THIS GUIDE IS TO BE READ IN CONJUNCTION WITH QUICK GUIDE TO HAZARD IDENTIFICATION

Pedagogical advantages

As engineers, students will have the responsibility to create designs that are safe, so far as is reasonably practicable (SFAIRP), for all end-users. Whether or not they realise it, engineers and designers hold people's lives in their hands, as well as the health and safety of the environment and the built environments around us. It is important that students understand:

- Nothing is entirely "safe"; any design has hazards associated with it, and the state of safety can only be measured in terms of theoretical or measured probability that harm can arise from a hazard
- Hence, the phrase used in legislation: "safe so far as (is) reasonably practicable" (abbreviated SFAIRP or SFARP), and
- If a hazard is to be tolerated, risks are to be reduced in accordance with the principle of ALARP: 'as low as reasonably practicable'.

SFAIRP is a phrase used in law, and places emphasis on the last two words - Reasonably Practicable - demanding designers do all that is reasonably practicable to ensure health and safety.

The key to ensuring a design is safe SFAIRP is to be able to identify hazards. If hazards are not identified, nothing can be done about them. Once hazards are identified, there is a propensity for engineers and designers to mitigate them – to make their designs safe SFAIRP, and not be 'caught-out' with a design that causes harm. Hence the focus on hazard identification.

The practice of hazard identification during the design requires students to consider the lifecycle of the design and all persons who will interact with the design throughout its life. They must consider how their actions as decision-makers about engineering and design can impact the safety of those individuals for the life of the design. There are many tools and techniques to identify hazards, and engineers should be aware of them.

Hazard identification is a skill. Because it is a skill, it can be: learned, practised, improved and mastered. Engineers and designers need to know this. Hazard identification should also be a consultative process, performed as a group and involving the end-users of the design, who, with their knowledge and experience of the application, are likely to identify hazards and contribute significantly to the options for, and the choice of, effective control measures.

Once hazards are identified, engineers and designers should know the hierarchy of controls and how to apply it, focussing on the upper-levels that change a design to be safer, as opposed to the lower-levels which tolerate living with un-mitigated or poorly-mitigated hazards.

Contemporary industry is concerned with risk. Risks and hazards are fundamentally different from each other, and engineers need to understand the difference in order successfully to identify hazards and do something about them by design, as opposed to a mindset of risk tolerance.

Assessment

For a given project, students can undertake a hazard identification and analysis exercise, either collectively or individually. It is preferable though that hazard identification be assessed as a group exercise. This mimics professional practice. Hazard identification is often performed as part of the design review process. In professional practice such reviews are undertaken by a group of designers, subject matter experts and end-users (constructors, operators, maintainers) who have hands-on experience with similar designs.

Use an example format provided or research and find a format that meets requirements.

Implementation

The hazard identification and analysis exercise may be performed on a specified design or on a student project. The design should be sufficiently complex to involve interactions with multiple persons throughout its lifecycle.

To plan the exercise the design should be divided into its basic sub-systems and lifecycle phases. This may be done by the students or their supervisor depending on complexity of the exercise and student ability.

During the exercise, students should consider each combination of sub-system and lifecycle phase to identify the hazards inherent to the activities and operations performed on that sub-system during that phase.

For each identified hazard, students should brainstorm practical measures to eliminate or mitigate the hazard according to the hierarchy of controls. Educators should guide students in 'reasonably-practicable' decision making to evaluate which controls should or should not be implemented.

At the end of the exercise, students should reflect on the design changes devised during the exercise and how they have effectively improved the safety for end-users for the life of the design.

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Indicative assessment

For a given project, students identify the hazards associated with the design. Consideration should be given to the hazards related to each life cycle phase of the project, the design, the build and test processes, the end users, the design and development team, the environment and the purpose and specifications of the design.

Hazards should be identified as an integral part of the design phase and reviewed throughout the build and test phases. Ongoing monitoring may identify new hazards or suggest different responses to reduce, mitigate or eliminate the hazard. These changes should be included in the hazard identification and control documentation.

