

# Appendix 1: Professional Engineering Capability Framework

Based on Engineers Australia Professional Engineer (Stage 2) Competencies

This document is a guide for novice engineers (graduates and interns), also their supervisors and mentors, to help novices acquire the capabilities needed for unsupervised, independent engineering practice and for chartered engineer status. Engineers intending to apply for chartered status must follow the requirements of the relevant engineering professional organisation in addition.

The document lists performances against each professional engineering competency that a supervisor or mentor could reasonably expect to observe in the first three years. These performances are generic in the sense that similar performances can be expected in any engineering discipline.

Regularly reviewing performances while meeting together face-to-face can help the novice and supervisor assess progress. The novice and supervisor can jointly enter the date(s) when each performance was observed *at an appropriate professional standard* and where the notes and other relevant records of the performance can be accessed. Alternatively, the supervisor or mentor can suggest some of the practice exercises and learning resources where improvement is needed. Completion of each of the practice exercises can also be noted. References to further learning materials are also provided, particularly book chapters in “Learning Engineering Practice” and “The Making of an Expert Engineer”.

Competencies are grouped in four sections: personal commitment, community obligations, generating value, and technical proficiency.

Creating written evidence of these performances such as technical reports, episode accounts, weekly reflections in work diary, and other documents will help novices demonstrate their achievements for recognition as a chartered professional engineer.

The “Year 1” sections list performances that a supervisor could reasonably expect to observe in the novice’s first year of practice. Help may be needed from the supervisor for many of these performances. The “Year 2-3” sections list additional performances for subsequent years, though some may also be observed in the first year.

This guide could also be used by assessors evaluating a candidate for chartered status. The candidate could be asked to describe the work they have achieved with reference to the listed performances in the context of his or her chosen area of practice, with reference to a portfolio of written evidence where appropriate, capturing the complexities that characterise engineering work.

There may be a few performances for which the candidate had no opportunities to demonstrate in his or her work experiences to date. However, it is reasonable to expect that most should be demonstrated by any engineer in the first three or four years of a career.

The document is part of the online appendix for the book *Learning Engineering Practice* by James Trevelyan.

## Performance descriptors

A hierarchy of key words helps to define performances, following the different levels of Bloom’s education taxonomy. Adopting these key words makes it easier to refer to evidence that supervisors can use to evaluate whether a given performance has reached an appropriate professional level.

Level 1: Knowledge from memory: Recognise, Recall

Level 2: Understanding, awareness of concepts relating different knowledge elements: Interpret, Describe (an example of), Classify, Summarise, Infer, Compare, Explain, Document (written description)

Level 3: Procedural knowledge: Apply, Implement, Demonstrate, Perform, Participate

Level 4: Distinguish elements of performances or a body of knowledge and understanding how they contribute to the whole: Identify, Distinguish, Select, Organise, Explain (attribute)

Level 5: Making judgements based on criteria, standards: Check, Critique, Coordinate, Monitor, Test, Inspect, Judge

Level 6: Assemble elements to form coherent or functional whole, reorganise into new arrangement: Hypothesise, Design, Create, Construct, Invent, Choreograph, Write (paper, research), Resolve (design, creative work)

## **Engineering**

Engineering is a human performance. Engineers are people with technical knowledge and foresight who conceive, plan and organise delivery, operation and sustainment of man-made objects and systems. These engineered solutions normally incorporate productivity improvements enabling people to do more with less effort, time, materials, energy, uncertainty, health risk and environmental disturbance.

Most engineers organise their work into projects. They start by conceiving safe solutions for human needs, often helping clients understand their needs and solutions in terms of engineering possibilities.

Working mostly with computers and simulations, engineers predict how well these solutions will operate and the cost to build, operate, sustain and, eventually, remove them. Engineers often predict the commercial benefits of these systems for customers and end-users.

There are always uncertainties: engineers inform clients and investors about risks and consequences. Sufficient trust and confidence need to be built before clients or investors are willing to commit finance, long before any benefits from a project start to arise. All this work leads to a decision by investors to provide enough finance for project execution, the second phase.

In the execution phase, engineers plan and coordinate collaborative efforts of skilled people, guided by shared knowledge, to ensure that technical intentions are implemented faithfully enough to achieve expected technical and commercial performance. Engineers perform much of their work on products or systems that continue to be used long past their intended life, designed using outdated standards and practices.

Engineers often collaborate in large teams, often today with people in different parts of the world with different time zones. They plan, organise and teach people to purchase and deliver components, tools and materials, and then transform, fabricate and assemble them to deliver the intended solution. They work with an agreed schedule and budget, handling countless foreseeable but unpredictable events that affect progress, performance, safety or the environment. Later, they organise sustainment: operations, upgrades, maintenance and repairs.

In the final phase, engineers plan and organise removal, disposal and environmental restoration. Materials are often reused or recycled, components are often refurbished and sold.

The ultimate objective is usually to satisfy client, investor and end-user expectations well enough for investors to come back and commission more projects.

Today there are nearly 300 specialised engineering disciplines, each based on a body of knowledge at least in part derived from more fundamental disciplines such as civil, electrical, electronic, environmental, mechanical, materials, and software engineering. However, most engineers' work performances are remarkably similar and many engineers work in more than one discipline through their career.

## **How this document originated**

This document originated from research on engineering practice, originally at the University of Western Australia, and subsequently at a few other universities. Recently, there has also been growing research interest in the transition from engineering education to practice.

This version of the document is part of the book "Learning Engineering Practice" published by Taylor and Francis, 2020. It has been developed in collaboration with Engineers Australia (EA).

The current EA competencies issued in 2012 incorporated results from this research. They form the framework for the document provided. The competency definitions did not include any learning recommendations, nor any details of the kinds of job performances expected of novice engineers in their early years of practice. It was apparent at the time that better guidance was needed for workplace learning.

In 2019, Engineers Australia suggested a document detailing competencies that novice engineers could be expected to demonstrate in the first, second and third years of practice. Unfortunately, competency definitions require engineering experience for appropriate interpretation.

Therefore, it seemed preferable to describe details of work performances one could expect from engineers in the first three years, aligned with each of the competencies, to help novice engineers and their supervisors monitor workplace learning. This Professional Engineering Capability Framework document lists these performances.

Merely listing workplace performances is not enough in itself. Engineers need a more detailed text explaining the principles of engineering practice and how the necessary skills can be developed.

