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1. INTRODUCTION

The following extracts are reproduced from Appendix B of the draft (5 February, 2004) Engineers Australia guidelines for *‘Assessment of eligibility for membership (Stage 1 Competency) for Candidates Not Holding an Accredited or Recognised Qualification’*. Appendix B provides the draft (5 February, 2004) Stage 1 Competency Standard for Professional Engineer.

2. GENERAL DESCRIPTION OF ROLE

Professional engineers are required to take responsibility for engineering projects and programs in the most far-reaching sense. This includes the reliable functioning of all materials and technologies used; their integration to form a complete and self-consistent system; and all interactions between the technical system and the environment in which it functions. The latter includes understanding the requirements of clients and of society as a whole; working to optimise social, environmental and economic outcomes over the lifetime of the product or program; interacting effectively with the other disciplines, professions and people involved; and ensuring that the engineering contribution is properly integrated into the totality of the undertaking. Professional engineers are responsible for interpreting technological possibilities to society, business and government; and for ensuring as far as possible that policy decisions are properly informed by such possibilities and consequences, and that costs, risks and limitations are properly understood as the desirable outcomes.

Professional engineers are responsible for bringing knowledge to bear from multiple sources to develop solutions to complex problems and issues, for ensuring that technical and non-technical considerations are properly integrated, and for managing risk.

The work of professional engineers is predominantly intellectual in nature. In the technical domain, they are primarily concerned with the advancement of technologies and with the development of new technologies and their applications through innovation, creativity and change. They may conduct research concerned with advancing the science of engineering and with developing new engineering principles and technologies. Alternatively, they may contribute to continual improvement in the practice of engineering, and in devising and updating the Codes and Standards that govern it.

Professional engineers have a particular responsibility for ensuring that all aspects of a project are soundly based in theory and fundamental principle, and for understanding clearly how new developments relate to established practice and experience and to other disciplines with which they may interact. One hallmark of a professional is the capacity to break new ground in an informed and responsible way.

Professional engineers may lead or manage teams appropriate to these activities, and may establish their own companies or move into senior management roles in engineering and related enterprises.



3. STAGE 1 COMPETENCY

Stage 1 competency represents the level of preparation necessary and adequate for entry to practice leading to these responsibilities. A graduate engineer would be expected to work initially under the supervision and guidance of more experienced engineers, while experience is gained. Graduate engineers are encouraged to undertake Professional Development Programs approved by Engineers Australia while developing the practice competencies that will qualify them for Stage 2 assessment and the status of Chartered Professional Engineer.

A Stage 1 Professional Engineer is expected to demonstrate competence across a broad field of engineering practice, or engineering discipline, and to have a good understanding of interfaces with other engineering disciplines. An accredited professional engineering degree program must develop breadth of understanding and outlook, and ability to engage with a wide range of technologies and applications, with sufficient depth in one or more specific areas of practice to develop competence in handling technically advanced and complex problems.

Well-established engineering disciplines include, for example, civil, chemical, computer systems, electrical and electronic, and mechanical engineering. Engineers Australia recognises, as equally valid, programs and competencies that span two or more of the traditional disciplines: for example aerospace, environmental, mechatronics, software, and telecommunications engineering. The term engineering discipline is used in these standards to denote any such broad field of engineering practice.

Stage 1 competency corresponds to completion of a 4-year Bachelor of Engineering degree accredited by Engineers Australia. The *Manual for the Accreditation of Professional Engineering Programs* provides guidance on the topics and subject areas expected to be covered in particular engineering disciplines.

It is not expected that candidates will have demonstrated every detail of the knowledge, competencies and attributes that follow; but they must demonstrate at least the substance of each element. Assessment will be made in a holistic way.

4. PROFESSIONAL ENGINEER STAGE 1: UNITS AND ELEMENTS OF COMPETENCY

Units are numbered PE1, PE2 etc. Elements are numbered PE1.1, PE1.2 etc. Indicators are denoted by a, b, c etc

4.1. PE1 KNOWLEDGE BASE

4.1.1. PE1.1 Knowledge of science and engineering fundamentals

a. Sound knowledge of mathematics to the level required for fluency in the techniques of analysis and synthesis that are relevant to the broad field of engineering, and to potentially related fields

b. Sound basic knowledge of the physical sciences, life sciences, and information sciences underpinning the broad field of engineering and potentially related fields, and appreciation of scientific method

- c. Strong grasp of the areas of engineering science that support the broad field of engineering
- d. Ability to work from first principles in tackling technically challenging problems

4.1.2. PE1.2 In-depth technical competence in at least one engineering discipline

- a. Knowledge of the major technical areas comprising least one engineering discipline, and competence in applying mathematics, science and engineering science to the analysis and solution of representative problems, situations and challenges in those areas
- b. Knowledge of materials and resources relevant to the discipline, and their main properties, and ability to select appropriate materials and techniques for particular objectives
- c. Awareness of current technical and professional practice, critical issues, and the current state of developments in the major technical areas that constitute the discipline
- d. Advanced knowledge in at least one area within the discipline, to a level that engages with current developments in that area; understanding of the relevant techniques and ability to apply them to representative problems and situations to a significant level of technical complexity and challenge
- e. Ability to ensure that all aspects of a project or program are soundly based in theory and fundamental principles and to recognise results, calculations or proposals that may be ill-founded, identify the source and nature of the problem and take corrective action
- f. Understanding of how new developments relate to established theory and practice, and to other disciplines with which they may interact

