysis.
- C. Water Treatment -- demands, hydraulic loading, storages (raw & treated water).

Total 100%

CIVIL/ENVIRONMENTAL DEPTH (PM) EXAM

**Approximate
Percentage of
Examination**

1. ENVIRONMENTAL

65%

- A. Wastewater Treatment -- Wastewater flow rates, primary clarification, biological treatment, secondary clarification, chemical precipitation, sludge systems, digesters, disinfections, nitrification/denitrification, effluent limits, wetlands, unit processes, operations.
- B. Biology (including micro & aquatic) -- Toxicity, algae, food chain, stream degradation, organic load, oxygenation/deoxygenation/oxygen sag curve, eutrophication, temperature, indicator organisms, disinfections, water taste & odor, most probable number (MPN), BOD, quality control.
- C. Solid/Hazardous Waste -- Collection, storage/transfer, treatment, disposal, quantity estimates, site & haul economics, energy recovery, hazardous waste systems, applicable standards.
- D. Ground Water and Well Fields -- Dewatering, well analysis, water quality analysis, sub drain systems, groundwater flow, groundwater contamination, recharge, aquifers (e.g., characterization).

2. GEOTECHNICAL

10%

- A. Subsurface Exploration and Sampling -- Drilling and sampling procedures, soil classification, boring log interpretation, soil profile development.
- B. Engineering Properties of Soils -- Permeability.
- C. Soil Mechanics Analysis -- Compaction, seepage and erosion.

3. WATER RESOURCES

25%

- A. Hydraulics -- Energy/continuity equation, pressure conduit, open channel flow, detention/retention ponds, pump application and analysis, pipe network analysis, flow rates (domestic, irrigation, fire), surface water profile, cavitation, friction/minor losses, flow measurement devices, flow equations, culvert design, velocity control
- B. Hydrology -- Storm characterization, storm frequency, hydrograph (unit & others), transpiration, evaporation, permeation, rainfall intensity & duration, runoff analysis, gauging stations, flood plain/floodway, sedimentation.
- C. Water Treatment -- Demands, hydraulic loading, storages (raw & treated water), rapid mixing, flocculation, sedimentation, filtration, disinfection, applicable standards.

TOTAL

100%

CIVIL/GEOTECHNICAL DEPTH (PM) EXAM

**Approximate
Percentage of
Examination**

1. GEOTECHNICAL

65%

- A. Subsurface Exploration and Sampling -- Drilling & sampling procedures, in-situ testing, soil classification, boring log interpretation, soil profile development.
- B. Engineering Properties of Soils -- Index properties, phase relationships, shear strength properties, permeability.
- C. Soil Mechanics Analysis -- Effective & total stresses, pore pressure, pressure distribution, lateral earth pressure, consolidation, compaction, slope stability, seepage and erosion.
- D. Shallow Foundations -- Bearing capacity, settlement, allowable bearing pressure, proportioning individual/combined footings, mat and raft foundations, pavement design.
- E. Deep Foundations -- Axial capacity (single pile/drilled shaft), lateral capacity (single pile/drilled shaft), settlement, lateral deflection, and behavior of pile/drilled shaft groups, pile dynamics & pile load tests.

- F. Earth Retaining Structures -- Gravity walls, cantilever walls, mechanically stabilized earth wall, braced & anchored excavations, earth dams, earth pressure diagrams, stability analysis, and service ability requirements.
- G. Seismic Engineering -- Earthquake fundamentals, liquefaction potential evaluation.

2. ENVIRONMENTAL **10%**

- A. Ground Water and Well Fields -- Dewatering, water quality analysis, groundwater contamination, aquifers (e.g., characterization).

3. STRUCTURAL **20%**

- A. Loadings -- Dead & live loads, earthquake loads.
- B. Materials -- Concrete mix design.
- C. Member Design -- Reinforced concrete footings, pile foundations, retaining walls.

4. TRANSPORTATION **5%**

- A. Construction -- Excavation/embankment, pavement designs.

TOTAL **100%**

CIVIL/STRUCTURAL DEPTH (PM) EXAM

**Approximate
Percentage of
Examination**

1. STRUCTURAL **65%**

- A. Loadings -- Dead & live loads, moving loads, wind loads, earthquake loads, repeated loads.
- B. Analysis -- Determinate, indeterminate, shear diagrams, moment diagrams.
- C. Mechanics of Materials -- Flexure, shear, torsion, tension & compression, combined stresses, deflection.

- D. Materials -- Reinforced concrete, pre-stressed concrete, structural steel, timber, concrete mix design, masonry, composite construction.
- E. Member Design -- Beams, slabs, columns, reinforced concrete footings, pile foundations, retaining walls, trusses, braces & connections, shear and bearing walls.
- F. Failure Analysis -- Buckling, fatigue, failure modes.
- G. Design Criteria -- UBC, BOCA, SBC, ACI, PCI, AISC, NDS, AASHTO, ASCE-7

2. GEOTECHNICAL

25%

- A. Subsurface Exploration and Sampling -- Boring log interpretation.
- B. Soil Mechanics Analysis -- Pressure distribution, lateral earth pressure.
- C. Shallow Foundations -- Bearing capacity, settlement, proportioning individual/combined footings, mat & raft foundations
- D. Deep Foundations -- *Axial capacity* - Single pile/drilled shaft; *Lateral capacity* - Single pile/drilled shaft. Behavior of pile/drilled shaft groups.
- E. Earth Retaining Structures -- Gravity walls, cantilever walls, braced & anchored excavations, earth pressure diagrams, and stability analysis.

3. TRANSPORTATION

10%

- A. Construction -- Excavation/embankment, material handling, optimization, scheduling.

TOTAL

100%

CIVIL/TRANSPORTATION DEPTH (PM) EXAM

**Approximate
Percentage of
Examination**

1. TRANSPORTATION

65%

- A. Traffic Analysis -- Traffic signal, speed studies, capacity analysis, intersection analysis, parking operations, traffic volume studies, mass transit studies, sight distance, traffic control devices, pedestrian facilities, bicycle facilities, driver behavior/performance.
- B. Transportation Planning -- Origin-destination studies, site impact analysis, capacity analysis, optimization/cost analysis, trip generation/distribution/assignment.
- C. Construction -- Excavation/embankment, material handling, optimization, scheduling, mass diagrams, pavement design.
- D. Geometric Design -- Horizontal curves, vertical curves, sight distance, super elevation, vertical/horizontal clearances, acceleration & deceleration, intersections/interchanges.
- E. Traffic Safety -- Accident analysis, roadside clearance analysis, counter-measurement development, economic analysis, conflict analysis.

2. GEOTECHNICAL

15%

- A. Subsurface Exploration and Sampling -- Soil classification, boring log interpretation, soil profile development.
- B. Engineering Properties of Soils -- Index properties, phase relationships.
- C. Soil Mechanics Analysis -- Compaction, seepage & erosion.
- D. Shallow Foundations -- Pavement design.

3. WATER RESOURCES

20%

- A. Hydraulics -- Open channel flow, flow rates (domestic, irrigation, fire), flow equations, culvert design, velocity control.
- B. Hydrology -- Rainfall intensity & duration, runoff analysis, flood plain/floodway.

TOTAL

100%

CIVIL/WATER RESOURCES DEPTH (PM) EXAM

**Approximate
Percentage of
Examination**

1. WATER RESOURCES

65%

- A. Hydraulics -- Spillway capacity, energy dissipation, energy/continuity equation, pressure conduit, open channel flow, detention/retention ponds, pump application and analysis, pipe network analysis, storm water collection, flow rates (domestic, irrigation, fire), surface water profile, cavitation, friction/minor losses, sub- & supercritical flow, hydraulic jump, flow measurement devices, flow equations, culvert design, velocity control.
- B. Hydrology -- Storm characterization, storm frequency, hydrographs (unit & others), transpiration, evaporation, permeation, rainfall intensity & duration, runoff analysis, gauging stations, flood plain/floodway, sedimentation.
- C. Water Treatment -- Demands, hydraulic loading, storages (raw & treated water), rapid mixing, flocculation, sedimentation, filtration, disinfection, applicable standards.