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| <b>1. Personal commitment: Dealing with ethical issues</b><br>Means that you anticipate the consequences of your intended action or inaction and understand how the consequences are managed collectively by your organisation, project or team; and means you demonstrate an ability to identify ethical issues when they arise and to act appropriately.                                                                                                                                                                                                                               |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Date<br>Notes location ref. |
| a) Describe situations that more experienced people have encountered when ethical issues, dishonesty, or conflicts of interest were apparent to them.                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| b) Describe restrictions on distribution of information and explain the reasons for restrictions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |
| c) Explain consequences for people who do not have access to information or foresight to know what might happen to them.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| d) With help from supervisor, identify stakeholders and their interests, explain how those interests are affected by the consequences of engineering actions. Include, as stakeholders, people who are not easily able to be represented in discussions, including future generations (section 5 lists examples of stakeholders).                                                                                                                                                                                                                                                        |                             |
| <b>Years 2-3, in addition...</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| aa) Describe workplace ethical standards, explain why personal integrity and honesty is important for individuals and the organisation.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                             |
| bb) Describe situations in which information must be shared with other people, and explain how stakeholder interests are advanced by sharing this information.                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |
| cc) Describe situations in which information must not be shared with some other people, and explain how stakeholder interests are advanced by not sharing this information.                                                                                                                                                                                                                                                                                                                                                                                                              |                             |
| dd) Describe actions that can protect interests of stakeholders when dishonesty or conflicts of interest have occurred.                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                             |
| ee) Explain how the benefits of engineering work are shared among stakeholders (see 5aa).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |
| ff) Explain differences in ways that people will perceive fairness in the benefit sharing, and how they develop their perceptions in the context of their personal networks, local culture, social media, news, and other information sources.                                                                                                                                                                                                                                                                                                                                           |                             |
| gg) Demonstrate appropriate behaviour when ethically challenged, such as when pressured to cut corners, not comply with Acts or Regulations etc., or act contrary to the interests of major stakeholders.                                                                                                                                                                                                                                                                                                                                                                                |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                             |
| 1. Understand how value is generated through engineering work (Learning Engineering Practice, Ch 15).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| 2. Practice listening, reading and people skills (Learning Engineering Practice, Chs 4-8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |
| 3. Ask more experienced people about ethical issues that have arisen in your workplace. Keep notes, but protect individuals by using pseudonyms.                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| 4. Discuss work situations and expectations with mentor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| 5. Whenever possible, take advantage of any possible opportunities to meet with stakeholders face to face. Ask them to explain how they see the engineering work affecting their interests. Take notes of these meetings in your work diary.                                                                                                                                                                                                                                                                                                                                             |                             |
| <b>Resources</b><br>These three resources apply for all sections of the document:<br>1) Work diary; 2) Supervisor; 3) Mentor.<br>Ideally a mentor is a senior engineer who is not the immediate supervisor, who will help development professionally and personally. Preferably the mentor should be from the same organisation in a different work area, sourced through a personal professional network.<br><br><b>Specific resources on ethics:</b><br>EA Code of Ethics ( <a href="https://www.engineersaustralia.org.au/ethics">https://www.engineersaustralia.org.au/ethics</a> ); |                             |

Written accounts of others resolving ethical dilemmas – case studies;  
Davis, M. (1998). Thinking Like an Engineer. New York, USA: Oxford University Press;  
Castille, C., & Fultz, A. (2018, January 3-6). *How does collaborative cheating emerge? A case study of the Volkswagen emissions scandal*. Paper presented at the Proceedings of the 51st Hawaii International Conference on System Sciences, Manoa, Hawaii, USA.  
Science and Engineering Ethics Journal, Springer;  
EA presentations on ethics in engineering;  
Ethics webinars;

**Revisions**

0.54: added performance gg) to demonstrate appropriate ethical behaviour under pressure to act unethically.

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| <b>2. Personal commitment: Practice competently</b><br>Means that you assess, acquire and apply the competencies and resources appropriate to the different activities you perform.                                                                                                              |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                    | Date<br>Notes location ref. |
| a) Discuss and understand needs and requirements with client or supervisor, write notes, ask clarifying questions, interpret in terms of engineering possibilities to seek confirmation, write summary, review summary face to face with client or supervisor to confirm.                        |                             |
| b) Write clear and concise agreement, summary or specifications of work requirements and completion criteria, keep track of changes as requirements and completion criteria evolve.                                                                                                              |                             |
| c) Create appropriately detailed work plan, write summary of progress and resource consumption relative to work plans daily, and calculate expenditure relative to budget weekly and monthly,, keep track of changes as requirements and completion criteria evolve.                             |                             |
| d) With help from supervisor, identify and list most resources needed to complete work, including relevant software, design guides, application notes, technical catalogues and data books, reference material, procedures, international, national and company standards (also section 13a, b). |                             |
| e) Obtain written approvals (or verbal approvals with emailed notes for confirmation) for resource usage.                                                                                                                                                                                        |                             |
| f) Perform a variety of technical engineering work in chosen areas of specialisation such as performance prediction, assessment, measurement, inspection, reverse engineering, design. Document this activity daily in work diary. (also section 16)                                             |                             |
| g) Develop ability to monitor and coordinate contributions by other people. Describe episodes, identifying main elements of the planning and organising phase, monitoring phase and completion phase, particularly monitoring methods and frequency.                                             |                             |
| h) Keep supervisor(s) informed about progress relative to plan, verbally each day if needed, with weekly written summary.                                                                                                                                                                        |                             |
| i) Identify aspects where further learning is needed to complete the work and ensure adequate sources of support and know-how are available when needed.                                                                                                                                         |                             |
| j) Maintain documents and records so that work can be transferred to colleague(s) at any time with minimal disruption if assigned to other responsibilities.                                                                                                                                     |                             |
| k) Arrange for documents, software coding or artefacts to be inspected and checked with reference to completion and relevant quality criteria by someone more experienced. Use constructive feedback to make necessary improvements before confirming completion.                                |                             |
| l) Retain, archive documents, software coding or records of artefacts with review comments.                                                                                                                                                                                                      |                             |
| m) With help of supervisor, create and maintain a two-year education or learning plan, including organisational and technical knowledge and skill development.                                                                                                                                   |                             |
| n) With supervisor identify individual performance indicators and expectations, write summary.                                                                                                                                                                                                   |                             |
| o) Evaluate time management capabilities and adopt improved practices if needed.<br><a href="https://jamesptrevelyan.com/2015/08/21/time-management-for-engineers/">https://jamesptrevelyan.com/2015/08/21/time-management-for-engineers/</a>                                                    |                             |
| <b>Years 2-3</b><br>In addition, beyond demonstrating an increasing level of independence in performing all aspects of engineering work in one or more areas of practice:                                                                                                                        |                             |
| aa) Demonstrate ability to anticipate all the resources and approvals needed to complete a technical task, before the work commences, with written documents recording any oversights and omissions.                                                                                             |                             |
| bb) Demonstrate ability to complete most tasks within planned times, with reference to written plans.                                                                                                                                                                                            |                             |
| cc) Demonstrate ability to coordinate contributions by other people within planned times. Describe coordination episodes, identifying most if not all elements of effective technical coordination performances.                                                                                 |                             |
| dd) Identify opportunities to generate value during uncommitted time, and demonstrate ability to generate value. Write proposals for productivity improvements (also section 10ee, ff).                                                                                                          |                             |
| ee) With help from supervisor, practice supervision of novices for selected aspects of their work.                                                                                                                                                                                               |                             |

