2006-384: FACULTY REWARD SYSTEM REFORM: BEGINNING PHASE II - SETTING CRITERIA FOR PROFESSIONALLY ORIENTED FACULTY IN ENGINEERING AND TECHNOLOGY

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Faculty Reward System Reform: Beginning Phase II – Setting Criteria for Professionally Oriented Faculty in Engineering and Technology

1. Introduction

This is the second of two papers prepared for a special panel session of the National Collaborative Task Force on Engineering Graduate Education Reform that is focusing one of its primary tasks on faculty reward system reform. Founded in 2000, the National Collaborative Task Force is an initiative of the ASEE-Graduate Studies Division, Corporate Members Council, and College Industry Partnership Division. The National Collaborative is comprised of leaders from industry, academia, and government all coming together to advance professional engineering graduate education for the advancement of engineering practice in the national interest to enhance U.S. competitiveness.

Using the findings of the 2005 Task Force panel, [1,2,3] which investigated the commonality of faculty reward systems in other professions such as law, this paper suggests parallel criteria for professionally oriented faculty reward systems in engineering and technology education that complement scientific research and that better support the professional scholarship, teaching, and engagement functions of engineering practice for technology development & innovation.

2. Professional Education for Engineers – The New Challenge for Industrial Innovation

While the U.S. system of graduate education in Science and Engineering (S&E) continues to set the world standard and sustains the preeminence of the U.S. scientific workforce for basic research at the nation's research universities, a balanced emphasis has not been placed on the advancement of professional education for the U.S. engineering workforce in industry to sustain preeminence in engineering practice for creative technology development & innovation.

2.1 Professional Context of Engineering Practice for Innovation

To meet the challenge, the National Collaborative Task Force on Engineering Graduate Education reform is leading a major reform in professionally oriented engineering graduate education to enhance the innovative capacity of the U.S. engineering workforce in industry to sustain U.S. preeminence in engineering practice for technology development & innovation to enhance competitiveness.

A major component of this educational reform for U.S. engineering workforce development is the development of professional master's and professional doctoral degrees in engineering that are aimed at increasing the creativeness, innovative capacity, and engineering leadership skills of engineering practitioners in industry. As broad-based technological innovations pervade every aspect of our daily lives, the need for America to invest in the growth of its engineering workforce for innovation and leadership though a new model of professional engineering graduate education rises to a national priority.

Broadening and deepening the innovation and leadership skills of the U.S. engineering workforce in industry can enhance U.S. innovation and extend productivity on many fronts. Using this deliberate approach to purposefully advance engineering graduate education to continue the growth of the nation's engineering professionals beyond entry-level will improve our society's ability to sustain its traditional preeminence in the implementation and management of new, innovative technologies that drive all economic wellbeing.

2.2 The Modern Practice of Engineering ─ For Creative Technology Development and Innovation in Industry

A new paradigm of the practice of engineering for the deliberate creation, invention, design, development, and innovation of new / improved / breakthrough technologies has emerged which is substantially different from that portrayed by U.S. science policy of 1945.

In today's innovation-driven economy, the vast majority of engineering innovations are needs-driven and market-focused, requiring deliberate engineering problem-solving and responsible engineering leadership. Today the practice of engineering for creative technology development and innovation is a purposeful and systematic practice. It is not a linear or sequential process following basic research as portrayed in the aforementioned science policy of 1945 (See Appendix A). Rather, engineering projects frequently drive the need for directed strategic research efforts at universities when necessary or anticipated to better understand the phenomena involved.

The reform of professional engineering graduate education is mandated by the new paradigm. A new type of professionally oriented engineering education at the graduate level is required that develops the innovative capacity of the U.S. engineering workforce for competitiveness and that supports the innovation skills required of engineers at all levels of leadership responsibility for the continuous development & innovation of technology in industry. The design of professional graduate education for creative engineering practitioners, who are emerging as leaders of technology development in industry, requires a different approach and process than presently provided by research-based graduate education for the graduate education of academic research scientists. It also requires a different type of faculty and a different focus as well.