2. ENVIRONMENTAL

25%

- A. Wastewater Treatment -- Unit processes
- B. Biology (including micro & aquatic) -- Toxicity, algae, food chain, stream degradation, organic load, eutrophication, temperature, indicator organisms, disinfection, water taste & odor, most probable number (MPN), BOD, quality control.
- C. Ground Water and Well Fields -- Well analysis, water quality analysis, groundwater flow, groundwater contamination, recharge, aquifers (e.g., characterization).

3. GEOTECHNICAL

10%

- A. Subsurface Exploration and Sampling -- Soil classification, boring log interpretation, soil profile development.
- B. Engineering Properties of Soils -- Permeability.
- C. Soil Mechanics Analysis -- Seepage and erosion.

TOTAL

100%

Notes:

1. The knowledge areas specified as A, B, C, ... etc., are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
2. Each depth (PM) exam contains 40 multiple-choice questions. Examinee chooses one depth exam and works all questions in the depth exam chosen.

Structural Design Standards¹

EFFECTIVE with the April 2001 Examinations (Revised October 26, 2000)

<u>ABBREVIATION</u>	<u>DESIGN STANDARD TITLE</u>
AASHTO	Standard Specifications for Highway Bridges , Sixteenth Edition, 1996, with interims through 1999, American Association of State Highway & Transportation Officials, Washington, DC
ACI 318	<u>Building Code Requirements for Structural Concrete</u> , 1995, American Concrete Institute, Farmington Hills, MI.
ACI 530	<u>Building Code Requirements for Masonry Structures</u> , 1995 &
ACI 530.1	<u>Specifications for Masonry Structures</u> , 1995, American Concrete Institute, Detroit, MI.
AISC/ASD²	<u>Manual of Steel Construction Allowable Stress Design</u> , Ninth Edition, 1989, American Institute of Steel Construction, Inc., Chicago, IL.
AISC/LRFD²	<u>Manual of Steel Construction Load and Resistance Factor Design</u> , Second Edition, 1994, American Institute of Steel Construction, Inc., Chicago, IL.
NDS⁵	<u>National Design Specification for Wood Construction</u> , 1991 Edition or 1997 Edition (ASD Only) & <u>National Design Specification Supplement</u> , 1991 Edition or 1997 Edition (ASD Only), American Forest & Paper Association (formerly National Forest Products Association), Washington, DC.
PCI	<u>PCI Design Handbook</u> , Fifth Edition, 1999, Precast/Prestressed Concrete Institute, Chicago, IL.
NBC^{3, 4}	<u>The BOCA National Building Code</u> , 1996, Building Officials & Code Administrators International, Inc., Country Club Hills, IL.
SBC^{3, 4}	<u>Standard Building Code</u> , 1997 Edition, Southern Building Code Congress International, Inc., Birmingham, AL.
ASCE 7⁴	<u>Minimum Design Loads for Buildings and Other Structures</u> , 1995, American Society of Civil Engineers, New York, NY.
UBC³	<u>Uniform Building Code</u> , 1997 Edition, International Conference of Building Officials, Whittier, CA.

NOTES:

1. Examinees are advised that solutions to examination problems, which reference a standard of practice, are scored based on this list. Solutions based on other standards may result in different answers, which may not receive credit. All problems are in English units.
2. Examinees may choose between the AISC/ASD and AISC/LRFD.
3. Examinees may choose between the NBC, SBC, or UBC.
4. ASCE 7-95 may be used for wind loads when using the NBC or SBC.
5. Available from ICBO, 5360 Workman Mill Road, Whittier, CA 90601-2298 phone (800) 284-4406.

Transportation Design Standards .

EFFECTIVE with the April 2001 Examinations
(Revised 5/12/99)

ABBREVIATION DESIGN STANDARD TITLE

- AASHTO** **A Policy on Geometric Design of Highways and Streets**,
1990 Edition, American Association of State Highway &
Transportation Officials, Washington, DC
- AI** **The Asphalt Handbook (MS-4)**, 1989 Edition, Asphalt Institute,
College Park, MD
- HCM** **Highway Capacity Manual (SR 209)**, Updated 1997, Third
Edition, Transportation Research Board - National Research
Council, Washington, DC
- MUTCD** **Manual on Uniform Traffic Control Devices**, 1988 Edition, U.S.
Department of Transportation - Federal Highway Administration,
Washington, DC
- PCA** **Design and Control of Concrete Mixtures**, 1990, Thirteenth
Edition, Portland Cement Association, Skokie, IL
- ITE** **Traffic Engineering Handbook**, 1999, Fifth Edition, Institute Of
Transportation Engineers, Washington, DC

Control Systems ■

EFFECTIVE October 1998 (Revised 5/17/99)

	APPROXIMATE PERCENTAGE OF EXAMINATION
1. SENSORS Fundamentals of measurement; sensor principles, selection and installation practices	16%
2. ANALOG AND DIGITAL DATA TRANSMISSION Conductor pairs; coaxial cable; fiber optics; shielding and grounding; protocols	6%
3. VALVES AND FINAL ELEMENTS Fluid mechanics; valve characteristics, selection, sizing and installation practices; relief valves	14%
4. PROCESS DYNAMICS Mass and energy balances, fluid flow and heat transfer for typical processes; transfer functions; responses to standard inputs; process identification by plant tests	6%
5. CONTROL SYSTEM ANALYSIS Block diagrams; stability, accuracy and response-time considerations	6%
6. CONTROLLERS/MODES/TUNING Controller and mode selection; tuning procedures	6%
7. DIGITAL CONTROL SYSTEMS Hardware and software fundamentals	8%
8. DISCRETE LOGIC, INTERLOCKS, ALARMS AND SEQUENCING Logic elements; timers/counters; design tools; recommended practices	18%
9. CODES AND STANDARDS Wiring; burner/boiler/pressure vessel safety	10%
10. DOCUMENTATION Standard symbols for process and instrument drawings; logic diagrams; displays	8%
11. ECONOMICS OF CONTROL Costs; benefits; payout criteria	2%
Total	100%

Notes

1. The examination is developed with questions that will require a variety of approaches and methodologies including design, analysis, application and operations.
2. This examination contains a total of 80 multiple-choice questions. Examinee works all questions.