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| ff) Identify relevant workplace procedures and sources of reference data. Write proposals for modifications to workplace procedures when needed, with explanations. Observe others following procedures to understand how they are used in practice.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| gg) Demonstrate familiarity with all relevant international, national, industry and company standards, and knowledge of underlying principles. Apply standards to expedite reliable engineering outcomes, and document regulatory compliance where needed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| hh) Apply appropriate quality assurance processes for relevant work activities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
| jj) Participate in quality assurance processes for activities performed by other people or organisations, for example by reviewing documents, inspecting engineering work, or performing or supervising testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
| kk) At least monthly, note acquisition of new skills and knowledge in work diary as a result of work activities or workplace learning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 1. Read and perform practice exercises in Learning Engineering Practice. Summarise Ch 12 on technical coordination.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| 2. Ask experienced engineers in organisation for sample or template documents or spreadsheets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| 3. Read and understand relevant international, national and company standards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| 4. Build competence with using relevant software, particularly spreadsheets, database, and word processing software (write list below). Learn to use macro facilities where relevant.<br>i) _____<br>ii) _____<br>iii) _____<br>iv) _____                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 5. Study recently completed projects in area of practice, meet with responsible engineers and understand all the constraints under which the work was performed and reasons for choosing particular solutions over alternatives. Write summary notes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| 6. Reverse engineer and assess performance of competing designs, products, processes, systems to extend technical and commercial appreciation of competition and marketplaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| <b>Resources</b><br>Engineers Australia definitions of areas of engineering practice.<br>Trevelyan, J. P. (2014) The Making of an Expert Engineer, Taylor & Francis (MoEE). Chapter 9 on Technical Coordination<br><br>CV, record of learning and competence (keep updated)<br>Career education plan (keep updated)<br>eCPD record online (keep updated)<br>EEA courses, seminars, webinars (keep records updated)<br>Workplace education opportunities provided by engineering product and service suppliers (keep records updated).<br><br>Plans and documentation from earlier completed projects.<br>Documentation on organisational process and procedures.<br>Index, information on commercial suppliers.<br>Application software.<br>Organisational design guides and standards.<br>Organisational and clients' Quality Assurance systems and processes.<br>Relevant standards, codes of practice |  |
| <b>Revisions</b><br>0.51: add o)added time management in year 1.<br>0.53: 2ff) observation of procedures in actual practice                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |

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| <b>3. Personal Commitment: Responsibility for engineering activities</b><br>Means that<br>i) you display a personal sense of responsibility for your work;<br>ii) you clearly acknowledge your own contributions and the contributions from others<br>iii) identify contributions you may have made as a result of discussions or collaboration with other people                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Date<br>Notes location ref. |
| a) Meet with the client or sponsor of the work, or their representatives, to ensure that agreed completion criteria have been met, and that satisfactory alternative arrangements are in place to complete any outstanding aspects. Provide appropriate documentation recording agreements reached.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             |
| b) Identify personal and organisational liability for consequences of engineering decisions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                             |
| c) Identify relevant intellectual property that contributes to, or results from workplace activities, e.g. copyright in software, reference books, patents, design rights, know-how, trade secrets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                             |
| d) Record personal intellectual property contributions, and contributions by other people.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| e) Read at least one account of a dispute involving engineering liabilities or intellectual property, and identify relevant aspects for current firm or project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                             |
| f) Identify “a chain of evidence” (reliable sources of information on which engineering results are based) and demonstrate how personal contributions rely on a chain of evidence.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                             |
| aa) Demonstrate awareness of recent relevant engineering liability or intellectual property disputes, identify relevant aspects for current firm or project.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                             |
| bb) Identify relevant software, reference works, patents, designs, copyright, construction methods, trade secrets, web sites and domains and other forms of intellectual property used in the course of work activities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                             |
| cc) Demonstrates awareness of creative commons rights and responsibilities, and which aspects of the firm’s intellectual property might be made available by this method and how this advances the interests of the firm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| dd) Search patent databases using international classification schemes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |
| ee) Evaluate the reliability and consistency of different components in the “chain of evidence”, document evaluation of strength of evidence on which conclusions or forecasts are based.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| Research on patents and other forms of intellectual property (IP Australia web site).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| Construct a reference library of relevant technical documentation, web site bookmarks, data sources, standards, technical application notes, and data sheets. Preferably use library cataloguing software (e.g. Endnote) to provide reference citations when required in technical documents.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| Study and practice critical thinking (also section 11).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                             |
| <b>Resources</b><br>US, European and other patent databases; IP Australia web site – explains fundamentals of intellectual property and protection measures.<br>Supplier catalogues, application notes, technical data sheets.<br>Manton, S. (2006). Integrated Intellectual Asset Management: a guide to exploiting and protecting your organisation's intellectual assets. Burlington, Vermont: Gower.<br>Common Law, negligence and liability reports in areas of practice.<br>Warren Centre for Advanced Engineering. (2009). Professional Performance, Innovation and Risk in Australian Engineering Practice (PPIR).<br><a href="https://thewarrencentre.org.au/project/professional-performance-innovation-and-risk/">https://thewarrencentre.org.au/project/professional-performance-innovation-and-risk/</a> |                             |



**Revisions**

0.52: New item 3a on agreeing that work meets completion criteria.

**4. Community Obligations: Develop safe and sustainable solutions**

Means that

- i) you apply and implement current workplace health and safety requirements;
- ii) you identify the economic, social and environmental impacts of engineering activities;
- iii) you anticipate and manage the short and long-term effects of engineering activities.

| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                          | <b>Date<br/>Notes location ref.</b> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|
| a) Demonstrate technical foresight: ability to anticipate future consequences of actions (also sections 12, 14b, 16). Document selected forecasts for future reference.                                                                                                                                                                                                                |                                     |
| b) Read, summarise relevant health, safety and environmental regulations.                                                                                                                                                                                                                                                                                                              |                                     |
| c) Apply workplace health and safety policies and practices, document selected instances in work diary. Examples could include job hazard analysis, health and safety risk assessments.                                                                                                                                                                                                |                                     |
| d) Identify safe practices that are relevant for personal work performance. Read and summarise MSDS for all potentially hazardous chemicals used in the workplace.                                                                                                                                                                                                                     |                                     |
| e) Describe the potential impacts of engineering activities, and operating constraints such as limits on water supply and disposal, greenhouse and other emissions, waste discharge and disposal, etc.                                                                                                                                                                                 |                                     |
| g) Describe the value generated by creating trust in the community and with regulatory authorities, identify examples of trust-building activities.                                                                                                                                                                                                                                    |                                     |
| h) Read, summarise environmental management plan, identify implications for work activities.                                                                                                                                                                                                                                                                                           |                                     |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                         |                                     |
| aa) Identify safe and sustainable practices for work performances by others, identify and describe opportunities for safety and sustainability improvements.                                                                                                                                                                                                                           |                                     |
| bb) Monitor environmental disturbances and identify opportunities to minimise or eliminate them, both within firm and on specific projects.                                                                                                                                                                                                                                            |                                     |
| cc) Assist in preparing reporting documents to verify compliance with health, safety and environmental requirements for regulators and other stakeholders.                                                                                                                                                                                                                             |                                     |
| dd) Identify equipment items and/or practices which do not comply with current health, safety or environmental requirements (though they may have when first implemented). Prepare recommendations on how the non-compliant aspects can be rectified to comply with current requirements, including identifying the risks and consequences of taking only partial or no rectification. |                                     |
| ee) Identify opportunities for energy-efficiency improvements, greenhouse emission reductions, pollution reduction, waste conversion to secondary by-products, material re-use and recycling. Develop business cases to encourage adoption of these measures (also section 10ee, ff).                                                                                                  |                                     |
| ff) Identify commercial or political influences on decisions that affect compliance with health, safety and environmental regulations, or affecting community obligations.                                                                                                                                                                                                             |                                     |
| gg) Describe examples illustrating workplace mental health issues.                                                                                                                                                                                                                                                                                                                     |                                     |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                              |                                     |
| Read, summarise recommended reference documents including detailed accounts of engineering failures and lessons learnt, such as Levy (1993), Petroski (1985, 1994), Bea (2011).                                                                                                                                                                                                        |                                     |
| Discuss safety, health and environmental (SHE) issues with supervisor and mentor. Discuss feasibility of SHE improvements.                                                                                                                                                                                                                                                             |                                     |
| Attend site safety training courses. Learn to distinguish the following concepts hazards, events, likelihood, consequences, risks, controls hierarchy.                                                                                                                                                                                                                                 |                                     |
| Obtain First Aid certificate.                                                                                                                                                                                                                                                                                                                                                          |                                     |