Today, new and improved technology is brought about primarily by the purposeful and systematic practice of engineering involving the deliberate recognition of meaningful human needs and the deliberate engineering creation of new "ideas and concepts" to effectively meet these needs though responsible leadership. Engineering practice and its resulting outcome, technology, have been redefined for the 21st century.

Engineering is no longer misconstrued as "applied science." [4] Rather, William A. Wulf, president of the National Academy of Engineering points out: "Engineering is design under constraint."[5] And, as the National Academy of Engineering (NAE) Phase II report, *Engineering 2020*, points out: [6]

- Engineering is a profoundly creative process.
- Technology is the outcome of engineering.
- Engineering is problem recognition, formulation, and solution.

2.3 Attributes of High-Quality Professional Education ─
Modern Engagement Theory of Professional Education for Engineering Professionals

As such, the modern teaching of engineering for working professionals at the graduate level must correlate with the modern practice of engineering. A new model of professional education for graduate engineers in industry is emerging that is focusing on innovation, engineering leadership, and solving unknown problems.

Education for the practice of engineering is quite different from education for scientific research. As the National Academy of Engineering (NAE) Phase II report, *Engineering 2020*, points out, at the undergraduate level ─ "the future engineering curriculum should be built around developing skills and not around teaching available knowledge. We must focus on shaping analytic skills, problem-solving skills, and design skills. We must teach future engineers to be creative and flexible, to be curious and imaginative."

The National Collaborative Task Force believes that at the graduate level professional graduate education for advanced engineering practice must include the next stages of developing the engineer's innovation and leadership skills in a manner concurrent with practice. But, the educational development of the "innovation and leadership skills" used by experienced, engineering professionals requires a different process and approach producing outcomes that are quite different that those resulting from traditional research-based graduate education.

Haworth and Conrad pointed out in their landmark study for the Council of Graduate Schools, as documented in their book *Emblems of Quality in Higher Education,* that one of the primary attributes of high-quality professionally-oriented graduate programs is the professional orientation, experience base, and engagement of the faculty in the practicing profession.[7]

From a learners perspective, as Haworth and Conrad note, professionally oriented faculty with experience, "who had been there," were especially appreciated by the students. Haworth and Conrad note that: "Throughout our study, we became increasingly aware that diverse and engaged faculty were fundamental to high-quality programs. In many programs we visited, faculty not only infused a variety of scholarly and experiential perspectives into their teaching, they also invested significant time and energy in teaching students. In so doing, these faculty consistently elevated the quality of students learning experiences in ways that enhanced their growth and development."

As Haworth and Conrad suggest that there are five primary attributes of high-quality graduate education for working professionals. They include:

- Experienced professionally oriented faculty with nonacademic work experience
- Experienced professionally oriented students with experience in the practicing profession
- Primary focus on student-centered learning rather than faculty-centered teaching
- Collaborative learning environments with shared mission and purpose
- Engagement theory of learning focusing on growth of professionals

With regard to engagement theory focusing on growth, Haworth and Conrad point out that "by defining high-quality programs as those which provide enriching learning experiences for students that have positive effect on their development, the theory provides people throughout higher education with a new vantage point for understanding program quality. Not only does this vantage point recognize student learning and development as the primary purpose of higher learning, but it also embraces a complementary conceptual template that is organized around understanding and exploring relationships among program attributes, learning experiences, and student outcomes."

Thus, if we are to develop professional curricula that are learner centered and skills-oriented, rather than faculty-centered and knowledge-oriented, as recommended by the National Academy of Engineering Phase II report *(Educating the Engineer of 2020),* then the model of engineering education and its process must both change from the linear research-driven model of 1945 to a professional model for engineering education in the professional context and social context of engineering practice. As the National Collaborative Task Force notes ─ one size or type of graduate education doesn't fit all. This applies also to faculty reward systems.

3. Reform of Faculty Reward Systems ─ For Professionally Oriented Faculty in Engineering and Technology

Whereas existing faculty reward systems are adequately designed for research-oriented faculty, the National Collaborative Task Force believes that they are insufficient for professionally-oriented faculty who teach and practice in the professional realm of creative engineering practice for technology development and innovation. The Task Force believes that any reform for professional engineering education at the graduate level can not sustain unless the core, professionally oriented faculty who will teach and lead the development of these new innovative programs, are rewarded accordingly. These professionally oriented faculty with experience in engineering practice are the very core of successful professionally oriented graduate programs ─ not only during the stages of their initial start-up but also for their sustainability.