Electrical

EFFECTIVE October 1991 (Revised 5/17/99)

	NUMBER OF PROBLEMS
1. FUNDAMENTAL DESIGN OF GENERATION SYSTEMS Large scale power plants.	1
2. FINAL DESIGN AND APPLICATIONS OF GENERATION SYSTEMS Large scale power plants.	1
3. FUNDAMENTAL DESIGN OF TRANSMISSION AND DISTRIBUTION SYSTEMS Transformers, protection, safety, overhead and underground lines, metering, batteries, relays, substations, circuit protectors, and intrinsic safety devices.	1
4. FINAL DESIGN AND APPLICATIONS OF TRANSMISSION AND DISTRIBUTION SYSTEMS Transformers, protection, safety, overhead and underground lines, metering, batteries, relays, substations, circuit protectors, and intrinsic safety devices.	2
5. FINAL DESIGN AND APPLICATIONS OF ROTATING MACHINES Motors and generators.	1
6. FINAL DESIGN AND APPLICATIONS OF INSTRUMENTATION Instrument transformers, metering systems, measurement systems, test procedures, and transducers.	1
7. FINAL DESIGN AND APPLICATIONS OF LIGHTNING PROTECTION AND GROUNDING Lightning protection and physical grounding of equipment and structures.	1
8. DESIGN OF CONTROL SYSTEMS Industrial process and operations controls, feedback controls, and transient theory.	2
9. DESIGN OF ELECTRONIC DEVICES Digital storage devices, integrated circuit components, and operational amplifiers.	2
10. APPLICATIONS OF ELECTRONIC DEVICES Digital storage devices, integrated circuit components, and operational amplifiers.	1

11. DESIGN OF INSTRUMENTATION	1
Instrument transformers, metering systems, measurement systems, test procedures, and transducers.	
12. APPLICATIONS OF INSTRUMENTATION	1
Instrument transformers, metering systems, measurement systems, test procedures, and transducers.	
13. DESIGN OF DIGITAL SYSTEMS	2
Digital systems including interfaces, protocols, and standards.	
14. DESIGN OF COMPUTER SYSTEMS	2
Digital and analog computer systems.	
15. APPLICATIONS OF COMPUTER SYSTEMS	1
Digital and analog computer systems.	
16. DESIGN OF COMMUNICATION SYSTEMS	2
Broadcast, voice and data communication; fiber optics, antennas, microwave systems, and HF transmission lines.	
17. APPLICATIONS OF COMMUNICATION SYSTEMS	1
Broadcast, voice and data communication; fiber optics, antennas, microwave systems, and HF transmission lines.	
18. DESIGN OF BIOMEDICAL SYSTEMS	1
Electrical applications in living systems.	
Total number of problems =	24

Notes

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics.
2. This examination contains both essay and multiple-choice problems. Examinee works eight (8) out of twenty-four (24) problems.
3. Effective April 2000, the 1999 edition of the National Electrical Code (NEC) applies to any code related questions.

Environmental ■

EFFECTIVE 9910 (Revised 10/8/98)

Approximate
Percentage of
Examination

1. WATER

Planning, research, development, project implementation, operations, and monitoring of waste, wastewater, storm water, and natural water systems

Wastewater/Storm Water	14%
Water	13%
Natural Water Systems	7%

2. SOLID AND HAZARDOUS WASTE

Planning, research, development, project implementation, operations, and monitoring of solid and hazardous waste systems

Solid/Hazardous Waste	21%
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3. AIR

Planning, research, development, project implementation, operations, and monitoring of air systems

Pollution Source	6%
Pollution Control Processes	9%
Ambient Air Quality	6%

4. ENVIRONMENTAL HEALTH, SAFETY, AND WELFARE

Research, development, project implementation, operations, and monitoring of environmental health, safety, and welfare

Risk Assessment	5%
Occupational and Radiological Health	7%
Fate and Transport	6%
Public Health	6%

TOTAL = 100%

Notes:

1. The examination is developed with problems that require a variety of approaches and methodologies including design, analysis, application, and operations. Some problems may require knowledge of engineering economics. This examination contains a total of 100 multiple-choice questions.
2. Examinee works all questions.

Fire Protection

EFFECTIVE October 1999 (Revised 5/17/99)

	APPROX. % OF EXAM
1. PLANNING AND DESIGN OF WATER SUPPLIES Water supplies dedicated to fire protection, public water supplies.	12%
2. PLANNING AND DESIGN OF BUILDING SYSTEMS Structural fire resistance, fire barriers, opening protection, means of egress, construction materials, smoke management systems, building use and occupancy.	13%
3. PLANNING AND DESIGN OF WATER-BASED SUPPRESSION SYSTEMS Specifying, evaluating, testing, and maintaining sprinkler and waterspray systems; fire and explosion suppression systems.	12%
4. PLANNING AND DESIGN OF NON WATER-BASED SUPPRESSION SYSTEMS Specifying, evaluating, testing, and maintaining CO ₂ , dry chemical, foam, and alternate agent systems; fire and explosion suppression systems.	13%
5. PLANNING AND DESIGN OF DETECTION AND ALARM SYSTEMS Specifying, evaluating, testing and maintaining heat, smoke, and flame detectors; alarm and supervisory systems.	12%
6. PLANNING AND DESIGN OF FIRE PREVENTION Control of combustible materials, ignition sources, and oxidizing agents.	13%
7. IMPLEMENTATION AND MONITORING OF FIRE PREVENTION Inspection, testing and preventive maintenance; process safety; hazard abatement.	12%
8. RESEARCH AND DEVELOPMENT OF HAZARD AND RISK ANALYSIS Quantification of frequency and severity of fire events, estimation of time available for occupant egress from rooms, analysis of damage potential to exposed objects from fire or explosion.	13%
Total	100%

Notes

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics.
2. This examination contains a total of 80 multiple-choice questions. Examinee works all questions.

Industrial

EFFECTIVE October 1999 (Revised 5/17/99)

	APPROXIMATE PERCENTAGE OF EXAMINATION
1. FACILITIES Site selection, plant layout, equipment, material handling and waste management systems, packaging equipment, capacity analysis, and power service and other utility requirements.	25%
2. MANUFACTURING Products, manufacturing processes, maintenance procedures, operations sequencing, machine grouping, robotics, automation, and value engineering.	25%
3. PRODUCTION AND INVENTORY SYSTEMS Forecasting, production scheduling, project scheduling, production control, resource planning, logistics, and distribution.	12%
4. WORK SYSTEMS AND ERGONOMICS Measuring work, methods analysis, incentive and other payment plans, workplace design, human-machine interfacing, and industrial hygiene and safety.	13%
5. QUALITY ASSURANCE Quality assurance plans, reliability analysis, control procedures, capability analysis, quality aspects of design.	12%
6. MANAGEMENT AND COMPUTER/INFORMATION SYSTEMS Organization design, staffing plans, productivity, human resources, computer systems analysis and design, specification of computer equipment, and computer communication protocols.	13%
Total	100%

Note

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics, probability and statistics, and operations research techniques.
2. This examination contains a total of 80 multiple-choice questions. Examinee works all questions.

Manufacturing ■

EFFECTIVE BEGINNING WITH OCTOBER 2000 EXAMINATION (Revised 10/27/99)

	Approximate Percentage of Examination
1. Product Process Design, Materials Application	27%
A. Materials Engineering and Applications	6%
1. Metals	
2. Plastics	
3. Fluids	21%
B. Product/Process Design	
1. R&D, Prototyping, testing	
2. Concurrent Engineering	
3. Design for X	
a. Manufacturing	
b. Assembly	
c. Maintenance	
d. System constraints	
e. Environment/recycling	
4. Engineering Graphics/CAD	
5. Engineering Design Analysis	
a. Modeling of products	
b. Simulation of processes	
c. Finite element analysis	
d. Risk analysis	
e. Probability of success	
f. Independence of requirements	
g. Other aspects of Engineering Design Analysis	
6. Cost engineering analysis	
a. Make vs. buy	
b. Variable vs. fixed costs	
c. Capital budgeting/cost justification of production systems or equipment	
d. Value engineering	
7. Tolerance Analysis/GD&T	
8. Process Design and Development	