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| Maintain personal mental, emotional and physical fitness through recreation and exercise.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| Notice and document unsafe or unsustainable practices for discussion with supervisor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| Improve knowledge on use of fluctuating renewable energy, energy storage methods, electricity demand management, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| Improve knowledge on waste processing and resource recovery technologies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| Record observations in work diary related to safety, health and environmental issues.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| <b>Resources</b><br>Engineers Australia Code of Ethics ( <a href="https://www.engineersaustralia.org.au/ethics">https://www.engineersaustralia.org.au/ethics</a> )<br>Learning Engineering Practice Ch 13, Ch 18;<br>The Making of an Expert Engineer, Ch 12;<br>Organisation's health and safety policy documents, environmental management plan;<br>Environmental approval documents for project or enterprise;<br>Health and safety, environmental regulations relevant for organisation;<br>Safe Work Australia legislation, model codes of practice / website;<br>Safe Design principles;<br>Online safety seminars;<br>HAZOP Training;<br>EA Sustainability Policy, Guides on Implementing Sustainability in Practice;<br>EA Policy on Climate Change;<br>Papers on triple-bottom-line economics;<br>EA Sustainable Energy Society;<br>Chemical MSDSs;<br>IPCC Reports on Climate Change and need for reducing greenhouse emissions;<br>Levy, M., & Salvadori, M. (1992). <i>Why Buildings Fall Down</i> . New York: W. W. Norton;<br>Petroski, H. (1985). <i>To Engineer is Human: The Role of Failure in Successful Design</i> . New York: St Martin's Press;<br>Petroski, H. (1994). <i>Design Paradigms: Case Histories of Error and Judgment in Engineering</i> Cambridge University Press.<br>Bea, R., & Deep Water Horizon Study Group. (2011). Final Report on the Investigation of the Macondo Well Blowout. Retrieved from <a href="https://ccrm.berkeley.edu/pdfs_papers/bea_pdfs/DHSGFinalReport-March2011-tag.pdf">https://ccrm.berkeley.edu/pdfs_papers/bea_pdfs/DHSGFinalReport-March2011-tag.pdf</a> ;<br>Chernobyl disaster: <a href="https://en.wikipedia.org/wiki/Chernobyl_disaster">https://en.wikipedia.org/wiki/Chernobyl_disaster</a> . |  |
| <b>Revisions</b><br>0.51: references Levy, Petroski, Macondo well blowout and Chernobyl disaster, MoEE Ch12.<br>0.52: include item on identifying non-compliant equipment or practices; new item on awareness of commercial or political influences on compliance with appropriate standards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |

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| <b>5. Community Obligations: Engage with the relevant community and stakeholders</b><br>Means that you identify stakeholders: individuals or groups of people who could be affected by the short, medium and long-term outcomes of engineering activities, or could exert influence over the engineered outcomes, including the local and wider community; and<br>means that you identify stakeholder interests, values, requirements and expectations using the terminology of the stakeholder through consultation and accurate listening; and<br>means that you work ethically to influence perceptions and expectations of stakeholders and negotiate acceptable outcomes in the best overall interest of relevant communities. |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Date<br>Notes location ref. |
| a) With help from supervisor, identify stakeholders and their interests, describe how those interests are affected by the consequences of engineering actions. Include, as stakeholders, people who are not easily able to be represented in discussions, including future generations (also section 1d).                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |
| b) Meet stakeholder representatives and ask them to explain how they see the project and what it means for their future, and identify conflicting interests and possible solutions (record notes, prepare summary).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| c) Write enterprise descriptions in terms that are meaningful for different stakeholders.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                             |

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| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| aa) Describe how the benefits of engineering work are shared among stakeholders (see 1ee, ff above).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| bb) Attend stakeholder meetings with senior colleague: observe meetings and describe how they manage stakeholder relations, influencing their thinking and perceived needs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| Learning Engineering Practice Ch 4, 5, 6, 7, 8 – Perception skills                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| Identify typical internal and external stakeholders: <ul style="list-style-type: none"> <li>o Client, beneficial owner(s), proponent, end user(s)</li> <li>o Community</li> <li>o Regulatory agencies</li> <li>o Employer, firm, shareholders</li> <li>o Team members</li> <li>o Other work groups</li> <li>o Suppliers, contractors</li> <li>o Local government, regional government, national government</li> </ul>                                                                                                                                                                                                                                                                                                                                |  |
| Attend public consultations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
| Learn history of similar projects.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| Practice explaining what your enterprise does and how it manages community interests to your friends: seek their feedback.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| <b>Resources</b><br>Engineers Australia Code of Ethics ( <a href="https://www.engineersaustralia.org.au/ethics">https://www.engineersaustralia.org.au/ethics</a> )<br>Movie “Erin Brockovich”;<br>Historical project reports;<br>Influencing and negotiation skills are introduced in “The Making of an Expert Engineer”, Chs 7, 8, 9, and 12;<br>Professional network – engineers with relevant experience in working with communities;<br>EA technical presentations;<br>Stakeholder engagement training courses;<br>Web resources such as <a href="https://bwms.eu/wp-content/uploads/2017/03/stakeholder-engagement-practitioner-handbook.pdf">https://bwms.eu/wp-content/uploads/2017/03/stakeholder-engagement-practitioner-handbook.pdf</a> . |  |
| <b>Revisions</b><br>0.53: Include code of ethics resource - relevant                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |

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| <b>6. Community Obligations: Identify, assess and manage risks</b><br>Means that you develop and operate within a hazard and risk framework appropriate for engineering activities.<br>Risks refer to the consequences of unpredictable, yet foreseeable events. It is important to reduce the likelihood of events with unfavourable consequences, and reduce their influences on project outcomes.<br>Some events can lead to favourable consequences, and maximizing the beneficial effects can also be helpful. |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Date<br>Notes location ref. |
| a) Identify some unpredictable, yet foreseeable events that significantly influence work group outcomes, or organisation outcomes. Engages with other people who can help with this performance.                                                                                                                                                                                                                                                                                                                    |                             |
| b) Document the anticipated consequences of these events. Use appropriate analysis and prediction tools (e.g. software) to quantify consequences where necessary.                                                                                                                                                                                                                                                                                                                                                   |                             |
| c) Design technical and administrative/management control measures that reduce the likelihood of unfavourable events, or help take advantage of favourable events.                                                                                                                                                                                                                                                                                                                                                  |                             |

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| d) When identified events occur, compare anticipated consequences with actual consequences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| e) Participate in discussions on risks among more experienced engineers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
| aa) Apply risk management standards and organisational risk management practices.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| bb) Collaborate with others in designing and implementing control measures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| cc) Identify all significant hazards and risks in relevant workplaces, and identify an appropriate management framework, such as a risk register, HAZOP, HAZID, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| dd) Identify the risk tolerance of different investors, firm, project owners, and end users. Describe in qualitative terms.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| ee) Describe relevant insurance policies and explain other financial measures to reduce or transfer commercial risks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| Read about risk management.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| Read relevant risk management standards and practice applying the methods they describe.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| Learn to engage a wide range different people to help identify unpredictable, yet foreseeable events with significant consequences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
| Observe the different ways that people interpret the same requirements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| Read "The Making of an Expert Engineer" Ch 7, section on how people interpret written requirements differently. Most risks arise because of interpretation differences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
| <b>Resources</b><br>Engineers Australia Code of Ethics ( <a href="https://www.engineersaustralia.org.au/ethics">https://www.engineersaustralia.org.au/ethics</a> )<br>AS4360 Risk Management;<br>AS/NZS 31000:2018 and application guidelines;<br>Earlier risk registers, risk management plans;<br>Insurance policies, terms and conditions, including where appropriate professional indemnity insurance or product liability insurance;<br>Warren Centre for Advanced Engineering. (2009). <i>Professional Performance, Innovation and Risk in Australian Engineering Practice (PPIR)</i> . Retrieved from Sydney: <a href="https://thewarrencentre.org.au/project/professional-performance-innovation-and-risk/">https://thewarrencentre.org.au/project/professional-performance-innovation-and-risk/</a> ;<br>Waring, A., & Glendon, I. A. (2000). <i>Managing Risk: Critical Issues for Survival and Success in the 21st Century</i> . London: International Thompson Business Press. |  |
| <b>Revisions</b><br>0.53: Include code of ethics resource – relevant<br>0.54: Extended cc) with appropriate management framework                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |

| <b>7. Community Obligations: Meet legal &amp; regulatory requirements</b>                                                                                                               |                             |
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| Means that you should be able to demonstrate an understanding of the laws, regulations, codes and other instruments which you are legally bound to apply, and apply these in your work. |                             |
| <b>Year 1</b>                                                                                                                                                                           | Date<br>Notes location ref. |
| a) List and describe main regulations influencing engineering activities, and principal requirements for compliance.                                                                    |                             |
| b) Describe application of the five most relevant engineering codes and standards. Explain aspects of these codes and standards that impose mandatory requirements.                     |                             |
| c) Apply relevant standards in the performance of assigned tasks (also section 2gg). Document this in work diary entries.                                                               |                             |
| d) Summarise relevant aspects of contract and employment regulations, legal frameworks, explain how these provisions influence engineering activities in the work group or project.     |                             |

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| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| aa) List and describe the hierarchy of relevant Acts, regulations, codes of practice, ministerial orders, industry and engineering standards for areas of practice.                                                                                                                                                                                                                                                                       |  |
| bb) Participate in gaining approvals for management and operating plans and licences, fulfilling due diligence requirements, maintaining adequate monitoring of work in progress, meeting reporting requirements, arranging inspections, reviews, and maintaining required level of documentation and record keeping.                                                                                                                     |  |
| cc) List and summarise relevant contracts that govern current work activities and explain the significant provisions that influence work activities (also section 9cc)                                                                                                                                                                                                                                                                    |  |
| dd) When a relevant standard does not exist, or it is necessary to deviate from standard practice, provide written evidence of appropriate due diligence. Perform design checking, inspection and testing that would satisfy a court of enquiry that all reasonable precautions had been taken to minimise adverse consequences.                                                                                                          |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| Read and summarise relevant engineering standards and practice application of standard methods for design and other engineering activities.                                                                                                                                                                                                                                                                                               |  |
| Read and summarise relevant Acts, Regulations, codes of practice.                                                                                                                                                                                                                                                                                                                                                                         |  |
| Read and summarise employment and work contracts.                                                                                                                                                                                                                                                                                                                                                                                         |  |
| <b>Resources</b><br>Engineers Australia Code of Ethics ( <a href="https://www.engineersaustralia.org.au/ethics">https://www.engineersaustralia.org.au/ethics</a> )<br>Relevant regulations, Codes of Practice and Standards;<br>Government reports on industry;<br>Employment contract, terms and conditions of employment, confidentiality agreement(s);<br>Commercial contracts between firm and clients, between firm and contractors. |  |
| <b>Revisions</b><br>0.53: Include code of ethics resource – relevant; Additional 7dd on due diligence                                                                                                                                                                                                                                                                                                                                     |  |

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| <b>8. Generating Value: Communication</b><br>Means that you can communicate in a variety of different ways to collaborate with other people, including accurate listening, reading and comprehension, based on dialogue when appropriate; and<br>Means that you can speak and write, taking into account the knowledge, expectations, requirements, interests, terminology and language of the intended audience.         |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                             | Date<br>Notes location ref. |
| a) Demonstrate oral and written communication skills, seek feedback on specific performances, record main feedback in work diary, and use feedback to improve performances.                                                                                                                                                                                                                                               |                             |
| b) Demonstrate active listening, writing accurate notes of conversations (e.g. telephone calls), including the significant words and phrases actually used by different people.                                                                                                                                                                                                                                           |                             |
| c) Demonstrate knowledge of appropriate etiquette and local practices for professional communications, for example choosing an appropriate method (e.g. face to face, telephone, text messages, email). When sending emails, demonstrate appropriate choices of appropriate content and attachments, when and to whom to send copies.                                                                                     |                             |
| d) Participate in work group and other meetings, contribute to discussions when appropriate, and build on ideas contributed by others.                                                                                                                                                                                                                                                                                    |                             |
| e) Explain technical concepts for lay people.                                                                                                                                                                                                                                                                                                                                                                             |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| aa) Demonstrate effective collaboration methods including technical coordination, project management and negotiation (also section 2cc).                                                                                                                                                                                                                                                                                  |                             |
| bb) Demonstrate ways to influence perceptions and understandings of others, including persuasive written documents and presentations.                                                                                                                                                                                                                                                                                     |                             |
| cc) Demonstrate effective methods to teach others and methods to learn from more experienced people. Summarise methods in work diary.                                                                                                                                                                                                                                                                                     |                             |
| dd) Demonstrate awareness of need to adopt different behaviour and communication practices in different cultures.                                                                                                                                                                                                                                                                                                         |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| Read and summarise relevant book chapters and complete the practice exercises. Continue to practice and develop accurate listening skills, and skills for reading complex documents.                                                                                                                                                                                                                                      |                             |
| Attend relevant courses to improve communication and documentation skills, seek feedback from wide cross section of people in organisation to improve abilities.                                                                                                                                                                                                                                                          |                             |
| Read contemporary fiction by well-respected writers out loud to yourself, 20-30 minutes daily, to improve your use of English.                                                                                                                                                                                                                                                                                            |                             |
| Practice asking open-ended questions such as "Please tell me more about that..."                                                                                                                                                                                                                                                                                                                                          |                             |
| Participate in work group meetings, ask open-ended questions and practice finding and explaining the strengths of ideas contributed by others.                                                                                                                                                                                                                                                                            |                             |
| <b>Resources</b><br>Learning Engineering Practice Ch 4, 5, 6, 7, 8, 17.<br>The Making of an Expert Engineer, Ch 7, 13;<br>Associations such as Toastmasters;<br>Serving on EA Committees such as Young Engineers Association;<br>Bolton, R. (1986). People Skills. New York: Touchstone Books;<br>Patterson, K., Grenny, J., McMillan, R., & Switzler, A. (2012). Crucial Conversations (2nd ed.). New York: McGraw Hill. |                             |
| <b>Revisions</b><br>0.52: Added section on professional communication etiquette (A. Jyothi suggestion).<br>0.54: Added dd), identifying different cultural practices, chapter references                                                                                                                                                                                                                                  |                             |