3.1 New Perspectives on Scholarship

The Task Force believes that reform can be implemented at universities through purposeful, planned action to evolve new unit criteria that are directly relevant to the mission and values of new professional graduate programs. Universities are still evolving their missions, purposes, and constituencies. In the 21st century, universities must continue to change if they are to survive. But the history of universities must be understood in order for us to know why we are where we are and why reform issues are so clouded. Earnest Boyer's book, *Scholarship Reconsidered,*[8] has helped to shed light on many of these issues.

As Boyer noted …"scholarship in earlier times referred to a variety of creative work carried on in a variety of places, and its integrity was measured by the ability to think, communicate, and learn." … but … "following the Second World War, the faculty reward system narrowed at the very time the mission of American higher education was expanding."

This was largely due to the 1945 Vannevar Bush report, *Science: the Endless Frontier,*[9] which initiated the compact between government and research universities for increased federal funding of basic research at the universities. As federal funding for basic research increased at universities during the 1960's, 70's, 80's, and 90's the university quest for this funding increased. Soon, scholarship was redefined to reward those faculty who could attract federal grants to sustain university finances through overhead from research.

As Boyer notes, "Research and publication have become the primary means by which most professors achieve academic status … According to the dominant view, to be a scholar is to be a researcher ─ and publication is the primary yardstick by which scholarly productivity is measured." But as Boyer pointed out this definition is too narrow and restricts other types of creativity at universities rather than sustains it. As Boyer noted: "The rich diversity and potential of American higher education cannot be fully realized if campus missions are too narrowly defined or if the faculty reward system is inappropriately restricted … It's time to recognized the full range of faculty talent and the great diversity of functions higher education must perform."

3.2 Redefining Scholarship ─ Enlarging the Professional Perspective of Scholarship for the Practice of Engineering

Although Earnest Boyer's book *(Scholarship Reconsidered)* was a landmark in 1990, it was still a first attempt to break out of traditional university modes of thinking for faculty reward systems. Nevertheless it fell into the traditional *"*applied" trap of the 1945 Vannevar Bush linear research-driven model of engineering practice for technology development which portrays basic research (discovery) as the primary driver of progress which was a prevalent belief system perpetuated by John Dewey on the use of the scientific method during America's progressive era.

Boyer listed four forms of scholarship, with "discovery" being the first. They are as follows:

- The Scholarship of "discovery" of knowledge
- The Scholarship of integration of knowledge
- The Scholarship of application of knowledge
- The Scholarship of teaching of knowledge

Dewey's definition that *"technology is the practical correlate of science"* ─ promoted during America's progressive era ─has been widely accepted. ***But it is not correct!***

As Ferguson notes, "From Bacon's time to the present ─ more than 350 years ─ promoters of the mathematical sciences have convinced their patrons that science is the way to truth and that it is also the chief source of the progressive inventions that have changed the material world. This myth that the knowledge incorporated in any invention must originate in science is now accepted in Western culture as an article of faith, and the science policies of nations rest on that faith." Moreover, "The myth was restated by Vannevar Bush on pp. 52 -53 of his *Endless Horizons* (Washington, D.C., 1946)."[10]

The sequential, linear research-driven model of technology development which portrays the "discovery" of new scientific knowledge attained through basic research then followed sequentially by “application” through engineering practice into technology, wherein engineers are thought to be the “appliers” of this new knowledge who practice in the “applied” realm, is now perceived in error.

But the underlying belief is still prevalent and has caused conditions during the last several decades requiring reform of professional engineering education itself. The myth continues today largely because of the quest for federal funding attained through scientific research grants at many research universities.

As a consequence, scholarship has been too narrowly defined in Science and Engineering (S&E) as that which produces new scientific knowledge and publications through basic research. But as the Council on Competitiveness report *Picking Up the Pace* pointed out, the perspective that technology innovation is a linear sequential process like a “relay race” where basic scientific research passes the baton to engineering for later development is outmoded. [11]

The practice of engineering for technology development and innovation *does not occur* this way. Nor does the advancement of engineering practice occur this way. The advancements of U.S. technology and the advancements of U.S. engineering practice that bring new technology about are primarily brought about by creative engineering professionals working in their specific fields in actual creative engineering practice in industry.