2. Manufacturing Processes	26%
A. Material Removal	9%
B. Fabrication, Joining and Assembly	8%
1. Fabrication Processes	
2. Joining and Assembly Processes	
C. Forming	6%
1. Casting and Molding Processes	
2. Hot and Cold Forming Processes	
3. Powders Processing	
D. Finishing	3%
1. Surface Modification	
2. Coatings	
3. Surface Performance (e.g., friction, corrosion, etc.)	
3. Production Systems, Controls & Equipment Design	27%
	17%
A. Production Systems & Control	
1. Tool & Equipment Selection	
2. Production System Design	
3. Safety, Health, & OSHA	
a. Environmental impact	
b. Ergonomics	
4. Facility Design/Plant Layout	
5. Process Planning	
6. Capacity Planning	
7. Cost Justification	
8. CAM/CIM Systems	
B. Equipment Design	10%
1. Machine Design	
2. Jig & Fixture Design	
3. Tool Design	

4. Quality

15%

1. Probability & Statistics
 - a. Frequency analysis
 - b. Reliability
 - c. Analysis of Variance
2. Statistical Control Methods
(Sampling/Charting/etc.)
3. Process & Equipment Capability Analysis
4. Inspection and Testing
5. Systems Analysis and Problem Solving

5. Manufacturing Management

5%

1. Project Management
2. Business/Engineering Ethics
3. Production Planning and Inventory Control
 - a. Line balancing
 - b. Quantitative Methods
 - c. Theory of Constraints
 - d. Queuing Theory
 - e. Learning Curves

TOTAL = 100%

Note:

1. The knowledge areas specified as a., b., c., ... etc. are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
2. This examination contains 80 multiple-choice questions. Examinee works all questions.

Mechanical ■

EFFECTIVE October 2001 (Revised 4/12/01)

The mechanical engineering examination is a breadth and depth examination. This means that **all** examinees work the breadth (AM) exam and **one** of the three depth (PM) exams. The three areas covered in the mechanical engineering examination are HVAC and Refrigeration, Machine Design, and Thermal and Fluids Systems. The breadth exam contains questions from these three areas of mechanical engineering. The depth exams focus more closely on a single area of practice in mechanical engineering.

Breadth Module (AM)	Approximate Percentage of Examination
1. General Knowledge, Codes & Standards	30%
A. Engineering Principles	15%
1. Heat Transfer	
2. Mass Transfer	
3. Fluid Mechanics	
4. Materials Properties	
B. Fundamental Engineering Practice	11%
1. Relevant Engineering Terminology	
2. Economic Analyses	
3. Project Management	
4. Ethics	
5. Regulations and Laws	
6. Industry and Company Design Standards	
7. Interpretation of Technical Drawings	
8. Electrical Principles	

C. Interpretation of Codes and Standards	4%
1. ASTM	
2. ANSI	
3. ASME	
2. Machine Design & Materials Knowledges	17%
A. Principles	11%
1. Strength of Materials	
2. Fatigue Theory	
3. Statics and Dynamics	
B. Applications	6%
1. Welding	
2. Pressure Vessels	
3. Vibration Analysis	
4. Materials Selection	
a. Corrosion	
b. Economics	
3. Hydraulics & Fluids	17%
A. Principles	9%
1. Compressible Flow	
2. Incompressible Flow	
3. Stress Analysis	
B. Applications	8%
1. Hydraulic Pumps	
a. Pressure Loss	
b. Efficiency	

4.	Energy Conversion / Power Systems Knowledge	18%
A.	Principles	10%
	1. Thermodynamic Cycles	
	2. Thermodynamic Properties	
B.	Analysis of Systems and Components	8%
	1. Energy Balances	
	2. Pumps/Compressors	
5.	HVAC and Refrigeration Knowledge	18%
A.	Principles	
	1. Psychrometrics	
	2. Thermodynamics	
	3. Cooling/heating cycles	
	Total	100%

HVAC and Refrigeration Depth Module (PM)

Approximate Percentage of Examination

1.	Fundamentals	34%
A.	Psychrometrics	15%
	1. Cooling/heating Cycles	
	2. Humidification/Dehumidification	

B. Principles **19%**

1. Thermodynamics
2. Fluid Mechanics
3. Heat Transfer Principles
4. Mass Transfer Principles
5. Compression Processes
6. Compressible Flow
7. Thermodynamic Cycles
8. Thermodynamic Properties
9. Energy Balances

2. Equipment and Materials **37%**

1. Cooling Towers
2. Boilers & Furnaces
3. Condensers
4. Pumps/compressors/fans
5. Evaporators/chillers
6. Cooling/heating coils
7. Control Systems Components
8. Refrigerants
9. Refrigeration Components

3. Applications **29%**

A. Systems Applications **21%**

1. Codes and Standards (FM, NFPA, ASHRAE, BOCA, UBC, SBCC, etc.)
2. Air Distribution Systems
3. Water Distribution Systems
4. Refrigeration Systems
5. Air Quality Requirement
6. Energy Recovery

B. Supportive Knowledges 8%

1. Vibration Control
2. Acoustics
3. Economic Analyses

Total 100%

Machine Design Depth Module (PM)

Approximate
Percentage
of Examination

1. Engineering Principles

43%

1. Materials Properties & Selection
2. Strength of Materials
3. Fatigue Theory
4. Vibration Analysis
5. Statics and Dynamics
6. Stress Analysis
7. Kinematics

2. Components

36%

1. Bearings
2. Gears
3. Springs
4. Shafts
5. Fasteners

3. Applications	21%
A. Systems Applications	13%
1. Economic Analyses	
2. Pressure Vessels	
3. Structural Analysis	
4. Mechanism Analysis	
5. Codes and Standards (ASTM, ANSI, ASME)	
B. Supportive Knowledges	8%
1. Fluid Mechanics	
2. Heat and Mass Transfer Principles	
3. Thermodynamics	
a. Properties	
b. Cycles	
4. Energy Balances	
5. Project Management	
6. Welding	
7. Fits & Tolerances	
8. Manufacturing Processes	
9. Quality Control	
Total	100%

Thermal and Fluids Systems Depth Module (PM)

Approximate
 Percentage
 of Examination

1. Fundamentals	33%
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- A. Engineering Principles 22%
 - 1. Materials Properties
 - 2. Fluid Mechanics
 - 3. Heat Transfer Principles
 - 4. Mass Transfer Principles
 - 5. Economic Analyses
 - 6. Project Management
 - 7. Compressible Flow
 - 8. Incompressible Flow
 - 9. Thermodynamics
 - a. Thermodynamic Cycles
 - b. Thermodynamic Properties
 - c. Energy Balances

- B. Supportive Knowledges 11%
 - 1. Strength of Materials
 - 2. Fatigue Theory
 - 3. Statics and Dynamics
 - 4. Welding
 - 5. Pressure Vessels
 - 6. Stress Analysis
 - 7. Psychrometrics

- 2. Components 34%**
 - A. Hydraulic System Components 14%
 - 1. Hydraulic Pumps
 - 2. Hydraulic and Pneumatic Lines, Fittings, and Control Components

 - B. Power Plant Components 20%
 - 1. Turbines
 - 2. Pumps/compressors
 - 3. Heat Exchangers
 - 4. Feedwater Heaters
 - 5. Cooling Towers
 - 6. Steam Generators
 - 7. Condensers

Metallurgical ■

EFFECTIVE October 1991 (Revised 6/10/99)

	NUMBER OF PROBLEMS
1. FABRICATION AND MECHANICAL PROCESSING PROCEDURES Powder metallurgy, welding, casting, rolling, forging, extrusion.	2
2. MATERIAL PROCESSING PROCEDURES Heat treating, surface modification, precipitation hardening, hardenability, carburizing, nitriding.	3
3. MINERAL PROCESSING PROCEDURES Materials handling; procedures and processes for the mechanical or chemical separation of minerals or grades or for the beneficiation of minerals; includes crushing, grinding, magnetic/electrostatic/heavy media/gravity/pyrochemical separation techniques.	3
4. EXTRACTIVE METALLURGY PROCEDURES Processes used to separate metals from ores; chemical engineering with emphasis on high temperature processes.	3
5. MATERIALS SELECTION Evaluation and recommendation of metals and alloys for various applications, recommendation of treatments to optimize utility of materials.	3
6. QUALITY CONTROL Metallurgical analysis required to determine and maintain quality of in-process and final products.	1
7. STRUCTURE/PROPERTY RELATIONSHIPS Evaluation of structure, powder metallurgy, fracture toughness	2
8. FAILURE ANALYSIS Determination of physical/chemical causes of failure of processes/equipment/material/services.	3
Total number of problems =	20

Notes

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics.
2. Examinee works eight (8) out of twenty (20) problems. Each problem consists of 10 multiple-choice questions.