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| <b>9. Generating Value: Performance</b><br>Means that you demonstrate an ability to apply appropriate tools or processes to achieve corporate objectives while accounting for personal obligations to the profession.                                                                                                                                                                                                                                                                             |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Date<br>Notes location ref. |
| a) Describe the main corporate objectives in terms of commercial and financial value, social and community objectives and sustainability objectives.                                                                                                                                                                                                                                                                                                                                              |                             |
| b) Describe organisational value creation, delivery and protection practices, such as <ul style="list-style-type: none"> <li>• Efficiency improvements</li> <li>• Reducing technical uncertainties</li> <li>• Improving performance forecasts</li> <li>• Design checks, inspection and testing</li> <li>• Project delivery processes</li> <li>• Project design reviews</li> <li>• Compliance with standards</li> <li>• Maintenance and sustainment</li> <li>• Environmental protection</li> </ul> |                             |
| c) Maintain records of time spent and work completed for accounting purposes, calculate total cost of work including on-costs, overheads and indirect costs.                                                                                                                                                                                                                                                                                                                                      |                             |
| d) Participate in meetings to discuss commercial and other organisational priorities.                                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| e) With help from supervisor review personal performance in context of expectations and criteria, set priorities for improvements where needed (Section 2n).                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| aa) Read, summarise and describe organisational vision, mission, strategy and business plan as it relates to the work group.                                                                                                                                                                                                                                                                                                                                                                      |                             |
| bb) Participate in discussions with prospective clients to help them understand solutions in terms of engineering possibilities.                                                                                                                                                                                                                                                                                                                                                                  |                             |
| cc) Read, summarise relevant contracts that govern current work activities, describe the significant provisions that influence work activities (also see 7cc).                                                                                                                                                                                                                                                                                                                                    |                             |
| dd) Explain duty of care requirements when undertaking a new task, implement effective measures to implement duty of care requirements.                                                                                                                                                                                                                                                                                                                                                           |                             |
| ee) Check, review, inspect, test deliverables (as appropriate) to ensure that they meet agreed requirements or specifications.                                                                                                                                                                                                                                                                                                                                                                    |                             |
| ff) Describe the information requirements for a final investment decision, and other project stage decision gates.                                                                                                                                                                                                                                                                                                                                                                                |                             |
| gg) Create invoices and/or statements of work completed in order to seek payments from clients or project sponsors.                                                                                                                                                                                                                                                                                                                                                                               |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                             |
| Participate in meetings with current and prospective clients.                                                                                                                                                                                                                                                                                                                                                                                                                                     |                             |
| Read and summarise reference material, Kletz (1991) and Reason (2003).                                                                                                                                                                                                                                                                                                                                                                                                                            |                             |
| Observe more experienced staff to learn how they manage client relationships and client expectations.                                                                                                                                                                                                                                                                                                                                                                                             |                             |
| Develop ideas and proposals to improve value creation, delivery or protection.                                                                                                                                                                                                                                                                                                                                                                                                                    |                             |
| Understand how contracts and commercial priorities influence different aspects of work practices.                                                                                                                                                                                                                                                                                                                                                                                                 |                             |
| With help from supervisor or mentor, understand potential conflicts of interest between commercial interests of clients or project owners, the firm, contractors, community stakeholders, one's own personal interests and obligations to the profession.                                                                                                                                                                                                                                         |                             |
| <b>Resources</b><br>Organisation business plans;<br>Employment contract, terms and conditions of employment, confidentiality agreement(s);                                                                                                                                                                                                                                                                                                                                                        |                             |

Commercial contracts between firm and clients, between firm and contractors;  
 Quality Assurance systems and processes, ISO 9000;  
 Kletz, T. (1991). *An Engineer's View of Human Error* (2nd ed.). London: Institution of Chemical Engineers, VCH Publishers.  
 Reason, J., & Hobbs, A. (2003). *Managing Maintenance Error*. Ashgate.

#### Revisions

0.51: Kletz, Reason references  
 0.53: Performance review 9e

### 10. Generating Value: Taking action

Means that you initiate, plan, lead or manage engineering activities.

Note that engineering leadership is mostly informal, and seldom relies on management or organisational authority. Leadership influence stems from respect for your knowledge, reputation, ethical standards, ability to listen to others and explain objectives to be achieved.

| Year 1                                                                                                                                                                                                                                                               | Date<br>Notes location ref. |
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| a) Describe work group priorities, contribute to work group tasks, create and document suggestions (also section 2).                                                                                                                                                 |                             |
| b) Adapt existing specifications, inspection and test plans and other relevant documents; apply inspection, testing, checking and review processes on small projects, document in work diary.                                                                        |                             |
| c) Create persuasive documents and presentations to argue for resource allocations and approvals on basis of value creation, delivery or protection for different stakeholders.                                                                                      |                             |
| d) Research suppliers, services and products, evaluate technical performance and commercial terms with reference to requirement specifications, and prepare procurement recommendations.                                                                             |                             |
| e) Adapt project plans, work breakdown structure, technical specifications, statements of work, inspection and test plans, checking and review processes for small engineering projects, based on enterprise templates or similar documents from completed projects. |                             |
| f) Manage small projects, including gaining approval for resources to be used, managing budgets and schedule, with reference to project planning documents.                                                                                                          |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                       |                             |
| aa) Describe all the steps required to implement engineering solutions in areas of practice.                                                                                                                                                                         |                             |
| bb) Create appropriate project plans, work breakdown structure, technical specifications, statements of work, inspection and test plans, checking and review processes for small and medium engineering projects.                                                    |                             |
| cc) Coordinate engineering activities and contributions by other people, including clients, supervisors or other more senior engineers, while maintaining sufficient control of timescale and budgets.                                                               |                             |
| ee) Create plans and budgets for identified initiatives, develop business case with supporting arguments in terms of value creation. Prepare written applications for financial and other resources.                                                                 |                             |
| ff) Create persuasive documents and presentations to argue for significant resource investment, and to gain approvals on basis of value creation, delivery or protection for different stakeholders.                                                                 |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                            |                             |
| Learn basic accounting, budgeting, cost estimation, cost control techniques.                                                                                                                                                                                         |                             |
| Learn about financial decision making in engineering contexts, including Net Present Value concepts, risk and return for investors, investor risk appetite, project stage gate approval processes, regulatory approval processes.                                    |                             |
| Develop project management abilities, writing effective technical specifications.                                                                                                                                                                                    |                             |
| Attend course on estimating in relevant area of practice.                                                                                                                                                                                                            |                             |



**Resources**

Learning Engineering Practice Ch 12, 14, 15, 16;  
 The Making of an Expert Engineer Ch 10, 11, 12;  
 Project Management Book of Knowledge (Project Management Institute);  
 Project management courses, qualifications;  
 Project planning and tracking tools;  
 Project management and control software;  
 Australian Cost Engineering Society;  
 Asset management tools.

**Revisions**

0.51: Chapters to read

**11. Generating Value: Judgement**

Means that you exercise sound judgement in engineering activities.

Judgement is needed when there are gaps or weaknesses in the chain of evidence that require assumptions to be made (also section 3).