As a consequence, the National Collaborative Task Force believes that scholarship should be more broadly defined at universities to include other types of original creative work. For the English department, unit criteria for scholarship can include the creative work of a new play or a new novel. Neither one is scientific research. Both represent intensive background investigation and new creative thought producing a tangible outcome. New knowledge is not necessarily the driving force for this creative work. Rather the passion for a new tangible outcome produced by new creative thought is the driving force.

3.3 Redefining Professional Scholarship for the Practice of Engineering

The Task Force believes that professional scholarship can be redefined for the profession of engineering to include creative engineering practice and innovative design that results in purposeful improvements, developments, or breakthroughs of new technology or policy to meet real-world human needs of people or industry. Although new technological knowledge results as an ultimate outcome of creative engineering practice, as does the advancement of engineering practice itself, the driver is not the “application” of new knowledge. Rather new technological knowledge is the result of “applying” the engineering method combined with the experience, knowledge, judgment, and innovation skill of the engineer to the solution of problems.

The primary driver is the scholar-practitioner’s passion as a responsible engineer to recognize meaningful hopes, wants, and needs of people combined with the accompanying passion to create new, improved, or breakthrough technology that effectively solves these needs. Accordingly, the professional education of engineers is quite different from the education of scientists because the missions, purposes, and methods of these two different pursuits are quite different from each other.

As such, the tangible outcomes created by engineers are quite different from the tangible outcomes created by scientists. Consequently, the Task Force notes that the scholarly work of professionally oriented faculty should not emulate that of a research-based faculty for scientific research. Engineering is quite different from scientific research. But it's not inferior to research. Just as engineering is different from science, good engineering scholarship is not inferior to good scientific scholarship. It simply is different.

Thus, a broader definition of scholarship for engineering practice is required. The Task Force believes that professional scholarship should be defined as original creative work based upon intensive background investigation, study, or practice which results in a meaningful creative work or tangible outcomes. For engineering, this involves the creation of new "ideas" or "concepts" that result in the solution of meaningful hopes, wants, and needs of people or industry in the form of new / improved / breakthrough products, processes, systems, or operations. This is the essence of engineering practice itself. After all engineering is a needs finding and creative problem-solving profession requiring responsible leadership and value judgment

4. Professional Scholarship ─
Defining New Unit Criteria for Professionally Oriented Faculty

The Task Force believes that reform of the faculty reward system for professionally oriented engineering faculty can be brought about through planned action by defining new unit criteria for recognition and reward that are:

a) Similar to those being used in other professions, (e.g. law and clinical medicine), and

b) Correlated with the nine levels of engineering (NSPE) and qualifications being used within the practicing profession of engineering

4.1 Commonality of Unifying Themes of Other Professions

As the findings of the 2005-National Collaborative Task Force panel indicated, there are three unifying themes for promotion and tenure criteria among other professions (e.g. law and clinical medicine).

They include:

- Teaching
- Professional scholarship
- Engagement in service to society

4.2 Defining New Unit Criteria ─
For Professional Graduate Education Programs

The Task Force believes that scholarship has been too narrowly defined during the last several decades, and recommends that the diversity of scholarship, including professional scholarship, must be recognized at the universities. Scientific research (investigation) is only one of many forms of scholarship.

Thus, as the National Academy of Engineering Phase II report, *Educating the Engineer of 2020,* recommends, “Colleges and universities should develop new standards for faculty qualifications, appointments, and expectations … and should create or adapt development programs to support the professional growth of engineering faculty.”

This applies not only for improving undergraduate engineering education ─ to prepare future practitioners ─ but also for improving engineering education at the graduate level to continue the advanced professional education of these engineering graduates for increased responsibility at the advanced levels of the practicing profession. Whereas scientific research is the scholarship of research scientists, creative engineering practice for technology development and innovation is the scholarship of professional engineers. As the Council on Competitiveness points out, it’s time for America to rebuild its competitive edge for innovation. [14]

4.3 Action Plan for Defining New Unit Criteria ─ Starting with a Clean Slate to Get It Right

The Task Force has reviewed several innovative criteria for faculty reward systems at schools that are specifically aimed at educating engineering practitioners.