Mining/Mineral ■

EFFECTIVE October 2000 (Revised October 22, 1999)

	NUMBER OF PROBLEMS
1. EXPLORATION Geoscience principles and techniques used to find, develop, and operate a mine	2
2. MINE PLANNING/OPERATIONS Mine types, mine layout, material handling requirements and systems, access roads and power supply	5
3. GROUND CONTROL Shaft, slope, and roof stability	2
4. MINERAL PROCESSING PROCEDURES Materials handling, procedures and processes for the mechanical or chemical separation of minerals or grades or for the beneficiation of minerals; includes crushing, grinding, magnetic/electrostatic/heavy media/gravity/pyrochemical separation techniques	4
5. RECLAMATION (ENV/GOV) Development of reclamation plans, safety, environmental/governmental regulations	3
Total number of problems =	16

Notes

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics.
2. This examination contains multiple-choice problems. Examinee works eight (8) out of sixteen (16) problems. Each problem consists of 10 multiple-choice questions.

Naval Architecture & Marine Engineering

EFFECTIVE October 1999 (Revised 4/27/99)

	Approximate Percentage of Examination
1. MECHANICS Rigid body mechanics; statics; equilibrium; deformable body mechanics	7%
2. LOADS Axial, flexural, torsional; fluid statics and dynamics; pressure induced; fatigue; thermal; bearings; cargo; seaway	8%
3. WELDS/CONNECTIONS Connections and fasteners	4%
4. STRUCTURAL MEMBERS Frames; plates; stiffened elements; hull girder	7%
5. VIBRATIONS Solid element and fluid vibrations	3%
6. HYDROSTATICS Hydrostatics of floating devices	6%
7. HYDRODYNAMICS Hydrodynamics resistance and propulsion	5%
8. TRANSPORT PROCESS Conservation of mass and energy; heat transfer; energy conversion devices	6%
9. FLUID FLOW Control devices and valves; pipe flow and resistance; hydraulics	6%
10. HVAC/REFRIGERATION Refrigeration systems and devices; HVAC system and devices	4%
11. COMBUSTION Combustion of gaseous, liquid, and solid fuels	3%
12. ELECTRICAL LOADS Analysis of electrical load	3%
13. ELECTRICAL DISTRIBUTION Design of distribution and power circuits	3%

14. ELECTRICAL ENERGY CONVERSION	3%
Electrical energy conversion devices such as motors, generators, and transformers	
15. EMERGENCY ELECTRICAL SYSTEM	1%
Emergency generators, batteries, and systems	
16. CAE	2%
2-d & 3-d manual sketching; 2-d & 3-d CAD; CAE; finite element techniques	
17. SHIP BUILDING/REPAIR	4%
Shipbuilding and repair processes; weight controls; launching and dry docking; trials and delivery and quality assurance	
18. ECONOMICS	5%
Engineering and ship economics	
19. OUTFITTING DESIGN	5%
Hull closure devices; deck equipment; outfitting equipment	
20. MATERIALS	3%
Ferrous and non-ferrous metals; plastics and composite materials	
21. CORROSION	2%
Galvanic cells; general wastage, pitting; crevice and stress corrosion	
22. POLLUTION PREVENTION	4%
Air, liquid, and solid pollution and methods of preventing	
23. REGULATIONS	2%
USCG, EPA, ABS, SOLAS, IMO	
24. HUMAN FACTORS	2%
OSHA, USCG, ABS, SOLAS, IMO, STCW	
25. WIND AND WAVES	2%
Dynamic forces and motions caused by winds and waves	
TOTAL =	100%

Note: This examination contains 80 multiple-choice questions. Examinee works all questions.

Nuclear

EFFECTIVE October 1997 (Revised 5/17/99)

	PERCENTAGE OF THE EXAMINATION
1. NUCLEAR POWER SYSTEMS NSSS, BOP, (e.g. heat exchangers), thermal hydraulics applications, PRA, and energy generation	25%
2. NUCLEAR FUEL AND WASTE MANAGEMENT Material balance, fuel composition design, economic analysis, depletion and burn up, radioactive materials handling, radioactive material storage (including spent fuel), radioactive material transportation, high and low level waste disposal, high and low level waste treatment	20%
3. NUCLEAR RADIATION PROTECTION/RADIATION SHIELDING Radioactive material control and monitoring, dose assessment, environmental surveillance, regulatory compliance, decontamination	20%
4. NUCLEAR CRITICALITY/KINETICS/NEUTRONICS Analysis of critical and subcritical systems, single and multi group calculations, point kinetics, bare and reflected systems, effects of strong absorbers, reactivity calculations	20%
5. NUCLEAR MEASUREMENTS AND INSTRUMENTS Radiation detection, sensors, instrumentation and control, counting statistics, electronics of instruments	15%
	TOTAL 100%

Notes

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis, application and operations. Some problems may require knowledge of engineering economics.
2. This examination contains 80 multiple-choice questions. Examinee works all questions.

Petroleum

EFFECTIVE October 1999 (Revised October 25, 1999)

Approximate
Percentage of
the Examination

I. Common Knowledge

See Note 3

- A. Principles of mathematics and the physical sciences
- B. Petroleum engineering terminology
- C. Relevant industry and company design standard
- D. Relevant industry regulatory/environmental law
- E. Industry and/or company-provided technical software/informational databases
- F. Project management techniques (costing, scheduling, contracting, logistics)
- G. Geoscience principles (pore pressure, fracture gradients, well bore stability, etc.)
- H. Risk analysis/contingency planning
- I. Surveillance/optimization techniques
- J. Economic principles
- K. Multi-disciplinary team participation
- L. Professionalism including ethics and due diligence

II. Drilling

22.5%

- A. Tubulars
- B. Cementing
- C. Drilling fluids
- D. Drill string
- E. Drilling mechanics
- F. Hydraulics
- G. Rig equipment capabilities
- H. Directional/horizontal drilling
- I. Wellheads
- J. Well control/BOP
- K. Solids control
- L. Bits

III. Completion, Production and Facilities

30%

- A. Proper lift mechanism selection given a set of well conditions
- B. Sucker rod pumping systems
- C. Gas lift, including intermitters, plunger lift, or gas lift valves
- D. Downhole pumps including ESPs, progressive cavity pumps or jet pumps
- E. Well and completion systems including nodal analysis
- F. Inflow performance curve analysis
- G. Production logging
- H. 2D sand fracture treatments
- I. Matrix acid treatments
- J. Tubing and downhole equipment
- K. Plug and abandonment procedures
- L. Remedial/recompletion operations (squeezing cementing, sand control, perforating, etc.)
- M. Selections of piping to accommodate flow rate, total pressure and pressure drop considerations
- N. Compressor application and sizing parameters
- O. Onsite processing equipment including separators, heater treaters, or dehydrators
- P. Onsite storage vessels including piping, valves and venting

Approximate
Percentage of
Examination

IV. Reservoir

30%

- A. Reservoir geoscience
- B. Oil/gas reservoir performance
- C. Methods to determine net pay
- D. Phase behavior/reservoir fluids
- E. Single/multiphase flow in porous media
- F. Gravity/capillary and viscous forces
- G. Methods for estimating reserves and recoveries
- H. Reservoir development techniques (patterns, rates, stimulation, etc.)
- I. Water/gas injection
- J. Reservoir simulation techniques

V. Formation Evaluation

17.5%

- A. Physical measurements (e.g., acoustic, nuclear, electrical)
- B. Derivation of properties from formation evaluation data including lithology, mechanical rock properties, fluid properties and borehole dimensions.
- C. Lithology
- D. Mechanical rock properties
- E. Fluid properties
- F. Logging methods (wireline, MWD/LWD, open hole, cased hole)
- G. Well testing (wireline, production test, DST, well test analysis)
- H. Coring (SWC, full hole core, petrophysical/lab analysis)

Total = 100%

Notes

1. The knowledge areas specified as A., B., C., ... etc. are examples of kinds of knowledge, but they are not exclusive or exhaustive categories.
2. This examination contains 80 multiple-choice questions. Examinee works all questions.
3. The committee chose to fold the Common Knowledge section into the other content sections.