Gaps or weaknesses arise because there is insufficient knowledge, time or resources to obtain reliable data for the chain of evidence.

| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                   | Date<br>Notes location ref. |
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| a) Demonstrate effective critical thinking (also section 3e).                                                                                                                                                                                                                                                                                                                                   |                             |
| b) Identify explicitly stated and implicit assumptions in technical reports or articles. Evaluate whether these assumptions are appropriate in particular circumstances.                                                                                                                                                                                                                        |                             |
| c) Identify weaknesses in “chain of evidence”, including assumptions. Estimate the time and cost to provide information needed to strengthen chain of evidence sufficiently.                                                                                                                                                                                                                    |                             |
| d) Identify when assumptions or rules of thumb can be applied instead of rigorous analysis, evaluate likely uncertainties introduced by doing so.                                                                                                                                                                                                                                               |                             |
| e) Describe appropriate assumptions and the consequences of making invalid assumptions.                                                                                                                                                                                                                                                                                                         |                             |
| f) Describe where judgement and assumptions have been used in documents to bridge knowledge and information gaps.                                                                                                                                                                                                                                                                               |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                  |                             |
| aa) Participate in engineering decision making, explain where the gaps or conflicting options were and how professional judgement has been applied in selected instances.                                                                                                                                                                                                                       |                             |
| bb) Evaluate time and cost constraints for providing information needed to strengthen chain of evidence sufficiently, decide whether uncertainties from making assumptions based on engineering judgement provide better value for stakeholders.                                                                                                                                                |                             |
| cc) Identify appropriate assumptions in most instances.                                                                                                                                                                                                                                                                                                                                         |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                       |                             |
| Study and practice critical thinking.                                                                                                                                                                                                                                                                                                                                                           |                             |
| Obtain technical reports from senior colleagues (or conference papers and journal articles) and learn to identify explicitly stated and implicit assumptions. Discuss findings with supervisor or mentor.                                                                                                                                                                                       |                             |
| When you see more experienced engineers or others making assumptions, ask them to explain their assumptions and how they learned to use them.                                                                                                                                                                                                                                                   |                             |
| <b>Resources</b><br>Facione, P. A. (2015). Critical Thinking: What It Is and Why It Counts. Retrieved from <a href="http://www.insightassessment.com/Resources/Critical-Thinking-What-It-Is-and-Why-It-Counts">http://www.insightassessment.com/Resources/Critical-Thinking-What-It-Is-and-Why-It-Counts</a><br>Technical reports;<br>Conference and journal papers;<br>Experienced colleagues. |                             |

**Revisions**

0.54: aa) and bb) clarified

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| <b>12. Technical Proficiency: Advanced engineering knowledge</b><br>Means that you comprehend and apply advanced theory-based understanding of engineering fundamentals to predict the consequences of engineering actions and activities.<br>You are expected to have advanced your engineering knowledge since graduating and be up to date with current practices in your area of practice. |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                  | Date<br>Notes location ref. |
| a) Identify and document opportunities to use advanced engineering knowledge with the help of discussions with mentor or supervisor.                                                                                                                                                                                                                                                           |                             |
| b) Contribute to research by writing papers, presenting at conferences, or helping to disseminate research results, while respecting confidentiality requirements.                                                                                                                                                                                                                             |                             |
| c) Apply advanced technical or commercial knowledge, analysis and prediction methods beyond current practice in the discipline as opportunities arise.                                                                                                                                                                                                                                         |                             |
| d) Apply embodied knowledge through conceptual understanding of analytical tools (e.g. software) to practice needs.                                                                                                                                                                                                                                                                            |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                 |                             |
| aa) Maintain in-depth understanding of specialist bodies of knowledge within engineering discipline, preparing technical reports, presentations or providing formal and informal explanations for colleagues.                                                                                                                                                                                  |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                      |                             |
| Keep in contact with alumni.                                                                                                                                                                                                                                                                                                                                                                   |                             |
| Maintain contact with university researchers to help keep up to date with recent developments.                                                                                                                                                                                                                                                                                                 |                             |
| Read relevant industry news publications, blogs.                                                                                                                                                                                                                                                                                                                                               |                             |
| Use specialised knowledge to predict performance whenever opportunities arise.                                                                                                                                                                                                                                                                                                                 |                             |
| Calibrate predictions on the basis of feedback from implementation.                                                                                                                                                                                                                                                                                                                            |                             |
| Attend relevant conferences, technical seminars, volunteer to provide technical presentations or papers.                                                                                                                                                                                                                                                                                       |                             |
| Postgraduate studies (part-time, distance, or full-time).                                                                                                                                                                                                                                                                                                                                      |                             |
| <b>Resources</b><br>Relevant technical conferences;<br>Industry news sites;<br>Relevant blogs;<br>Research journals;<br>Advanced computational and modelling tools.                                                                                                                                                                                                                            |                             |
| <b>Revisions</b>                                                                                                                                                                                                                                                                                                                                                                               |                             |

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| <b>13. Technical Proficiency: Local engineering knowledge</b><br>Means that you acquire and apply local engineering knowledge and, where appropriate, you apply engineering knowledge contributed by other people including suppliers, consultants, contractors and independent experts.                                                                                                   |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                              | Date<br>Notes location ref. |
| a) Operate information systems to access data, specifications, project plans, CAD documents, codebase, and software defining product, process or system, including associated tooling, fixtures, all other relevant software, documentation and data. Can access configuration documents and systems that define current and historical status of product, process or system and variants. |                             |

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| b) Operate information systems for correspondence (email, messaging transcripts), document storage and archiving, human resource management, payroll, purchasing authorisation and expense claims.                                                                                                                                                                                                                               |  |
| c) Construct a personal database with systematically collected information on people familiar with local practices, materials, standards, suppliers, service providers.                                                                                                                                                                                                                                                          |  |
| d) Engage with engineers in other disciplines, service providers, suppliers, contractors and experts to develop relationships in order to access local engineering knowledge. Demonstrate awareness of commercial and other interests influencing information provided.                                                                                                                                                          |  |
| e) Demonstrate technical coordination abilities: gaining willing and conscientious collaboration from people with relevant knowledge, skills, experience and resources to perform a task (also sections 2e, 2cc).                                                                                                                                                                                                                |  |
| f) Attend training courses provide by specialist engineering product, service, component and system suppliers (and maintain appropriate records).                                                                                                                                                                                                                                                                                |  |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| aa) Apply technical coordination to gain willing and conscientious collaboration of people with relevant knowledge and skills, document selected episodes in work diary, including selection of appropriate monitoring methods and frequency.                                                                                                                                                                                    |  |
| bb) Describe instances when new local or technical knowledge was gained by working with others.                                                                                                                                                                                                                                                                                                                                  |  |
| cc) Obtain relevant local knowledge when needed through social networks and relationships with contacts accumulated through experience, identify engineering constraints or opportunities associated with local capabilities or conditions.                                                                                                                                                                                      |  |
| dd) Operate information and management systems used to coordinate project, operations and maintenance activities, work group activities, enterprise resource planning, and financial reporting.                                                                                                                                                                                                                                  |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Attend local events to develop engineering social network such as trade shows, product launches, Engineers Australia events.                                                                                                                                                                                                                                                                                                     |  |
| Participate in social activities with engineers and others to help build trusting relationships.                                                                                                                                                                                                                                                                                                                                 |  |
| Create and maintain maps of social networks that can help provide access to local engineering, information system and procedural knowledge for each product or system relevant to ongoing engineering activities, and for the enterprise's organisational and management systems.                                                                                                                                                |  |
| <b>Resources</b><br>Work diary, private database to store information on local practices, materials, standards, suppliers, service providers;<br>Company internal databases, Wikis;<br>People in firms who have relevant contacts, are aware of specialist suppliers;<br>Trade product catalogues;<br>Australian Standards;<br>Company standards and industry codes of practice;<br>Professional networks;<br>Senior colleagues. |  |
| <b>Revisions</b><br>0.53: Codebase added 13a, courses by specialist suppliers 13f.<br>0.54: extend cc) to include consideration of constraints and opportunities                                                                                                                                                                                                                                                                 |  |

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| <b>14. Technical Proficiency: Problem analysis</b><br>Means that you define, investigate and analyse engineering problems and opportunities.<br>Problems also become apparent when predicted or actual performance is less than expectations, unexpected events delay progress or costs exceed expectations, or when client or end-user needs cannot be met by applying well-known solutions and methods. |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                                                             | Date<br>Notes location ref. |