Of note, are the tenure and promotion criteria used at Western Kentucky University which have been changed specifically to better implement its program of project-based learning; and the University of St Thomas who has recognized the importance of engaging the profession.

Although individual schools will naturally define their own tenure and promotion criteria, the Task Force believes that general guidelines can be defined for professionally oriented programs applying a set of broad guiding principles. These principles should correlate with the comparable professional qualifications already established by NSPE (See Appendix E).

The National Collaborative Task Force suggests that the following plan of action to define unit tenure and promotion criteria that reflect teaching, professional scholarship, and engagement of service in engineering practice.

- Action 1 ─ To define types of professional scholarly activity or creative performance in professional aspects of engineering as a complement to research

- Action 2 ─ To define the characteristics of teaching / mentoring that enables growth of working professionals

- Action 3 ─ To define the characteristics of engagement to society at the advanced professional level in engineering practice

- Action 4 ─ To define new schemes for financing professional schools (similar to law schools) to sustain advanced professional engineering education

5. Conclusions ─ A Work in Progress for Planned Reform

The work of the National Collaborative is a work in progress. Although reform of faculty reward systems to advance professional engineering education will not be easy, it is not insurmountable. The Task Force believes that at the heart of an effective plan of action is the development of new unit criteria specifically designed to meet the mission and values of newly created professionally oriented graduate programs themselves. One cannot be put into place for long-term sustainability without the other. The Task Force believes that professionally oriented graduate programs must be founded within the mainstream of university operations as autonomous professional organizational units and not as research units. Then the action required for implementation of unit faculty reward criteria defined by the unit is straightforward. However, the autonomous unit must be dedicated and committed to the professional education of engineering practitioners as its first priority. The Task Force believes that it would be unrealistic and foolhardy to try to force professionally oriented criteria into research units.

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Appendix A

Engineering Process for Needs-Driven, (Market-Focused)
Technology Development & Innovation in Industry

Needs → Engineering → Technology

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Directed Scientific Research to gain a better understanding of phenomena when needed or anticipated during the technology development project

Appendix B

Stages of Professional Maturation, Autonomy, and Responsibilities in Engineering Practice for Responsible Technology Leadership

<u>Stages of Growth</u>	<u>Typical Responsibilities-Autonomy-Judgment</u>
ENGINEER IX	An engineer-leader at this level is in responsible charge of programs so extensive and complex as to require staff and resources of sizeable magnitude to meet the overall engineering objectives of the organization.
ENGINEER VIII	An engineer-leader at this level demonstrates a high degree of creativity, foresight, and mature judgment in planning, organizing, and guiding extensive engineering programs and activities of outstanding novelty and importance. Is responsible for deciding the kind and extent of engineering and related programs needed for accomplishing the objectives of the organization.
ENGINEER VII	In a leadership capacity, is responsible for an important segment of the engineering program of an organization with extensive and diversified engineering requirements. The overall engineering program contains critical problems, the solutions of which require major technological advances and opens the way for extensive related development.
ENGINEER VI	In a leadership capacity, plans, develops, coordinates, and directs a number of large and important projects or a project of major scope and importance. Or, as a senior engineer, conceives, plans, and conducts development in problem areas of considerable scope and complexity. The problems are difficult to define and unprecedented. This involves exploration of subject area, definition of scope, and selection of important problems for development.
ENGINEER V	In a leadership capacity, plans, develops, coordinates, and directs a large and important project or a number of small projects with many complex features. Or, as an individual principle engineer, carries out complex or novel assignments requiring the development of new or improved techniques and procedures. Work is expected to result in the development of new or refined equipment, materials, processes, or products. Technical judgment knowledge, and expertise for this level usually result from progressive experience.
ENGINEER IV	Plans, schedules, conducts, or coordinates detailed phases of engineering work in part of a major project or in a total project of moderate scope. Fully competent engineer in all conventional aspects of the subject matter of the functional areas of assignments. Devises new approaches to problems encountered. Independently performs most assignments requiring technical judgment.
ENGINEER III	Performs work that involves conventional types of plans, investigations, or equipment with relatively few complex features for which there are precedents. Requires knowledge of principle and techniques commonly employed in the specific narrow areas of assignments.
ENGINEER I/II (Entry Level Engineer)	Requires knowledge and application of known laws and data. Using prescribed methods, applies standard practices/techniques under direction of an experienced Engineer.