PRINCIPLES AND PRACTICE OF LAND SURVEYING

EFFECTIVE October 1999

Approximate
Percentage Of
Examination

PROJECT MANAGEMENT

12%

- Evaluate project elements to define scope of work.
- Select appropriate vertical and/or horizontal datum and basis of bearings.
- Determine levels of precision and order of accuracy.
- Prepare and negotiate proposals and/or contracts.
- Consult and coordinate with allied professionals and/or regulatory agencies.
- Consult with and advise clients and/or their agents.
- Facilitate regulatory review and approval of project documents and maps.
- Determine and secure entry rights.

RESEARCH

7%

- Research and evaluate evidence from private record sources.
- Research and evaluate evidence from public record sources.
- Research and evaluate court records and caselaw.
- Gather parol evidence.

MEASUREMENTS/LOCATIONS

32%

- Recover horizontal/vertical control.
- Identify pertinent physical features, landmarks, and existing monumentation.
- Calibrate instruments.
- Perform geodetic surveys using conventional methods.
- Perform geodetic and/or plane surveys using GPS methods.
- Perform plane surveys using conventional methods.
- Perform astronomic measurements.
- Perform record or as-built surveys.
- Perform ALTA/ACSM surveys.
- Perform hydrographic surveys.
- Perform trigonometric leveling.
- Perform differential leveling.
- Perform photogrammetric control surveys.
- Perform field verifications of photogrammetric maps.
- Produce survey data using photogrammetric methods.
- Utilize survey data produced from photogrammetric methods.
- Perform boundary surveys.
- Perform route and right-of-way surveys.
- Perform topographic surveys.
- Perform flood plain surveys.
- Perform construction surveys.
- Perform condominium surveys.

COMPUTATIONS/ANALYSIS

17%

- Compute survey data.
- Analyze and adjust survey data.
- Evaluate parcel evidence.
- Reconcile survey and record data.
- Compute areas and volumes.
- Convert survey data to an appropriate datum.
- Prepare worksheets for analysis of surveys.
- Utilize computer-aided drafting systems.

LEGAL PRINCIPLES/RECONCILIATION **16%**

- Identify and evaluate field evidence for possession boundary line discrepancies, and potential adverse possession claims.
- Identify riparian and/or littoral boundaries.
- Apply Public Land and other Survey System principles.
- Evaluate the priority of conflicting title elements.
- Determine locations of boundary lines and encumbrances.
- Advise clients regarding boundary uncertainties.
- Testify as an expert witness.
- Review documents with clients and/or attorneys.

LAND PLANNING & DESIGN **3%**

- Determine subdivision development requirements and constraints.
- Determine and prepare lot and street patterns for land division.
- Design horizontal and vertical alignment for roads within a subdivision.

DOCUMENTATION/LAND INFORMATION SYSTEMS **13%**

- Perpetuate and/or establish monuments and their records.
- Prepare sketches and/or preliminary plats.
- Document potential possession claims.
- Prepare and file record of survey.
- Prepare survey maps, plats, and reports.
- Prepare land descriptions.
- Develop and/or provide data for LIS/GIS.

TOTAL **100%**

Note: There are a total of 100 questions on the examination.

Structural I ■

EFFECTIVE APRIL 2000 (Revised March 26, 1999)

	Approximate Percentage of Examination
I. ANALYSIS	
A. Loads, Moments, Shears and Deflections	22%
Vertical Loads (Static, moving, snow), Lateral Loads (Earth/hydraulic, seismic, wind), Temperature, Shrinkage and/or Creep Effects, Miscellaneous Bridge Loads, Load Combinations	
B. Structural Stability	15%
Overturning, Sliding, Load Path	
II. DESIGN	
A. Flexure and Shear/Torsion	20%
Reinforced Concrete, Pre-stressed Concrete, Structural Steel, Timber, Masonry, Composite Construction	
B. Axial Load and/or Combined Bending and Axial Loaded Members	13%
(Columns, Walls, Truss Members), Reinforced Concrete, Structural Steel, Timber, Masonry, Composite Construction	
C. Foundations	8%
Shallow Foundations, Deep Foundations	
D. Connections (Including Lateral Loads)	10%
Reinforced Concrete, Pre-stressed Concrete, Structural Steel, Timber, Masonry	
E. Lateral Load Resisting Structures	12%
Diaphragms, Shear Walls, Frames	
Total =	100%

Notes:

1. The examination is developed with problems that will require a variety of approaches and methodologies including design, analysis and application. Some problems may require knowledge of engineering economics. Approximately 20% of the exam will test bridge knowledge.
2. This examination contains a total of eighty (80) multiple-choice questions. Examinee works all questions.

Structural II ■

EFFECTIVE April 1997 (Revised 5/17/99)

NUMBER OF
PROBLEMS

MORNING (Essay)

1. BRIDGES Concrete and/or steel	1
2. BUILDINGS Concrete, masonry, steel, and/or timber	1
Total number of morning problems =	2

AFTERNOON (Essay)

All afternoon problems have seismic content

1. BRIDGES with SEISMIC Concrete and/or steel	1
2. BUILDINGS with SEISMIC Concrete, masonry, steel and/or timber	1
Total number of afternoon problems =	2

Notes

1. Examinees are to work any one (1) problem selected from the two (2) problems presented in each session, in accordance with local instructions. All problems are essay type.

Appendix C
Survey of Licensing Practices

Survey of Licensing Practices

To obtain information on the practices of licensing boards in other states, a questionnaire was developed and sent to the Boards in all of the US states and jurisdictions. The questionnaire deals with topics of key interest in the legislatively-mandated study of the California BPE&LS: use of titles, branch definitions, overlaps between branches, and disciplinary practices related to practice outside an engineer's nominal branch.

At this time, responses have been received from 27 Boards. If additional responses are received, this summary will be updated, and revised copies will be distributed to the original slate of recipients.

At the start of the survey, respondents are asked: Does your board register or license a qualified engineer as a:

- Discipline-specific engineer, restricted to practice in a specific field; or
- Professional Engineer limited to practice in his/her field of expertise.

These definitions are taken from the NCEES "2000 Information Survey," an annual survey of state boards conducted by NCEES, so board representatives should be familiar with the concept and terminology. For brevity, these states are referred to as "DISC" or "PE" in the following tabulation of responses to our survey. (California is a "DISC" state but, to date, has not responded to this survey.) Five "DISC state or territories (AK, NE, NV, Guam, and Northern Mariana Islands) and 22 states (CO, FL, ID, KY, MD, ME, MI, MN, MO, MS, MT, NH, NM, NC, NY, OH, OR, SC, SD, VA, WI, and WY) have responded to date.