As well as identifying what the hazards are, an assessment of the likelihood and impact must be made, decisions made about how best to control the hazard, and responsibilities allocated for monitoring and control. The hierarchy of control should be used to inform the control decisions.

All relevant stakeholders must be informed of the hazards identified and decisions taken to control hazards

Sample instructions

Once initial concepts have been developed, perform a design review to identify and analyse the foreseeable hazards associated with the design.

In preparation for the design review, consider:
- The sub-systems to be developed and integrated
- The lifecycle phases of the project
- All the persons who will interact with the design through its life
- How the design will interact with and impact the environment

As a group, systematically review the design for all sub-systems and lifecycle phases, plus their interfaces to identify hazards. For each hazard:
- Describe the hazard, noting the sub-systems and lifecycle phases to which it applies.
- Apply the hierarchy of controls to mitigate the hazard and record the identified control measures, noting where each control sits within the hierarchy of controls.
- Select the control measures that are reasonably practicable to implement
- Allocate responsibility to follow through on control measure implementation.

Submit with other project documents in line with designated timelines.

Indicative Rubric

	Not Satisfactory	*Satisfactory*	*Very Good - meets Satisfactory criteria plus…*
Hazard Identification	☐ Student does not participate	☐ Student actively participates in hazard identification exercise ☐ Student contributes to suggestion of hazard controls	☐ Student leads the group systematically through the design ☐ Student focusses on higher-level control measures implementable through design
Hazard Register	☐ No hazard register provided or incomplete ☐ Hazard register contains no hazards	☐ Hazard register provided Hazard register includes the following details: ☐ Description of hazards ☐ Control measures identified ☐ Residual hazards ☐ Responsibilities allocated	☐ Evidence of systematic review of design ☐ Control measures focus on design interventions ☐ Evidence of reasonably-practicable decision making

Frequently asked questions

1. ***What is the difference between a hazard and a risk?***

A hazard is a situation or thing that has the potential to harm a person, asset or the environment. Hazards objectively exist. Risk is the possibility of harm that might occur when exposed to a hazard, often expressed as a combination of consequence and likelihood of occurrence.

2. ***As a designer of something that will last for 50-100 years, how can I ensure the safety SFAIRP of people will dispose of it so-long into the future when I have no idea how they will dispose of it?***

It is the designer's duty to do what is reasonably practicable. This could include considering:

- the health and environmental impact of materials,
- the hazards associated with decommissioning'
- the potential methods for disassembly'
- the potential means of disposal.

If the designer does not know, it may be reasonably practicable to consult others to find out, or to document the reasonable steps taken even if nothing is found.

3. ***What is "systematic coverage?"***

For their designed equipment, layout, component, system, equipment, plant, software (etc), engineers are required to identify hazards for:

- All lifecycle phases
- All disciplines
- All systems, sub-systems, plant types, equipment, software, tools, test equipment
- All workplaces (for all work, from prototyping to disposal)
- All human-to-asset interfaces (activities and tasks)
- All environmental interfaces
- All asset interfaces (internal to an asset or system, or external interfaces with interfacing assets and systems)
- All foreseeable use
- All foreseeable misuse

Further Reading & References

Guide for safe design of plant. (2014). Safe Work Australia. Retrieved from https://www.safeworkaustralia.gov.au/doc/guide-safe-design-plant

How to determine what is reasonably practicable to meet a health and safety duty. (2013). Safe Work Australia Retrieved from https://www.safeworkaustralia.gov.au/doc/how-determine-what-reasonably-practicable-meet-health-and-safety-duty

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Safe design for engineering students: An educational resource for undergraduate engineering students. (2006). Australian Safety and Compensation Council Retrieved from https://www.safeworkaustralia.gov.au/system/files/documents/1702/safedesignforengineeringstudents_introduction_2006_pdf.pdf