Appendix C

A Comparison between Career Paths that Support Academic Research at Universities and those that Support Engineering Practice for Innovative Technology Development in Industry and Government Service

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Industry/Government (Technology Development)	**Universities (Academic Research)**
Senior Executive Levels	Senior Executive Levels
Engineer IX (GS-18, 17,16) Vice President of Engineering and Technology	Dean of Engineering/Technology
Executive Engineer Levels - Technology Leadership	Administrative Academic Levels
Engineer VIII (GS-15) Director of Engineering	Department Head
Engineer VII (GS-14) Department/Division Manager	Distinguished Professor
Engineer VI (GS-13) Technical Area Manager	Professor
Senior Engineer/Project Management Levels	Senior Research Specialist Levels
Engineer V (GS-12) Senior/Principal Engineer/Project Leader/Group Leader	Associate Professor
Engineer IV (GS-11) Project Engineer/Process Engineer	Assistant Professor (PhD)
Engineer III (GS-9) Design/Development Engineer	Post-Doctorate in Research
Entry Level in Engineering Practice	Entry Level in Academic Research
Engineer II/I (GS-7, 5) Entry Level Engineer/Engineer-in-Training	Graduate Research Assistant

Appendix D

Qualifications for Professional Scholarship and Engagement in the Practicing Profession

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Engineer VI

Equivalent Federal General Schedule Grade
GS-13

General Characteristics. Has full technical responsibility for interpreting, organizing, executing, and coordinating assignments. Plans and develops engineering projects concerned with unique or controversial problems which have an important effect on major organization programs. This involves exploration of subject area, definition of scope and selection of problems for investigation and development of novel concepts and approaches. Maintains Liaison with individuals and units within or outside the organization with responsibility for acting independently on technical matters pertaining to the field. Work at this level usually requires extensive progressive experience.

Direction Received. Supervision received is essentially administrative, with assignments given in terms of broad general objectives and limits.

Typical Duties & Responsibilities. One or more of the following: 1) in a supervisory capacity a) plans, develops, coordinates, and directs a number of large and important projects or a project of major scope and importance; or b) is responsible for the entire engineering program of an organization when the program is of limited complexity and scope. The extent of his or her responsibilities generally requires a few (3 to 5) subordinate supervisors or team leaders with at least one in a position comparable to level V; 2) As individual researcher or worker conceives, plans and conducts research in problem areas of considerable scope and complexity. The problems must be approached through a series of complete and conceptually related studies, are difficult to define, require unconventional or novel approaches, and require sophisticated research techniques. Available guides and precedents contain critical gaps, are only partially related to the problem or may be largely lacking due to the novel character of the project. At this level, the individual researcher generally will have contributed inventions, new designs, or techniques which are of material significance in the solution of important problems; 3) As a staff specialist serves as the technical specialist for the organization (division or company) in the application of advanced theories, concepts, principles, and processes for an assigned area of responsibility (i.e. subject matter, function, type of facility or equipment, or product). Keeps abreast of new scientific methods and developments affecting the organization for the purpose of recommending changes in emphasis of programs or new programs warranted by such developments.

Responsibility For Direction of Others. Plans, organizes, and supervises the work of a staff of engineers and technicians. Evaluates progress of the staff and results obtained and recommend major changes to achieve overall objectives. Or, as individual research or staff specialist may be assisted on individual projects by other engineers or technicians.

Typical Position Titles. Senior or Principal Engineer, Division or District Engineer, Production Engineer, Assistant Division, District or Chief Engineer, Consultant, Professor, City or County Engineer.

Education. Bachelor's Degree in engineering from an ABET accredited curriculum, or equivalent, plus appropriate continuing education.