The following pages give the number of Yes, No, and N/A (Not Applicable, Not Available, or No Answer) responses to each question. In the comments, "PE boards" and "DISC boards" are used for brevity to distinguish the two types of jurisdictions.

1. Can all licensed engineers use the title PE?

PE	Y-22	N-0	N/A-0
DISC	Y-5	N-0	N/A-0

2. Can licensed engineers use a title indicating their branch of engineering, such as civil engineer, electrical engineer, chemical engineer, nuclear engineer, etc.?

PE	Y-17	N-5	N/A-0
DISC	Y-5	N-0	N/A-0

2a. Can "Licensed" or "Registered" be combined with the branch title?

PE	Y-19	N-3	N/A-0
DISC	Y-4	N-1	N/A-0

3. Does your roster or directory (hard-copy or electronic) of licensed engineers indicate the branch or branches in which they were examined?

PE	Y-8	N-13	N/A-1
DISC	Y-4	N-0	N/A-1

Comment: PE boards tend to stress the PE title, while DISC boards (which may require separate licenses for each branch in which an engineer wants to practice) feel obligated to record and publicize an engineer's branch (es).

4. Can an applicant for licensure ask to be examined in any branch of engineering regardless of:

(a) The area of education?

PE Y-21 N-1 N/A-0

DISC Y-5 N-1 N/A-0

(b) The area of his experience?

PE Y-19 N-3 N/A-0

DISC Y-2 N-3 N/A-0

Comment: By a slight margin, DISC boards show a preference for licensing in the area of an applicant's experience, but do not insist on licensing in the area of his education; PE boards are apparently indifferent, if the applicant can pass a Principles-and-Practices exam.

5. Must an applicant's experience have been gained under the supervision of a licensed engineer:

(a) In any branch of engineering?

PE Y-12 N-5 N/A-5

DISC Y-1 N-4 N/A-0

(b) In his own branch of engineering?

PE Y-6 N-9 N/A-7

DISC Y-3 N-1 N/A-1

Comment: This question may be ambiguous, as "any branch" can include the applicant's own branch. DISC boards appear to be more insistent than PE boards that engineers get their experience under an engineer in their own branch.

5a. Can you make an exception to the previous rule if an engineer's experience was entirely in industry, under the supervision of an engineer:

(a) Who was not licensed?

PE Y-9 N-5 N/A-8

DISC Y-1 N-4 N/A-0

(b) Who was qualified for licensure but not actually licensed?

PE Y-10 N-10 N/A-2

DISC Y-1 N-4 N/A-0

Comment: One PE board wrote: "Because we have exemptions in our law, we allow individuals who have gained engineering experience under the supervision of an exempt engineer to credit for that experience, e.g. industrial, federal, and local exempted work."

6. How are branches of engineering defined in your statute or regulations:

(a) By name only?

PE Y-3 N-0

DISC Y-1 N-0

(b) By your own state-specific definitions?

PE Y-0 N-0

DISC Y-2 N-0

(c) By reference to NCEES exam specifications?

PE	Y-7	N-0
DISC	Y-2	N-0

(d) Other?

PE	Y-0	N-0
DISC	Y-0	N-0

(e) Not defined?

PE	Y-12	N-0
DISC	Y-1	N-0

Comment: Only two DISC boards said that they have state-specific branch definitions. (If California has responded, it would have had to say "Y"). Other DISC boards use definitions from a variety of sources. PE boards do not use branch definitions, rely on NCEES exam specifications, or refer to branches only by name.

7. If you have state specific definitions, how were they developed:

(a) By board Members?

(b) By Board Staff?

(c) By technical advisors?

PE	Y-0	N-0	N/A-21
DISC	Y-0	N-0	N/A-5

(d) By professional societies?

(e) By surveys of practitioners?

(f) By copying other Boards?

Comment: Almost all PE boards, which do not need branch definitions, found this question "Not Applicable" or "N/A." Two DISC boards stated that they have state-specific definitions but did not indicate how the definitions were developed. Answers to this question were thus almost all "N/A."

8. Do your definitions of engineering branches allow overlaps between branches, i.e., areas of activity common to two or more branches?

PE	Y-6	N-1	N/A-15
DISC	Y-2	N-2	N/A-1

Comment: Six PE boards indicate that overlaps are allowed, apparently making explicit what is generally taken for granted in a PE licensing scheme, while the majority thought the question was "Not Applicable" or did not answer. The DISC boards are divided on this question.

9. Do your statutory provisions or regulations state that licensed engineers must work only in areas where they are competent by virtue of education and experience?

PE	Y-19	N-3	N/A-0
DISC	Y-3	N-2	N/A-0

Comment: No boards failed to answer this question. A “No” answer might be interpreted as indicating reliance on engineers’ codes of ethics to guide behavior.

10. Is practice outside of the branch in which an engineer was examined (and not exempt under some provision of the law) a per se violation under your law or regulations?

PE Y-3 N-19 N/A-0

DISC Y-3 N-2 N/A-0

Comment: Practice outside an engineer’s nominal branch is not considered an offense on its face by most PE boards, but it is by DISC boards.

11. Does your Board take Disciplinary action against engineers for practicing outside of the branches in which they were licensed or tested?

PE Y-7 N-14 N/A-1

DISC Y-3 N-2 N/A-0

Comment: In a majority of states, 16 out of 27 boards do not take action for practicing outside of their nominal branches: something more is apparently needed to initiate a disciplinary action.

12. How many such cases have you had in the past ____ years?

Comment: Answers to this question ranged from none to “1-2 in 10 years” or “18 in 2 years” for two DISC boards, and from none to “2 in past year,” “7 in 3 years,” “15 in 3 years,” “10 in past year” and “15” for five PE boards.

13. Do these cases originate from:

(a) “Competence” complaints from clients or employers?

PE Y-7 N-1 N/A-14

DISC Y-1 N-0 N/A-4

(b) “Turf” complaints from other engineers?

PE Y-5 N-2 N/A-15

DISC Y-2 N-0 N/A-3

(c) Other Sources? Please Describe.

PE Y-5 N-2 N/A-15

DISC Y-2 N-0 N/A-3

Comment: In view of answers to Q12, many boards evidently considered this question not applicable and did not answer. Two boards answering “Other” mentioned, “public” or “public agencies,” one said, “advertising,” one said, “code officials;” and one said “building officials.”

14. In such cases, does a “proof of competence” constitute a sufficient defense?

PE Y-6 N-1 N/A-15

DISC Y-1 N-2 N/A-2

15. Does your Board engage in any consumer education programs to describe the various branches of engineering and their activities, e.g., publishing a pamphlet on "How to Hire an Engineer"?

PE	Y-1	N-21	N/A-0
DISC	Y-1	N-2	N/A-0

16. If your Board decides to recognize a new branch of engineering which already has an NCEES exam, what action is needed:

(a) Revise the statute?

PE	Y-0	N-8	N/A-12
DISC	Y-0	N-1	N/A-4

(b) Revise the regulations?

PE	Y-3	N-6	N/A-12
DISC	Y-0	N-1	N/A-4

(c) None-we give all NCEES exams?

PE	Y-16	N-0	N/A-4
DISC	Y-4	N-0	N/A-1

Comment: 20 of the 27 boards give all of the NCEES exams. At least 16 of the boards would not need to revise their statutes or regulations to accommodate a new branch of engineering.

17. If your board were asked to recognize a new branch of engineering which does not already have an NCEES exam, what action would the Board take:

(a) Refuse the request?

PE	Y-9	N-3	N/A-8
DISC	Y-3	N-0	N/A-2

One state said: Board decision

Another: Never happened

(b) Endorse the request and forward it to NCEES?