4.1.3. PE1.3 Techniques and resources

- a. Ability to develop and construct mathematical, physical and conceptual models of situations, systems and devices, ability to utilise such models for purposes of analysis and design, and understanding of their applicability and shortcomings
- b. Ability to characterise materials, devices and systems relevant to the broad field and related fields
- c. Awareness of current tools for analysis, simulation, visualisation, synthesis and design, particularly computer-based tools and packages, and competence in the use of a representative selection of these
- d. Appreciation of the accuracy and limitations of such tools and the assumptions inherent in their use; ability to verify the credibility of results achieved, preferably from first principles, to a reasonable approximation



- e. Proficiency in a substantial range of laboratory procedures in the discipline, and strong grasp of principles and practices of laboratory safety
- f. Ability to design and conduct experiments, devise appropriate measurements, analyse and interpret data and form reliable conclusions
- g. Ability to perceive possible sources of error, eliminate or compensate for them where possible, and quantify their significance to the conclusions drawn
- h. Ability to construct and test representative components or sub-systems in a laboratory setting

4.1.4. PE1.4 General Knowledge

- a. Broad educational background and/or general knowledge necessary to understand the place of engineering in society

4.2. PE2 ENGINEERING ABILITY

4.2.1. PE2.1 Ability to undertake problem identification, formulation, and solution

- a. Ability to identify the nature of a technical problem, make appropriate simplifying assumptions, achieve a solution, and quantify the significance of the assumptions to the reliability of the solution
- b. Ability to investigate a situation or the behaviour of a system and ascertain relevant causes and effects
- c. Ability to address issues and problems that have no obvious solution and require originality in analysis
- d. Ability to identify the contribution that engineering might make to situations requiring multidisciplinary inputs (see also PE2.2 and PE2.3) and to recognise the engineering contribution as one element in the total approach

4.2.2. PE2.2 Understanding of social, cultural, global, and environmental responsibilities and the need to employ principles of sustainable development

- a. Appreciation of the interactions between technical systems and the social, cultural, environmental, economic and political context in which they operate, and the relationships between these factors
- b. Appreciation of the imperatives of safety and of sustainability, and approaches to developing and maintaining safe and sustainable systems
- c. Ability to interact with people in other disciplines and professions to broaden knowledge, achieve multidisciplinary outcomes, and ensure that the engineering contribution is properly integrated into the total project
- d. Appreciation of the nature of risk, both of a technical kind and in relation to clients, users, the community and the environment

4.2.3. PE2.3 Ability to utilise a systems approach to complex problems and to design and operational performance

- a. Ability to engage with ill-defined situations and problems involving uncertainty, imprecise information, and wide-ranging and conflicting technical and non-technical factors
- b. Understanding of the need to plan and quantify performance over the life-cycle of a project or program, integrating technical performance with social, environmental and economic outcomes
- c. Ability to utilise a systems-engineering or equivalent disciplined, holistic approach to incorporate all considerations
- d. Understanding of the process of partitioning a problem, process or system into manageable elements, for purposes of analysis or design; and of re-combining these to form the whole, with the integrity and performance of the overall system as the paramount consideration
- e. Ability to conceptualise and define possible alternative engineering approaches and evaluate their advantages and disadvantages in terms of functionality, cost, sustainability and all other factors
- f. Ability to comprehend, assess and quantify the risks in each case and devise strategies for their management
- g. Ability to select an optimal approach that is deliverable in practice, and justify and defend the selection
- h. Understanding of the importance of employing feedback from the commissioning process, and from operational performance, to effect improvements

4.2.4. PE2.4 Proficiency in engineering design

- a. Proficiency in employing technical knowledge, design methodology, and appropriate tools and resources to design components, systems or processes to meet specified performance criteria
- b. Experience in personally conducting a variety of such designs typical of the engineering discipline
- c. Experience in personally conducting a major design exercise to achieve a substantial engineering outcome to professional standards, demonstrating capacity to:
 - elicit, understand and document the required outcomes of a project and define acceptance criteria
 - consider the impact of all development and implementation factors including constraints and risks
 - write functional specifications, using engineering methods and standards, that meet the user requirements



- seek advice from appropriate sources, including advice on latest applicable technologies
- identify and analyse possible design concepts, and propose and agree optimal solution
- ensure that the chosen solution maximises functionality, safety and sustainability, and identify any possibilities for further improvement
- develop and complete the design or plan using appropriate engineering principles, resources, and processes
- specify the equipment and operating arrangements needed
- ensure integration of all functional elements to form a coherent, self-consistent system; check performance of each element and of the system as a whole
- check the design solution against the engineering and functional specifications
- quantify the engineering tasks required to implement the chosen solution
- devise and document tests to verify performance and take any corrective action necessary

d. Alternatively, experience as a member of a team conducting such a major design exercise, and ability to demonstrate a key contribution to the team effort and the success of the outcome