Licensure Status. Licensed Professional Engineer

Typical Professional Attainments. Member of Professional Society (Member Grade).Member of Technical Societies (Member Grade); Publishes engineering papers, articles, textbooks

Engineer V

Equivalent Federal General Schedule Grade
GS-12

General Characteristics. Applies intensive and diversified knowledge of engineering principles and practices in broad areas of assignments and related fields. Make decisions independently on engineering problems and methods, and represents the organization in conferences to resolve important questions and to plan and coordinate work. Requires the use of advanced techniques and the modifications and extension of theories, precepts and practices of the field and related sciences and disciplines. The knowledge and expertise required for this level of work usually result from progressive experience.

Direction Received. Supervision and guidance relate largely to overall objectives, critical issues, new concepts, and policy matters. Consults with supervisor concerning unusual problems and developments.

Typical Duties & Responsibilities. One or more of the following: 1) In a supervisory capacity, plans, develops, coordinates, and directs a large and important engineering project or a number of a small projects with many complex features. A substantial portion of the work supervised is comparable to that described for engineer IV; 2) As individual researcher or worker, carries out complex or novel assignments requiring the development of new or improved techniques and procedures. Work is expected to result in the development of new or improved techniques and procedures. Work is expected to result in the development of new or refined equipment, materials, processes, products, and/or scientific methods; 3) As staff specialist, develops and evaluates plans and criteria for a variety of projects and activities to be carried out by others. Assesses the feasibility and soundness of proposed engineering evaluation tests, products, or equipment when necessary data are insufficient or confirmation by testing is advisable. Usually performs as a staff advisor and consultant as to a technical specialty, a type of facility or equipment, or a program function.

Responsibility For Direction of Others. Supervises, coordinates, and reviews the work of a small staff of engineers and technicians, estimates personnel needs and schedules and assigns work to meet completion date. Or, as individual researcher or staff specialist may be assisted on projects by other engineers or technicians.

Typical Position Titles. Senior or Principal Engineer: Resident, Project, Office, Design, Process, Research, Assistant Division Engineer, Associate Professor, Project Leader.

Education. Bachelor's Degree in engineering from an ABET accredited curriculum, or equivalent, plus appropriate continuing education.

Licensure Status. Licensed Professional Engineer

Typical Professional Attainments. Member of Professional Society (Member Grade), Member of Technical Societies (Member Grade); Publishes engineering papers, articles, textbooks

Engineer IV

Equivalent Federal General Schedule Grade
GS-11

General Characteristics. As a fully competent engineer in all conventional aspects of the subject matter of the functional area of the assignments, plans and conducts work requiring judgment in the independent evaluation, selection, and substantial adaptation and modification of standard techniques, procedures, and criteria. Devises new approaches to problems encountered. Requires sufficient professional experience to assure competence as a fully trained worker, or, for positions primarily of a research nature, completion of all requirements for a doctoral degree may be substituted for experience.

Direction Received. Independently performs most assignments with instructions as to the general results expected. Receives technical guidance on unusual or complex problems and supervisory approval on proposed plans for projects.

Typical Duties & Responsibilities. Plans, schedules, conducts, or coordinates detailed phases of the engineering work in a part of a major project or in a total project of moderate scope. Performs work which involves conventional engineering practice but may include a variety of complex features such as conflicting design requirements, unsuitability of conventional materials, and difficult coordination requirements. Work requires a broad knowledge of precedents in the specialty area and a good knowledge of and practices of related specialties.

Responsibility For Direction of Others. May supervise or coordinate the work of engineers, drafters, technicians, and others who assist in specific assignments.

Typical Position Titles. Engineer or Assistant Engineer, Resident, Project, Plant, Office, Design, Process, Research, Chief Inspector, Assistant Professor.

Education. Bachelor's Degree in engineering from an ABET accredited curriculum, or equivalent, plus appropriate continuing education.

Licensure Status. Licensed Professional Engineer

Typical Professional Attainments. Member of Professional Society (Member Grade),Member of Technical Societies (Associate Grade or Equivalent)/Member of Technical Societies (Member Grade); Publishes engineering papers, articles, text books