PE	Y-6	N-2	N/A-14
DISC	Y-1	N-0	N/A-4

(c) Approve the request and undertake to develop a state-specific exam?

PE	Y-1	N-6	N/A-15
DISC	Y-4	N-0	N/A-1

Comment: About half of the boards will refuse requests for new exams. PE boards are reluctant to develop state-specific exams; DISC boards are more willing to develop state-specific exams. One PE board said the decision would be subject to a "Sunrise Test" rule (evidently the reverse of a "Sunset Rule.")

17a. Would it be necessary to:

(a) Obtain legislative approval and amend the law?

PE	Y-2	N-10	N/A-10
DISC	Y-1	N-1	N/A-3

(b) Revise the regulations?

PE	Y-7	N-6	N/A-9
DISC	Y-2	N-1	N/A-2

(c) No changes needed in law/regulations?

PE	Y-9	N-4	N/A-9
DISC	Y-2	N-1	N/A-2

18. All things considered, are you satisfied with your licensing scheme?

PE	Y-19	N-1*	N/A-2
DISC	Y-4	N-0	N/A-1*

* See 18b for board remarks.

Comment: Almost all of the boards expressed satisfaction with their current licensing schemes; only two boards expressed dissatisfaction.

18a. If “yes”, what is its best feature?

Responses:

“Simple but effective.”

“We allow any NCEES exam; if they add, we add.”

“Registered engineers earn trust to practice within their area of expertise.”

“Ease of understanding, simple and widespread acceptance.”

“Customer service is our best feature.”

“Expedites approval of Model Law Engineer applications.” “Discipline specific licensure.”

“Board members review all applications.”

“Follow NCEES Model which makes a very smooth licensing process and reciprocity licensure.”

“Allows us to function professionally.”

“We license NCEES Model Law candidates administratively within a week.”

“Worked well in the past without complaints.”

“The board does have authority to question competence when issue is raised.”

“It works.”

“ Puts the burden on the licensee but is not too restrictive. Everybody is familiar with the “3Es’— Education, Experience, and Exam—for judging competence.”

“Yes, overall.”

18b.If “No,” what is its worst feature?

One PE Board and one DISC board expressed some dissatisfaction with their current licensing schemes:

“Provisions that require an engineer’s experience to be gained under a licensed engineer and do not allow us to make exceptions (Q5 and 5a) are unnecessarily restrictive and discourage engineers in industry from seeking licensure.” (PE Board)

“We only register six disciplines, so some fields cannot easily practice in our state.” They also noted that they are considering a change in their licensure scheme. (DISC Board)

Conclusions

Without harm to the public, elements of a better licensing scheme that have been suggested for California—elimination of the distinction between “practice” and “title” branches, recognizing all branches for which NCEES exams are available, licensing all engineers as a “P.E.” with authority to practice in any area where they are competent, and focusing more on competence and less on individual branch definitions—are already incorporated in the licensing practices of other states. Without harm to public, these practices simplify Board operations and enhance Board efficiency.

Transmitted E-mail and Survey Request Sent to State Boards

Dear Sir or Madame:

I am writing on behalf of the CA Society of Professional Engineers. We are in the process of gathering some data for a report we are writing relative to PE licensing practices in others states. This is a second notice to the states we have not received responses to yet.

Would you please do us the favor of printing out the attached survey and faxing it back to us? FAX 1-916-422-7785. The results of this survey will be reported as numbers only - in other words any reference to which state reported what data will be removed.

We need to have the information by October 25, 2001. If you have any questions, please feel free to call us toll free at: 1-866-367-2773 or email me at m.kramer@cspe.com

Thank you in advance for your help with this important project!

Marti Kramer, CAE
CEO - CA Society of
Professional Engineers
<http://www.cspe.com>

SURVEY OF LICENSING PRACTICES

Name of person completing Survey _____ STATE _____

Number of Professional Engineers Licensed by State _____

We're collecting information on engineering licensing procedures for a report to the California legislature. We have some questions we would like to ask you.

Does your board register or license a qualified engineer as a:

- Discipline-specific engineer, restricted to practice in a specific field; or _____
 - Professional Engineer limited to practice in his/her field of expertise. _____
1. Can all licensed engineers use the title "Professional Engineer" or "P.E."? Y N
 2. Can licensed engineers use a title indicating their branch of engineering, such as civil, engineer, electrical engineer, chemical engineer, nuclear engineer, etc.? Y N
 - 2a. Can "Licensed" or "Registered" be combined with the branch title? Y N
 3. Does your roster or directory (hard-copy or electronic) of licensed engineers indicate the branch or branches in which they were examined? Y N
 4. Can an applicant for licensure ask to be examined in any branch of engineering, regardless of:
 - a) The area of his education? Y N
 - b) The area of his experience? Y N
 5. Must an applicant's experience have been gained under the supervision of a licensed engineer:
 - a) In any branch of engineering? Y N
 - b) In his own branch of engineering? Y N
 - 5a. Can you make an exception to the previous rule if an engineer's experience was entirely in industry, under the supervision of an engineer:
 - a) Who was not licensed? Y N
 - b) Who was qualified for licensure but not actually licensed? Y N

6. How are branches of engineering defined in your statute or regulations:
- a) By name only Y N
 - b) By your own state-specific definitions? Y N
 - c) By reference to NCEES exam specifications? Y N
 - d) Other _____ Y N
 - e) Not defined Y N
7. If you have state-specific definitions, how were they developed:
- a) By Board members? Y N
 - b) By Board staff? Y N
 - c) By technical advisors? Y N
 - d) By professional societies? Y N
 - e) By surveys of practitioners? Y N
 - f) By copying other Boards? Y N
8. Do your definitions of engineering branches allow overlaps between branches, i.e., areas of activity common to two or more branches? Y N
9. Do your statutory provisions or regulations state that licensed engineers must work only in areas where they are competent by virtue of education and experience? Y N
10. Is practice outside of the branch in which a licensed engineer was examined (and not exempt from licensing under some provision of the law) a per se violation under your law or regulations? Y N
11. Does your Board take disciplinary action against engineers for practicing outside of the branches in which they were licensed or tested? Y N
12. How many such cases have you had in the past _____ year(s)?
13. Do these cases originate from:
- a) "Competence" complaints from clients or employers? Y N
 - b) "Turf" complaints from other engineers? Y N
 - c) Other sources? Please describe: Y N

- | | | |
|--|---|---|
| 14. In such cases, does a “proof of competence” constitute a sufficient defense? | Y | N |
| 15. Does your Board engage in any consumer education programs to describe the various branches of engineering and their activities, e.g. publishing a pamphlet on “How to Hire an Engineer”? | Y | N |
| 16. If your Board decides to recognize a new branch of engineering which already has an NCEES exam, what action is needed: | | |
| a) Revise the statute? | Y | N |
| b) Revise the regulations? | Y | N |
| c) None – we give all NCEES exams? | Y | N |
| 17. If your Board is asked to recognize a new branch of engineering which does not already have an NCEES exam, what action would the Board take? | | |
| a) Refuse the request? | Y | N |
| b) Endorse the request and forward it to NCEES? | Y | N |
| c) Approve the request and undertake to develop a state-specific exam? | Y | N |
| 17a. Would it be necessary to: | | |
| a) Obtain legislative approval and amend the law? | Y | N |
| b) Revise the regulations? | Y | N |
| c) No changes needed in law/regulations? | Y | N |
| 18. All things considered, are you satisfied with your licensing scheme? | Y | N |
| 18a. If “yes”, what is its best feature? | | |
| 18b. If “no”, what is its worst feature? | | |