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| a) Identify major issues in terms of value generation (creation, delivery, protection), engage in discussions to help identify problems, suggest further studies to understand the problems, with details recorded in work diary.                                                     |  |
| b) Apply appropriate systematic methods to forecast consequences in the absence of solutions.                                                                                                                                                                                         |  |
| c) Ask mentor, supervisor and others with experience to suggest people with experience of similar problems in the past. Seek out these people and describe their experiences, or engage them in further discussions to help understand problems, with details recorded in work diary. |  |
| d) Research similar engineering situations to learn how similar problems have been solved before, evaluate strengths and weaknesses with the benefit of hindsight.                                                                                                                    |  |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                        |  |
| aa) Participate in stakeholder negotiations (for example, involving other disciplines, client, suppliers, etc.) on problems to identify different interests and relevant values.                                                                                                      |  |
| bb) Through personal network, seek people with experience of similar problems, describe their suggestions, or engage them in further discussions to help identify root causes of problems with details recorded in work diary.                                                        |  |
| cc) If possible, arrange to meet at least one customer, end user or maintainer every few months and ask them about opportunities to improve the products or services provided by the firm. Listen, summarise and document explanations.                                               |  |
| dd) Write reflection on whether a problem could be avoided entirely by thinking differently, or lessened by seeking a concession in requirements from client or end users, with episode details recorded in work diary.                                                               |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                             |  |
| Develop and extend personal network by attending appropriate events such as seminars, conferences, exhibitions, etc.                                                                                                                                                                  |  |
| Practice analysis methods that enable fast and accurate predictions to forecast consequences or different solutions. (Also see section 12 above)                                                                                                                                      |  |
| <b>Resources</b><br>Technical reports describing similar problems and their solutions;<br>Digital modelling and analytical tools;<br>Suppliers of technical products, processes, analysis service providers, laboratories.                                                            |  |
| <b>Revisions</b><br>0.52: Added item on implementing appropriate solutions.<br>0.53: 14d added use of engineering science knowledge<br>0.54: Moved consideration of solutions to 15.                                                                                                  |  |

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| <b>15. Technical Proficiency: Creativity and innovation</b><br>Means that you develop creative and innovative solutions<br>Engineers use several systematic methods for creating innovative solutions, and anticipate that several iterations are usually needed, each improving on the last one. Creating new solutions requires analysis and investigations. |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                  | Date<br>Notes location ref. |
| a) In the context of any work-related activity, describe at least one other solution for achieving similar or better value generation. List any relevant advantages and disadvantages in terms of both technical and economic performance.                                                                                                                     |                             |
| b) At least monthly, observe and describe in work diary how engineering solutions in the form of products, processes, systems or procedures, avoided problems that would otherwise add costs, waste, delays, uncertainty, health risks, or environmental disturbances.                                                                                         |                             |
| c) Evaluate the effectiveness of solutions to similar problems used in the past.                                                                                                                                                                                                                                                                               |                             |
| d) Practice use of systematic methods to create multiple solutions, and use systematic analysis methods to evaluate the relative strengths of different solutions.                                                                                                                                                                                             |                             |
| e) If possible, implement chosen solution, or create proposal to implement one or more appropriate solutions in order to gain necessary resources.                                                                                                                                                                                                             |                             |
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| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| aa) In the context of any work-related activity, generate ideas for improved value creation, delivery or protection, record details in work diary or other documents.                                                                                                                                                                                                                                                                           |  |
| bb) Ask the people responsible for marketing and/or selling the results of the work performed, or seeking new work for the firm, to explain the needs of the clients or customers they work with. Listen, summarise and document explanations.                                                                                                                                                                                                  |  |
| cc) Document at least one proposal every four months for a new or improved product, process, or system that would better meet the needs of end users, and improve value generation by the firm.                                                                                                                                                                                                                                                 |  |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Observe previous engineering solutions and evaluate their strengths and weaknesses.                                                                                                                                                                                                                                                                                                                                                             |  |
| Whenever possible, discuss these solutions with people familiar with their details and ask them for their evaluation of their strengths and weaknesses.                                                                                                                                                                                                                                                                                         |  |
| Practice systematic idea generation methods such as TRIZ to improve ability to create new ideas when required.                                                                                                                                                                                                                                                                                                                                  |  |
| Record ideas that occur to you in your work diary, whether relevant or not to your current work activities. Often the best ideas arise in the course of completely unrelated activities: practice writing them down as soon as possible.                                                                                                                                                                                                        |  |
| <b>Resources</b><br>Learning Engineering Practice, Ch 15;<br>Griffin, A., Price, R. L., & Vojak, B. A. (2012). Serial innovators how individuals create and deliver breakthrough innovations in mature firms: Stanford Business Books;<br>Gadd, K. & Goddard, C. (2011) TRIZ for Engineers: Enabling Inventive Problem Solving, Wiley, ISBN 978 04706 84337;<br>Innovation seminars by government or other agencies;<br>Inventors associations. |  |
| <b>Revisions</b><br>0.51: TRIZ reference<br>0.54: Solution performances moved from section 14.                                                                                                                                                                                                                                                                                                                                                  |  |

| <b>16. Technical Proficiency: Evaluation</b>                                                                                                                                                                                                                                                                                                                     |                             |
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| Means that you evaluate the outcomes and impacts of engineering activities.                                                                                                                                                                                                                                                                                      |                             |
| <b>Year 1</b>                                                                                                                                                                                                                                                                                                                                                    | Date<br>Notes location ref. |
| a) Analyse data relating to the performance of a product, process or system, and compare results with predicted or specified performance. Measurements or simulation data can be used, depending on context and requirements.                                                                                                                                    |                             |
| b) Estimate the likelihood and extent that this performance difference will be perceptible by an end user, operator, owner or other stakeholder(s) of the product, process or system, in technical or economic terms and perceived value. Estimate the likelihood and extent that this performance difference will influence environmental disturbances, if any. |                             |
| c) Particularly if the analysis is performed with software packages, use at least one independent method such as a spreadsheet calculation or an experiment with scale model to confirm the analysis results.                                                                                                                                                    |                             |
| <b>Years 2-3, in addition:</b>                                                                                                                                                                                                                                                                                                                                   |                             |
| aa) Plan, implement data collection for performance analysis, including acquisition and installation of measurement instrumentation, plant or software modifications (if any), data transmission and storage.                                                                                                                                                    |                             |
| bb) Prepare documentation detailing the procedure(s) required for data collection, including all the costs and expenses involved.                                                                                                                                                                                                                                |                             |
| cc) Ensure that the documentation is sufficient for another person to repeat the analysis at a later date. Arrange for the documentation to be reviewed by one or more people with relevant experience, and incorporates suggested changes and improvements.                                                                                                     |                             |
| <b>Practice exercises</b>                                                                                                                                                                                                                                                                                                                                        |                             |

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| Document details of the activities required for perform data collection and performance analysis and estimate the cost, including the additional cost of obtaining the data required for the performance analysis.                                                                                                          |  |
| The documentation should clearly indicate any limitations in the analysis such as the statistical significance of the results, limitations in the data available, assumptions made in analysing the data, etc. The documentation should include information on the cost of the analysis activity required.                  |  |
| <b>Resources</b><br>Earlier technical reports describing performance inspections, testing, data collection and analysis;<br>Web sites, design application notes, technical catalogues by instrumentation suppliers;<br>Training courses and seminars on relevant inspection, measurement and analysis techniques, software. |  |
| <b>Revisions</b>                                                                                                                                                                                                                                                                                                            |  |

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