4.2.5. PE2.5 Ability to conduct an engineering project

a. Experience in personally conducting and managing an engineering project to achieve a substantial outcome to professional standards, or as a member of a team conducting such a project, and ability to demonstrate a key contribution to the team effort and the success of the outcome

A Stage 1 graduate should have undertaken and completed two or more construction projects, at least one investigative project and at least one major design project. At least one substantial project should be conducted individually, and at least one as part of a team. Accredited degree programs should provide and require such project work for all students.

b. Understanding of project management techniques and ability to apply them effectively in practice

c. Have produced at least one major report demonstrating mastery of the subject matter and ability to communicate complex material clearly to both technical and lay readers

4.2.6. PE2.6 Understanding of the business environment

- a. Introductory knowledge of the conduct and management of engineering enterprises and of the structure and capabilities of the engineering workforce
- b. Appreciation of the commercial, financial, and marketing aspects of engineering projects and programs and the requirements for successful innovation
- c. Ability to assess realistically the scope and dimensions of a project or task, as a starting point for estimating costs and scale of effort required
- d. Understanding of the need to incorporate cost considerations throughout the design and execution of a project and to manage within realistic constraints of time and budget
- e. General awareness of business principles and appreciation of their significance

4.3. PE3 PROFESSIONAL ATTRIBUTES**4.3.1. PE3.1 Ability to communicate effectively, with the engineering team and with the community at large**

- a. High level of competence in written and spoken English
- b. Ability to make effective oral and written presentations to technical and non-technical audiences
- c. Capacity to hear and comprehend others' viewpoints as well as convey information
- d. Effectiveness in discussion and negotiation and in presenting arguments clearly and concisely
- e. Ability to represent engineering issues and the engineering profession to the broader community

4.3.2. PE3.2 Ability to manage information and documentation

- a. Ability to locate, catalogue and utilise relevant information, including proficiency in accessing, systematically searching, analysing and evaluating relevant publications
- b. Ability to assess the accuracy, reliability and authenticity of information
- c. Ability to produce clear diagrams and engineering sketches
- d. Fluency in current computer-based word-processing and graphics packages



- e. Ability to maintain a professional journal and records and to produce clear and well-constructed engineering documents such as progress reports, project reports, reports of investigations, proposals, designs, briefs, and technical directions
- f. Awareness of document identification and control procedures

4.3.3. PE3.3 Capacity for creativity and innovation

- a. Readiness to challenge engineering practices from technical and non-technical viewpoints, to identify opportunities for improvement
- b. Ability to apply creative approaches to identify and develop alternative concepts and procedures
- c. Awareness of other fields of engineering and technology with which interfaces may develop, and openness to such interactions
- d. Propensity to seek out, comprehend and apply new information, from wide range of sources
- e. Readiness to engage in wide-ranging exchanges of ideas, and receptiveness to change

4.3.4. PE3.4 Understanding of professional and ethical responsibilities, and commitment to them

- a. Familiarity with Engineers Australia's Code of Ethics, and any other compatible codes of ethics relevant to the engineering discipline and field of practice, and commitment to their tenets
- b. Awareness of legislation and statutory requirements relevant to the discipline and field of practice
- c. Awareness of standards and codes of practice relevant to the discipline and field of practice

4.3.5. PE3.5 Ability to function effectively as an individual and in multidisciplinary and multicultural teams, as a team leader or manager as well as an effective team member

- a. Manage own time and processes effectively, prioritising competing demands to achieve personal and team goals and objectives
- b. Earn trust and confidence of colleagues through competent and timely completion of tasks
- c. Communicate frequently and effectively with other team members
- d. Recognise the value of diversity, develop effective interpersonal and intercultural skills, and build network relationships that value and sustain a team ethic

- e. Mentor others, and accept mentoring from others, in technical and team issues
- f. Demonstrate capacity for initiative and leadership while respecting others' agreed roles

4.3.6. PE3.6 Capacity for lifelong learning and professional development

- a. Recognise limits to own knowledge and seek advice, or undertake research, to supplement it
- b. Take charge of own learning and development; understand the need to critically review and reflect on capability, invite peer review, benchmark against appropriate standards, determine areas for development and undertake appropriate learning programs
- c. Commit to the importance of being part of a professional and intellectual community: learning from its knowledge and standards, and contributing to their maintenance and advancement
- d. Improve non-engineering knowledge and skills to assist in achieving engineering outcomes

4.3.7. PE3.7 Professional Attitudes

- a. Present a professional image in all circumstances, including relations with clients, suppliers and stakeholders as well as professional and technical colleagues
- b. Demonstrate intellectual rigour and readiness to tackle new issues in a responsible way
- c. Demonstrate a sense of the physical and intellectual dimensions of projects and programs, and related information requirements, based on reasoning from first principles and on developing experience